



CORROSION DEPARTMENT INCL. FRENCH CORROSION INSTITUTE

# Research in Progress 2026

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# Content

<b>INTRODUCTION</b>	<b>4</b>
<b>MRC LIST</b>	<b>5</b>
<b>TRANSPORT</b>	<b>10</b>
Aerospace	10
Automotive	14
<b>SURFACE PROTECTION</b>	<b>26</b>
Automotive	26
Coil coating	28
Medical implants	29
<b>BUILDING AND INFRASTRUCTURE</b>	<b>31</b>
Coatings	31
Coil coating	32
Corrosion in concrete	41
Corrosion in soil	42
Construction	46
Cultural Heritage	49
Paint	50
Water distribution	51
<b>MARINE MATERIALS</b>	<b>58</b>
Cathodic protection	58
Coatings	59
Monitoring and sensors	61
Offshore	63
Stainless steel	71
<b>ENERGY</b>	<b>72</b>
Biorefinery and biomass	72
Cathodic protection in soils	73
CCUS	76
Fuel cells and electrolysers	80
Hydrogen	85
Nuclear	95
Nuclear waste disposal	96
Oil & Gas	99
Wind energy	101
<b>PROCESS INDUSTRY</b>	<b>103</b>
Biorefinery and biomass	103
Chemistry	106
<b>LIST OF PUBLICATIONS</b>	<b>108</b>

# Introduction

## Driving the Future of Corrosion Solutions

For more than 60 years, we've been at the forefront of corrosion science – turning advanced expertise into real-world value for our partners. With over 100 specialists dedicated to corrosion and corrosion protection, we help industries worldwide make confident, sustainable decisions about their materials.

From our state-of-the-art laboratories in Kista and Borås in Sweden, and across our French facilities in Brest, St Etienne, and Lyon, we deliver world-class testing and research. Our extensive network of test sites – ranging from atmospheric exposure fields in Bohus Malmön, Brest, and Gällivare to seawater facilities in Brest and Kristineberg, soil exposure sites across France and Sweden, and even mobile truck-based testing—ensures that our results reflect the conditions materials face every day.

More than 150 companies are part of our Member Research Consortia (MRC), joining forces to solve shared challenges and accelerate innovation. Within our 14 MRCs, competitors become collaborators – pooling resources, cutting R&D costs, and gaining access to the latest insights and breakthroughs. Membership means broader networks, greater influence, and early access to cutting-edge knowledge. All our MRCs welcome new members ready to shape the future of corrosion protection.

This Research in Progress publication highlights the exciting work underway across our organization. Inside, you'll find:

- A snapshot of ongoing research programs driven by industry needs
- Projects funded through collaborative industrial efforts, European initiatives, and regional and national agencies
- An overview of our MRCs and their member companies.
- A summary of our 2025 publications and achievements

Whether you're looking for solutions, inspiration, or new collaboration opportunities, this brochure offers a window into the innovation happening right now.

We hope this Research in Progress edition sparks new ideas and opportunities. If a project catches your attention, our project leaders would be delighted to tell you more. Your next breakthrough might be just a conversation away.

Yours Sincerely,

**Andrew Gordon,**  
Department Manager,  
Corrosion department

Our membership companies are governed by two different non-profit Associations, one established in Sweden (IKI) and the other in France (ARCOR).

For more information on the membership associations, please contact:

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Being member of our associations implies joining one of the following Member Research Consortia (MRC).

## MRC AUTOMOTIVE CORROSION

Aluminium Duffel BV	Nemak Linz GmbH
Aperam	Nippon Steel Corporation
ArcelorMittal	Nissan Motor Corporation
Ascott Analytical Equipment Limited	NOF Metal Coatings
Auson	Novelis Switzerland SA.
Baoshan Iron & Steel CO., Ltd	Porsche AG
Chemetall GmbH	POSCO
Constellium	PPG
ControlArt AB	Provexa
Daimler Truck AG	Q-LAB
Dörken Coatings GmbH & Co. KG	Renault
Ford Motor Company	Robert Bosch -GmbH
General Motors LLC	Salzgitter Mannesmann Forschung GmbH
Gestamp HardTech AB	SSAB EMEA AB
Gränges Sweden AB	Stellantis
Honda Motor Co., Ltd.	Toyota Motor Europe NV/SA
Hydro Extruded Solutions	TRATON AB
Hyundai Motor Company	UACJ Corporation
Hyundai Steel	Valeo Thermal Systems
Jaguar Land Rover	voestalpine
JFE Steel Corporation	Volvo Car Corporation
Mercedes-Benz AG	Volvo Technology AB
Metalsa S.A.P.I. de C.V.	
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## MRC AEROSPACE INDUSTRY

Airbus	Henkel Technologies
Airbus Helicopters	Liebherr
Airbus Defense and Space	PPG Industries Ltd
AkzoNobel Car Refinishes	Safran
Boeing Company	SOCOMORE
Constellium	SAAB
DGA	
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## MRC SURFACE TECHNOLOGY

ArcelorMittal Global R&D (AC&CS)	ProCoat Tecnologias S.L.U.
BASF Coatings GmbH	TopAnalytica
Becker Industrial Coatings Ltd.	TRATON AB
Hydro Extruded Solutions	voestalpine Stahl GmbH
SSAB EMEA AB	Volvo Car Corporation
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## MRC COIL COATED STEEL MATERIALS

AkzoNobel Hilden GmbH	SNCZ
ArcelorMittal Global R&D (AC&CS)	SSAB EMEA AB
Becker Industrial Coatings Ltd.	TataSteel NL
Bluescope Steel	TataSteel UK
Chemetall GmbH	Ternium Siderar
Henkel Technologies	The Sherwin Williams Company
Hyundai Steel	VM Building Solutions
PPG France Business	voestalpine Stahl GmbH
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## MRC CORROSION AND CATHODIC PROTECTION IN SOILS

ArcelorMittal R&D Gent (OCAS)	Nippon Steel
ArcelorMittal R&D Esch/Alzette	Nordion Energi AB
BAC Corrosion Control	Storengy
BS Coatings	Tata Steel NL
EDF	Terega
GRTgaz	TotalEnergies One Tech
JFE Steel Corporation	
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## MRC CORROSION PROPERTIES OF POLYMER

ALTA Performance Materials (f.d INEOS Comp.)	Kemira Kemi AB
Amiblu Technology AS	Lubrizon Advanced Materials BV
AOC (Aliancys) Nederland B.V.	Nordpipe Composite Engineering Oy
Georg Fischer DEKA GmbH	Plasticon Germany GMBH
Glencore Nikkelverk AS	SABIC Innovative Plastics B.V.
Götaverken Miljö AB	SIMONA AG
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## MRC BRASS ALLOYS

ESBE AB	ISIFLO A/S
FM Mattson Mora Group AB	LK Systems AB
IMI Hydronic Engineering AB	Nordic Brass Gusum AB
ISIFLO AB	
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## MRC CORROSION IN PULP AND PAPER INDUSTRY

Billerud Skog & Industri AB, Gävle	Stora Enso AB/ Skoghall Mill
Billerud Sweden AB, Skärblacka Bruk	Södra Skogsägarna ek. för. (Södra Cell Mönsterås)
Billerud Sweden AB, Karlsborgsverken	Södra Skogsägarna ek. förening (Södra Cell Värö)
SCA Obbola AB	Valmet AB
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## MRC CORROSION PROTECTION

Carboline Norge A/S	NKT HV Cables AB
DACAR AB	SSAB EMEA AB
Equinor Energy ASA	ST Control
Hempel A/S	Stockholm Stad, Trafikkontoret
Hilti Aktiengesellschaft	Tikkurila Sverige AB
Hitachi Energy Sweden AB Components	Trafikverket
International Färg AB (/AkzoNobel)	Zinc Info Norden AB
LKAB Kiruna	Zingametall BV
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## MRC MARINE CORROSION

AB Volvo Penta	Industeel, Arcelor Mittal
Alleima	National Oilwell Varco
Aker Solutions/OneSubsea	Outokumpu Stainless AB
Aker BP	Petrobras
Aperam	Saipem
DGA	TechnipFMC
EDF	TotalEnergies One Tech
EQUINOR	Vallourec
Grundfos Holding	Voestalpine Böhler Edelstahl
Harbour Energy	
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## MRC PAINT AND LINING FOR STEEL

AB Volvo Penta	Nof Metal Coatings
AkzoNobel	Orano TN
DGA	Peintures Maestria
EDF	TotalEnergies One Tech
Thalès Group	
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## MRC HYDROGEN

Alleima	Storengy
Airbus Operation SAS	Subsea7 France
Aperam	Tata Steel NL
Baker Hughes	Technip Energies
DGA	Technip FMC Subsea France
GE Power Conversion	Tenaris
Industeel, ArcelorMittal	Terega
NV Bekaert	TotalEnergies One Tech
National Oilwell Varco	Trapil
Natran	UGITECH
OCAS / ArcelorMittal R&D Gent	Vallourec
Schlumberger	voestalpine Böhler Edelstahl
SHELL	
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## MRC BIOREFINERY

Alleima EMEA AB	Primco
Aperam	TotalEnergies One Tech
IFPEN	Valmet AB
Industeel, ArcelorMittal	Valmet Technologies Oy
Outokumpu Stainless AB	
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## MRC CCUS AND H<sub>2</sub>S

Alleima	Saipem
Aperam	Subsea7
ArcelorMittal / OCAS	Technip Energies
TechnipFMC-FlexiFrance	TotalEnergies One Tech
National Oilwell Varco	Vallourec
Outokumpu Stainless AB	voestalpine Böhler Edelstahl
Shell	
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## MRC BRINE AND WATERS

Alleima	Industeel, Arcelor Mittal
Aperam	Outokumpu Stainless AB
EDF	SIAAP
Veolia Environnement	
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## MRC NAVAL PAINT

SSF	Hempel
DGA	Jotun
Naval Group	AkzoNobel
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## TRANSPORT

Project Title: <b>Development of a robust and reliable accelerated corrosion test in the aerospace industry II</b>		Acronym: <b>CorrTestAero II</b>
Research area: <b>Transport, Aerospace</b>	Project period: <b>01/01/2023 – 01/01/2027</b>	
Research leader: <b>Fabienne Peltier</b> fabienne.peltier@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>MRC Aerospace Industry</b>	
	Keywords: Aerospace, corrosion test, aluminium	

It is often considered that aluminium alloys exhibit good resistance to atmospheric corrosion due to the presence of a fine oxide passivating layer. Nevertheless, these alloys are not immune to corrosion which can take the form of localised corrosion like pitting or intergranular corrosion (such as exfoliation corrosion). Thus, the assessment of corrosion behaviour under atmospheric conditions is a major topic for many applications including the aerospace industry. In this context new alloys have been developed in the last decades as alternative to AA 2024. Moreover, in the last decades, new environmental regulations have led to major changes for aluminium corrosion protection. So, by limiting or prohibiting some chemicals (CrVI), the European regulation REACH (Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals) has induced major changes in some finish processes of aluminium alloys (chromate conversion, chromic acid anodizing, chromate sealing).

Hence, from the above, there is a need to qualify new materials and surface finishes for different applications in the aerospace industry (including both exterior and interior applications and maintenance aspects). One major difficulty in this task is the lack of robust and reliable corrosion test(s) in this field. Today salt spray (e.g. ISO 9227) is widely used and it is not representative to service conditions and thus not adapted to new developments (alloys and surface finishes). Another problem is that long term corrosion data under atmospheric conditions for these new alloys are, for the moment, rather limited. Some data on outdoor corrosion of new alloys surface finishes are available but they are restricted to exposure performed at 45° angle in a very few numbers of sites (which normally not favours intergranular corrosion).

In the first project "CorrTestAero" devoted to the development of new accelerated corrosion tests, materials with known behavior were selected to be critical on results obtained with the new tests and to determine if the developed test is representative of service conditions. The data have also been correlated to data from field exposures in a marine atmosphere (36 months) to design testing conditions that show the best correlation to the field data.

Based on the results from the matrix of experiment and experience, accelerated tests were selected to be validated in a second phase with different materials with less known behavior.

Project aims:

- To obtain the long-term behaviour of painted materials after 5 years of exposure
- To implement or validate a test (designed in the first project) which correlates with field exposures on painted materials
- To study the repeatability and the reproducibility of the test for a standardization of the test in aerospace industry

## TRANSPORT

Project Title: <b>Solutions for Corrosion Optimized and Prediction with Efficient Network of Environment Sensors</b>		Acronym: <b>Scorpenes</b>
Research area: <b>Transport, Aerospace</b>	Project period: <b>01/01/2023 – 31/12/2026</b>	
Research leader: <b>Nathalie LeBozec &amp; Johan Becker</b> nathalie.lebozec@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>Public Funding (EDA)</b>	
	Keywords: Aeronautic, condition-based maintenance, sensors	

Degradations due to corrosion are a major concern in aeronautic and related issues can appear along the service life of aircraft and helicopters. Although materials and protective coatings are carefully selected to prevent onset of corrosion, exposure to harsh environments, e.g. to marine conditions or decontamination agents may still conduct to corrosion of structural parts. Evidence of corrosion is usually assessed during scheduled maintenance operations which are not considering in-service conditions (exposure to salt contaminants, high relative humidity levels, temperature variations ...) of helicopters and aircraft. This type of maintenance may be therefore inadequate being too extensive or insufficient. Developing solutions enabling to trigger maintenance operations is therefore of great interest and would significantly reduce costs and increase the availability of aircraft and helicopters.

The main objective of the project is therefore to build a condition-based maintenance solution related to corrosion management on aircraft and helicopters and to improve the corrosion testing reliability. This will be achieved through developments and tests of environmental sensors, corrosion monitoring techniques and assessments on specimens aiming to reproduce real helicopters/aircraft assemblies. The design of an accelerated corrosion test to better reproduce in-service conditions will be also investigated.

**Project aims:**

- To understand, model and simulate the aging of sensors in variety of environmental conditions representative of flight conditions
- To identify, understand and simulate representative level of corrosion of structures to implement adequate maintenance solutions

## TRANSPORT

Project Title: <b>Instrumentation and Standardization of accelerated corrosion test</b>		Acronym: <b>INSTANT</b>
Research area: <b>Transport, Aerospace</b>	Project period: <b>01/08/2024 – 01/08/2028</b>	
Research leader: <b>Fabienne Peltier &amp; Johan Becker</b> fabienne.peltier@institut-corrosion.fr johan.becker@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>Cost shared industry</b>	
	Keywords: Accelerated corrosion tests, bare alloys, painted aluminium alloys, sensors, Al	

Aluminum alloys are not immune to corrosion which can take the form of localized corrosion. Thus, the assessment of the corrosion behavior of aluminum alloys under atmospheric conditions is a major topic for the aerospace industry. One major difficulty in this task is the lack of robust and reliable accelerated corrosion test(s) in this field. Indeed, several tests such as the Neutral Salt Spray Test (ASTM B117) are used to assess the general corrosion resistance of aluminum, but these tests were not developed specifically for the aerospace industry and are not representative of service conditions.

Other tests have been developed in the automotive industry and have been used in a multi material concept to test steel-based materials and aluminum alloys (mostly from the 3000, 5000 and 6000 series). However, the experience with aerospace materials in cyclic corrosion tests is rather limited. This project aims therefore to deepen the understanding of the corrosion processes of bare and painted aluminum alloys in more representative cyclic corrosion tests. This will be conducted through i) the assessment of the performances of different systems in terms of resistance to cyclic corrosion tests in recently developed and standardized cyclic corrosion tests, ii) comparisons with the behavior of similar systems in field conditions (Brest and Mumbai) and iii) the development of a statistical and physical model built from electrical resistance (ER) corrosion sensor data, galvanic current and from material characterizations.

Project aims:

- Deepen the understanding of the corrosion processes of bare and painted aluminum alloys in more representative cyclic corrosion tests
- Standardize of an accelerated cyclic testing method for aerospace applications
- Develop a statistical and physical model builds from both sensor data and material characterizations

## TRANSPORT

Project Title: <b>Worldwide outdoor exposure of aluminium alloys II</b>		Acronym: <b>WorldAlu II</b>
Research area: <b>Transport, Aerospace</b>	Project period: <b>1/01/2026 – 31/12/2028</b>	
Research leader: <b>Fabienne Peltier</b> e-mail: fabienne.peltier@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>Cost shared industry</b>	
	Keywords: Atmospheric exposure, worldwide, aluminium alloys, Cr free	

Aluminium alloys are generally considered resistant to atmospheric corrosion thanks to their protective oxide layer, but they can still suffer from localized forms such as pitting and intergranular corrosion. Assessing their long term atmospheric corrosion behaviour is therefore essential. Although some large scale exposure programs exist, most available data concern pure aluminium rather than actual industrial alloys.

Environmental regulations, particularly the EU REACH regulation, have restricted the use of chromates, leading to major changes in corrosion protection processes. New anodizing methods (such as TSAA and BSAA) and modified sealing or pretreatment steps have been introduced, but outdoor corrosion data for these new systems remain limited. The transition is challenging because industrial and military standards impose strict performance requirements.

At the same time, new aluminium alloys – such as Al Li alloys—have been developed for improved mechanical performance, yet long term atmospheric corrosion data for these materials are scarce. Existing outdoor studies are few, often limited to 45° exposures at only a small number of sites, which does not always promote intergranular corrosion. As a result, no global and systematic evaluation of new alloys and surface finishes under diverse climates has been performed.

The WordAlu project (2015–2020), led by the French Corrosion Institute, investigated the performance of several new surface finishes under various weathering conditions worldwide. Although the project provided a ranking of systems, statistical analysis was limited by the small number of chromium free systems included.

The new project aims to expose a larger number of REACH compliant materials across a wider range of climates to better understand how environmental parameters influence the corrosion behaviour of REACH compliant painted aluminium systems.

Project aims:

- **To collect data** on corrosion performance of aluminium alloys in a wide range of climatic conditions at well-managed weathering sites around the world
- **To assess the corrosion behaviour of Cr free painted aluminium** alloys under various weathering conditions
- **To compare** field exposure results to accelerated corrosion tests developed in the MRC aerospace
- **To study the effect of different parameters** (chloride concentration, temperature, pollutant...) on the corrosion performance of the different systems

## TRANSPORT

Project Title: <b>Development of an accelerated corrosion test that better mimic field conditions</b>		Acronym: <b>MRC-AC 21</b>
Research area: <b>Transport, Automotive</b>	Project period: <b>01/01/2024 – 31/12/2025</b>	
Research leader: <b>Bo Rendahl</b> bo.rendahl@ri.se Tel: +46 10 228 48 58	Source of funding: <b>MRC Automotive Corrosion</b>	
	Keywords: Accelerated corrosion testing, Mobile on-vehicle exposure	

The studies performed on the corrosivity in road environment have shown that approximately 90 % of the corrosion takes place during the winter period when there is frequent use of de-icing salt on the roads but also rather low temperatures.

When looking into the OEM's different accelerated corrosion tests, all of them increase the corrosivity of the test with high temperatures. The corrosion mechanism taken place at these higher temperatures will probably not be the same as what will be found in the field. An accelerated test at lower "winter" temperatures might thus better mimic the corrosion observed in the field.

The activities within the project are to perform a series of cyclic corrosion tests with selected automotive materials together with atmospheric corrosion sensors at lower temperatures. The new tests at lower temperatures will have a considerably lower acceleration factor compared with the OEM's cyclic test used today and therefore the exposure period will become much longer.

**Project aims:**

From the obtained results and together with existing field data try to develop an accelerated corrosion test that better mimics the corrosion observed in the field.

## TRANSPORT

Project Title: <b>Warm Press-Formed Zinc-Coated Third Generation Advanced High Strength Steels with High Crash and Corrosion Resistance and Minimized Microcracking</b>		Acronym: <b>WarP-AHSS</b>
Research area: <b>Transport, Automotive</b>	Project period: <b>01/10/2023 – 31/03/2027</b>	
Research leader: <b>Dominique Thierry</b> dominique.thierry@ri.se Tel: +33 67 68 06 676 Christophe Mendibide Christophe.mendibide@institut-corrosion.fr	Source of funding: <b>European funding (RFCS)</b>	
	Keywords: Medium manganese steel, Automotive corrosion, LME, hot stamping	

Steel sheets at automakers are formed in different ways (e.g. cold forming, hot forming, roll forming etc.) for use in car bodies. Hot stamping (or hot forming or hot pressing or press hardening) is one of the forming methods for automotive components which is growing rapidly in Europe. The major process steps for producing sheet steels at the steelmaker and their processing at the automaker using the hot forming process. Hot stamping allows manufacturing of complex parts with minimal spring back, which is not possible by cold stamping process, while simultaneously achieving ultrahigh strength levels in service.

“Medium manganese steels” (MMnS) are candidate materials for the 3rd generation advanced high strength steels. These steels typically contain 3-12 wt.% Mn, along with low C in a ferritic and/or martensitic matrix. The broad possibility of changing the heat treatment of these steels can lead to a wide spectrum of final mechanical properties ( $R_m \sim 800\text{-}1500$  MPa and  $A \sim 10\text{-}45\%$ ) that can be achieved. Interestingly, the relatively high amount of Mn additions in MMnS decreases the ferrite-to-austenite transformation temperature ( $A_{e_3}$ ) in these steels. Although MMnS are usually intended for cold stamping applications, their low  $A_{e_3}$  can allow lower reheating and hot stamping temperatures if used for hot stamping leading to a “warm stamping” process. This possibility can ensure that during the warm stamping of Zn-coated sheet steel no Zn-rich liquid phase is in contact with the steel substrate minimizing the risk of LME and associated coating degradation.

**Project aims:**

- To develop “warm pressed” medium Mn steel products that will use significantly lower processing temperatures enabling the use of Zn-coated sheet steels for warm stamping parts
- To avoid the occurrence of LME and other coating and surface degradations during warm stamping

The consortium is formed with the following partners: Tata Steel (Coordinator), Steel Institute (IEHK) of RWTH, RISE, CSIC-CENIM and Volkswagen.

## TRANSPORT

Project Title: <b>Field survey</b>		Acronym: <b>MRC-AC30</b>
Research area: <b>Transport, Automotive</b>	Project period: <b>01/04/2023 – 31/12/2025</b>	
Research leader: <b>Bo Rendahl</b> bo.rendahl@ri.se Tel: +46 10 22 84 858	Source of funding: <b>MRC Automotive corrosion</b>	
	Keywords: Real-life performance	

RISE has performed several surveys of the corrosion resistance of the car body. Parts of the car body have been collected from dismantling plants from collision damaged vehicles. The last survey was reported 2014 and included inspection of more than 1900 crevice surfaces of year models 2006 to 2009. A follow up project but in a minor extent is run within the MRC Automotive corrosion.

The project has two focus areas whereas the first one is focusing on thin-film technology as a replacement to phosphating. Thin-film technology have been used by some OEMs for more than 10 years, it is thereby possible to get access to vehicles that have been in service for a long period of time.

The second focus is to investigate the effect of design, adhesives and sealers by collecting hem-flanges and spot-welded joints from chosen car models. The parts will be opened, documented and, if interesting, evaluated with respect to corrosion.

**Project aims:**

- Investigate the performance of vehicles pre-treated with thin-film technology after 5 to 10 years in service in one of the most corrosive road networks in the world
- Evaluate and compare the corrosion resistance of the car body of some recent models and to evaluate the effects of design as well as adhesives and sealers

## TRANSPORT

Project Title: <b>Influence of the composition of recycled cast aluminum alloys on their corrosion and fatigue corrosion performance</b>		Acronym: <b>ReCalCor</b>
Research area: <b>Transport, Automotive</b>	Project period: <b>01/05/2023 – 31/12/2026</b>	
Research leader: <b>Flavien Vucko &amp; Bo Rendahl</b> flavien.vucko@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>Cost shared industry</b>	
	Keywords: Cast Aluminum, recycling, fatigue	

In the automotive industry, the transition towards global e-mobility to fulfill current and future CO<sub>2</sub> emission regulations is quite challenging. Extensive research and developments are done to improve the efficiency of electric engines and to reduce the weight of batteries. However, the decrease of the weight of the vehicle itself is of key importance for its energy efficiency and carbon footprint. In addition to this, the use of recycled materials, in particular aluminum alloys, can even further improve the environmental impact the vehicle manufacturing.

To lighten future vehicles, multi-material concepts are necessary, and aluminum alloys are of high interest due to their versatile properties combining lightweight, high strength and good corrosion properties. Die-cast aluminum alloys is a material of choice for complex geometries. The current trends towards mega-casting will make it even more important. Indeed such technique allow to improve profitability by reducing assembly time, length of the assembly line, but need further developments in terms of component design to optimize their weight. Mega-casting also helps to increase the material utilization as well as the use of secondary aluminum.

For the integrity of the cast components, both pitting and intergranular corrosion are particularly risky in case of high or cyclic loads as both could act as crack initiation sites. Combination of mechanical stress and corrosive environments could also lead to environmental assisted cracking or fatigue-corrosion mechanisms that would even further reduce the lifetime of the component.

As a conclusion, the corrosion behavior of secondary cast aluminum and its impact on mechanical and fatigue behavior must be investigated to anticipate the risk of failure under service conditions.

#### Project aims:

- Investigate the influence of Cu and Fe content on the corrosion properties of various commercially available cast alloys
- Investigate the properties of model cast alloys to mimic successive recycling operations
- Quantify the impact of corrosion on the mechanical properties and fatigue/fatigue-corrosion performance of the cast alloys
- Gives recommendation in terms of material selection and design of cast parts made of secondary alloys

## TRANSPORT

Project Title: <b>Assessment of Corrosivity Towards Automotive Materials in Road Environments</b>		Acronym: <b>ACTAM</b>
Research area: <b>Transport, Automotive</b>	Project period: <b>01/06/2024 – 31/05/2028</b>	
Research leader: <b>Bo Rendahl</b> bo.rendahl@ri.se Tel: +46 10 228 48 58	Source of funding: <b>Joint Industrial Project</b>	
	Keywords: Mobile exposure, Corrosivity, Road environment	

In the last decade, there have been a strong focus in the automotive industry on lowering the weight of the vehicles with the aim to reduce the emissions. Extended research has been carried out to facilitate the use of lightweight materials in vehicles. The latest transition, going from vehicles with combustion engine to introducing hybrid and electric vehicles has been made over a short period of time. This introduces new challenges with respect to corrosion, with one being linked to the battery housing. OEMs have different solutions to cover and protect the battery, for example by a battery housing produced in cast or extruded aluminium or coated or uncoated steel with E-coating etc. Other transitions are the use of more environmentally friendly pre-treatments to replace the phosphating process and the use of E-coatings with lower curing temperatures due to the increased cost for energy. The aim to lower the carbon footprints has put a lot of attention on the increased use of re-circulated materials, in specific aluminium alloys both as sheet materials and the forecasted higher use of cast aluminum materials.

The changes in the climate, with more extreme weather conditions as well as an increased global average temperature, might have an impact on the corrosivity in the road environments and this study aims to give valuable data to map the road environment in different areas of the world.

The project is divided into 5 work packages dedicated to assessment of corrosivity in selected areas.

WP1 - Selection of exposure areas

WP2 - Material selection and specimen preparations

WP3 - Evaluation methods to assess corrosivity

WP4 - Monitoring and analyses of road environments

WP5 - Analyses of corrosion products

Project aims:

- To assess the corrosivity towards different materials, coatings, and configurations used within the automotive industry, in selected areas of the world
- To establish correlation between the relative corrosivity of different materials and environmental data at different exposure locations (composition of road mud, temperature, relative humidity)
- To gain more knowledge in terms of environmental parameters affecting the corrosion of materials used for automotive applications

## TRANSPORT

Project Title: <b>Renewable Advanced high strength steels for Vehicle Efficiency and Sustainability</b>		Acronym: <b>RAVES</b>
Research area: <b>Transport, Automotive</b>	Project period: <b>1/09/2025 – 31/08/2028</b>	
Research leader: <b>Flavien Vucko &amp; Smita G. Rao</b> flavien.vucko@institut-corrosion.fr Smita.gangaprasad.rao@ri.se Tel: +33 298 05 15 52	Source of funding: <b>Research Fund for Coal and Steel</b>	
	Keywords: Steel Circularity, Advanced High Strength Steels	

As steel remains the dominant material in the automotive sector – accounting for 16% of the global 1.85 billion tons annual steel production—it also contributes to nearly 30% of global industrial CO<sub>2</sub> emissions. Traditional steelmaking processes have limited capacity for scrap steel integration, while alternative methods allow for significantly higher scrap utilization, offering substantial potential for carbon reduction.

The RAVES (Renewable Advanced High Strength Steels for Vehicle Efficiency and Sustainability) project aims to look into these alternative methods and develop strategies to produce advanced high strength steels (AHSS) from end-of-life vehicles (ELV).

The project focuses on defining acceptable residual levels in future steels, understanding the impact of contaminants on AHSS microstructures, and optimizing thermo-mechanical treatments to ensure desired properties. It also investigates the risk of defects like cracking and embrittlement due to contaminant interactions, building a comprehensive database linking composition, microstructure, and performance.

Using advanced techniques such as atomic force microscopy (AFM) for detailed microstructure analysis and scanning kelvin probe Force microscopy (SKPFM) to study the electrochemical properties of inclusions, combined with accelerated corrosion testing under simulated real-world conditions, RISE contributes to the project by investigating how contaminants influence material performance. RISE also aims to lead in-situ corrosion studies using synchrotron-based ambient pressure X-ray photoelectron spectroscopy (AP-XPS) to analyze surface changes during exposure. These contributions help develop robust, high-quality secondary AHSS, supporting a more sustainable and circular automotive industry.

Project aims:

- Enhance steel circularity
- Understand contaminant impact of AHSS properties

## TRANSPORT

Project Title: <b>Towards Zero emission 3D printed copper electrical motor Windings</b>		Acronym: <b>Z-3D-Windings</b>
Research area: <b>Transport, Automotive</b>	Project period: <b>2024-09-01 – 2028-02-29</b>	
Research leader: <b>Katarina Bokström, Carmen Cobo Sanchez</b> e-mail: katarina.bokstrom@ri.se Tel: +46 73 088 6548	Source of funding: <b>Public funding (Vinnova)</b>	
	Keywords: Electrification, copper, additive manufacturing	

This Z-3D-Windings project aims to transform the manufacturing of electric motor windings using advanced additive manufacturing (AM) by evaluating the technical challenges and environmental impact of the process.

These more flexible designs that can be made with AM should i) reduce some harmonic losses in the motors, ii) create more efficient space utilization for copper in the motor, iii) allow for more efficient and built-in cooling, iv) increase the power/efficiency of the motors and v) improve the recyclability of the motors at the end of their lifetime. This project aims to increase the speed of this innovation to be used in the electric vehicle market, resulting in improved performance and durability.

Project aims:

This project aims to create and evaluate more efficient motor designs with improved field factors and reduced environmental impacts, by exploiting the use of additive manufacturing.

## TRANSPORT

Project Title: <b>Hydrogen effect on the formability of 3rd generation advanced high strength steels to be used for future vehicle designs</b>		Acronym: <b>H2FORM3G</b>
Research area: <b>Transport, Automotive</b>	Project period: <b>01/07/2024 – 31/12/2027</b>	
Research leader: <b>Flavien Vucko</b> flavien.vucko@institut-corrosion.fr +33 29 80 51 552	Source of funding: <b>Public funding (RFCS)</b>	
	Keywords: <b>3<sup>rd</sup> generation AHSS, hydrogen embrittlement, formability</b>	

Understanding the effect of hydrogen on the formability of 3rd generation AHSS is crucial to fully exploit their great potential as cost-effective and sustainable lightweight solutions for future mobility. Therefore, the main objective of H2FORM3G is to provide the necessary tools to prevent the risk of cracking during the manufacture of automotive components and reduce the risk of delayed fracture after forming. To reach this goal, the project aims to generate a comprehensive understanding of the interaction between hydrogen and the microstructure of quenching and partitioning (Q&P) steels during the process of forming to ensure its safe application in the manufacture of lightweight automotive parts at affordable costs. The project includes the development of new characterization methodologies and predictive models that will contribute to accelerate the design and optimization of new automotive components made of 3rd Generation AHSS with reduced weight (10 - 20% with corresponding savings in CO<sub>2</sub> emissions) and improved crash-safety performance. The application of these new methodologies and models will 1) reduce the time to market of new high performance steel products by reducing the time and cost of prototype validation, 2) reduce the number of failed parts during production due to more accurate determination of risk of cracking during forming, and 3) reduce the amount of material waste (estimated 25% reduction in scrap and failed parts compared to the current situation and 20% GHG emission savings based on machine usage/time reduction) by limiting the use of trial and error methods and encouraging the use of digital predictive models. H2FORM3G solutions are expected to strengthen the technological competitiveness of the EU steel and automotive industry (accounting for 6.1% of total EU employment), crucial for Europe's prosperity (the automotive industry alone represents over 7% of the EU's gross domestic product).

**Project aims:**

- To establish a relationship between hydrogen content, microstructure evolution (phase transformation of austenite to martensite) and the mechanical behaviour of 3rd Gen steel grades
- To better understand the hydrogen embrittlement mechanisms by the development of a microscopic scale model based on a crystal plasticity constitutive law coupled to a hydrogen diffusion model
- To determine an appropriate failure criterion thanks to the full characterisation of the forming limit curves on as-received and hydrogen charged materials
- To evaluate the risk of hydrogen-assisted cracking during manufacturing and the risk of delayed fracture after forming
- To quantify the environmental impact of the proposed solutions

## TRANSPORT

Project Title: <b>Dry pretreatments for automotive materials</b>		Acronym: <b>MRC-35</b>
Research area: <b>Transport, Automotive</b>	Project period: <b>28/04/2025 – 31/12/2026</b>	
Research leader:  <b>Clara Vestberg, Karin Törne</b> clara.vestberg@ri.se +46 10 228 48 64 karin.torne@ri.se	Source of funding: <b>MRC Automotive Corrosion &amp; MRC Surface Technology</b>	
	Keywords: Laser cleaning, Atmospheric plasma, surface treatment	

Prior to applying coatings for corrosion protection on automotive components, metallic surfaces are commonly pretreated through degreasing, cleaning and activation steps. In this project, laser and atmospheric plasma cleaning are being investigated as innovative pretreatment methods.

Dry pretreatment is a family name for surface pretreatment that modifies a material's surface properties without the need of liquids and enables a faster, cleaner and more environmentally friendly surface treatment compared with many wet chemical processes. Laser and plasma treatments are used not only for cleaning purposes but also tailoring surfaces for better bonding in adhesive joints, improved surface energy and wettability, surface restructuring and application of nano-coatings. The techniques can be used on a wide range of materials to prepare surfaces locally or on a larger scale.

The potentials of laser and plasma treatments have been summarized in a literature report. An experimental campaign will compare dry pretreatments with conventional wet pretreatments in terms of cleanliness, adhesion and corrosion resistance.

**Project aims:**

- Gain knowledge about alternative pretreatment methods such as laser and plasma cleaning
- Gain insight on how laser or plasma cleaning affects the surface and adhesion of subsequent organic coatings
- Investigate the impact of dry pretreatments on the corrosion properties of automotive materials

## TRANSPORT

Project Title: <b>Comparison between accelerated corrosion testing at high and low temperatures of automotive materials</b>		Acronym: <b>MRC-23</b>
Research area: <b>Transport, Automotive</b>	Project period: <b>01/01/2025 – 31/12/2026</b>	
Research leader: <b>Clara Vestberg</b> clara.vestberg@ri.se +46 10 228 48 64	Source of funding: <b>MRC Automotive Corrosion</b>	
	Keywords: Accelerated corrosion testing, field exposure	

Accelerated atmospheric corrosion tests are commonly used to assess the corrosion resistance of automotive materials in a much shorter timeframe compared to real outdoor exposures. Aside from varying relative humidity levels and salt application in the corrosion cycle, the acceleration is achieved by increasing the testing temperature (from ambient up to 40°C). On the other hand, most of the corrosion on vehicles takes place during the winter periods in regions using deicing salts when the average temperature is typically in the range of 0°C. To better understand the impact of temperature in accelerated corrosion conditions, automotive materials in this study were exposed to accelerated corrosion tests at 10°C and 40°C. The results were compared to a five-year outdoor exposure on running vehicles in Sweden.

The accelerated test cycles were tailored to represent typical humidity patterns observed in temperate winter conditions. Salt solutions were regularly applied in different forms, e.g. manual spraying and synthetic road mud, to investigate different corrosion initiation methods. The results showed the paint delamination was dependent on the temperature for painted carbon steel and on the salt load for painted galvanized steel. However, for painted aluminum, the test at low temperature was found to be the severest condition, regardless of the salt load. The corrosion products were characterized by IR-spectroscopy to underline the differences in corrosion mechanisms between the test methods.

Project aims:

- Compare results from accelerated corrosion tests with field exposures
- Elucidate different corrosion mechanisms at low and high temperature
- Design a new accelerated test that better mimics field conditions

## TRANSPORT

Project Title: <b>Adhesive bonding of aluminium – A comparison between field and accelerated corrosion testing</b>		Acronym: <b>ABA-FACT</b>
Research area: <b>Transport, Automotive</b>	Project period: <b>30/04/2025 – 30/09/2026</b>	
Research leader: <b>Elsa Lindström &amp; Carmen C. Sanchez</b> Elsa.lindstrom@ri.se +46 10 228 42 29	Source of funding: <b>Cost shared industry</b>	
	Keywords: Adhesive bonding, Mobile exposure, Accelerated corrosion testing, Corrosion mechanisms	

To reduce the overall weight of vehicles, aluminium alloys, joined with adhesive bonding, are increasingly used within the automotive industry. Adhesive bonding is a method that is commonly used for joining aluminium parts, both for structural and hang on parts on the car body. As inconsistencies are commonly observed between results from accelerated corrosion tests and field, there is a need for a more reliable test method.

This project investigates adhesive bonded aluminium lap-shear samples with different pretreatments and adhesives subjected to both accelerated corrosion tests and mobile field exposure. Previous results have shown larger losses in adhesive strength for samples out in the mobile field exposure compared to a 12-week exposure of VDA 233-102. In addition, a difference in the type of failure between test type and adhesives has been observed.

To create a more reliable test method that will better mimic field conditions for adhesive bonded aluminium systems, the origin of variations and differences seen between samples and test methods must be identified. This is done using characterization techniques like DSC and FTIR to analyse adhesives and sample surfaces.

Project aims:

- To understand the origin of differences between accelerated corrosion test and mobile vehicle exposure for adhesive bonding of aluminium
- To understand the impact of parameters like climate, road mud and vibrations
- To identify what are the key factors and continue method development for an accelerated test cycle that better mimics field conditions.

## TRANSPORT

Project Title: <b>Elyfog - Testing and development of long-term reliable electrical contacts</b>		Acronym: <b>Elyfog</b>
Research area: <b>Transport, Automotive</b>	Project period: <b>15/09/2023 – 15/09/2026</b>	
Research leader: <b>Karin Törne</b> Karin.torne@ri.se Tel: +46 10 228 48 81	Source of funding: <b>Public funding (Vinnova)</b>	
	Keywords: Electric vehicles, contact resistance, aging	

In electric powertrains, fast charging and discharging of batteries and high voltages, current, and power levels and other stresses make the characteristics of the electrical contacts critical for the basic functions of the vehicles as well as for lighting, window lifts, infotainment, etc. In other words, faulty or inferior contacts will cause unnecessary energy losses, non-functioning or at worst inoperative vehicles. It is therefore critical for EV OEMs to ensure they are using highly reliable electrical connection concepts, designed to withstand the higher voltages and temperatures sustained in these environments. Depending on the mounting location of the electrical connection also environmental exposure and corrosion resistance needs to be considered as well.

The project will analyse how different materials, surface treatment, concept, and assembly affect performance and long-term properties. Properties to evaluate are primarily: mechanical joint strength and electrical contact resistance (structural and functional characteristics) in correlation to the chosen configuration (geometry, surface properties, materials, fasteners, assembly parameters). Changes of the parameters during exposure to mechanical, electrical and environmental loads will also be evaluated.

**Project aims:**

- Development of a test rig allowing for simultaneous application of two or more stresses and online measurement of electrical contact resistance over the runtime of the experiment.
- Evaluation of at least 3 established material combinations and surface treatment for electrical contacts and development of at least 3 optimized combinations for a comparative study
- Instructions and guidelines for testing, material selection and assembly to improve connection lifetime and guidelines for re-using connection parts and the use of recycled materials in electrical connections

## SURFACE PROTECTION

Project Title: <b>Recycled aluminium alloy coatings with chemically tailored electro-chemical potential for safe protection of steel structures</b>		Acronym: <b>ALCOAT</b>
Research area: <b>Surface protection, Automotive</b>	Project period: <b>01/09/2023 – 28/02/2028</b>	
Research leader: <b>Dominique Thierry</b> Dominique.thierry@ri.se Tel: +33 67 68 06 676	Source of funding: <b>European funding (RFCS)</b>	
	Keywords: Metallic coatings, high strength steel, galvanic protection, Aluminium, Hydrogen embrittlement	

Although currently indispensable in steel corrosion protection, zinc coatings have several drawbacks, including lower corrosion resistance in marine environments, the risk of hydrogen embrittlement when applied to high strength steels, and a relatively low recycling rate. The only economically viable alternative metallic coating material, aluminium, is cheaper, lighter, widely available, and more corrosion resistant. However, it is unable to provide sufficient protection to steel in defects, leading to red rust formation, and thus it is used only marginally.

### Project aims:

To solve these shortcomings, this project will develop two new families of aluminium alloy coatings for protection of wind towers, ships, and other structures exposed to sea water and atmosphere, and steel sheet products for automotive, building, and home appliance industries. The coating composition and microstructure will be designed using advanced computational and molecular modelling. A novel, ground-breaking chemically-tailored potential difference concept will be developed and applied to precisely tailor the potential difference between the coatings and steel substrate in relevant environments. Application of this revolutionary concept will ensure that the corrosion potential of the coatings is more negative than that of steel guaranteeing thus sacrificial protection of steel in defects and protection against red rust formation, and still more noble than that of zinc, which is in a range where the risk of hydrogen embrittlement exists.

The new coatings will be more sustainable than zinc coatings due to lower corrosion rate, lighter due to lower specific mass of aluminium, ensure savings of primary raw materials due to use of iron-contaminated aluminium scrap, and improve the safety of steel constructions due to no risk of hydrogen embrittlement.

The consortium comprises the following partners: University of Chemistry and Technology Prague (Coordinator), RISE, Výzkumný a zkušební ústav Plzeň, Tata Steel Nederland Technology B.V., Catalan Institute of Nanoscience and Nanotechnology, RMIT Europe, RMIT University, Pyrogenesis SA.

## SURFACE PROTECTION

Project Title: <b>Cleaning and pre-treatment of Al-alloys</b>		Acronym: <b>CAROL</b>
Research area: <b>Surface protection, Automotive</b>	Project period: <b>01/08/2025 – 01/08/2026</b>	
Research leader: <b>Karin Törne</b> Karin.torne@ri.se Tel: +46 10 228 48 81	Source of funding: <b>MRC surface technology</b>	
	Keywords: pre-treatment, cleaning, painted aluminum alloys, contaminates	

This project will primarily focus on surface treatments of aluminum alloys and the effect of Cu and Zn contamination. When recycling aluminum the amount of contaminant may increase. Cu will separate into intermetallic or particles in the microstructure. In a previous project the potential difference between Cu inclusions and surrounding matrix was found to induce localised corrosion.

In this project the effect of Cu intermetallics on surface pre-treatment prior to painting will be investigated. The surface of samples after surface treatment, alkaline etching, acid etching and thin film pre-treatment will be characterized by SKPFM, SEM/EDS, and FTIR. Painted samples will be exposed to different weathering conditions and evaluated for filiform corrosion.

**Project aims:**

Improve the fundamental understanding of the effect of Cu and Zn in aluminum alloys during

- Alkaline etching
- Acid etching
- Alkaline and acid etching

## SURFACE PROTECTION

Project Title: <b>Depth resolved chemical imaging of radiation cured organic coatings</b>		Acronym: <b>RadCure</b>
Research area: <b>Surface protection, Coil coating</b>	Project period: <b>01/12/2025 – 01/12/2027</b>	
Research leader: <b>Karin Törne</b> Karin.torne@ri.se Tel: +46 10 228 48 81	Source of funding: <b>MRC surface technology</b>	
	Keywords: Radiation cured, depth profile, UV degradation	

Radiation cured primers and topcoats are suggested as new energy efficient alternatives to heat cured paints. However, many aspects of radiation cured systems are fundamentally different to thermally cured ones and are not well understood. This includes the effect of curing agents and pre-treatment and how they affect adhesion and water uptake.

Method:

- Test matrix of radiation cured coatings (polyurethane acrylate and polyethylene acrylate) with and without pigments
- Chemical analysis (FTIR-FPA imaging, AFM-IR) of the coating cross sections to assess conversion rate and other chemical differences.
- Exposure to accelerated weathering (QUV) and field exposure
- Correlate results of the chemical analysis before and after exposure to adhesion and water uptake.

Project aims:

- Assess conversion rate and other detectable chemical gradients along cross sections of a selection of radiation cured organic coatings.
- Determine the distribution of degradation products in the EB cured coatings after accelerated weathering.
- Study the effect of pigments on the degradation behaviour.

## SURFACE PROTECTION

Project Title: <b>Biopolymer-bioglass-antioxidant composite coatings for protection of 316LVM stainless steel sternal wires against inflammation-induced corrosion</b>		Acronym: <b>BioCoatCorr</b>
Research area: <b>Surface protection, Medical implants</b>	Project period: <b>01/07/2026 – 30/06/2028</b>	
Research leader: <b>Michel Prestat &amp; Flavien Vucko</b> michel.prestat@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>Horizon Europe</b>	
	Keywords: Sternal wires, plastic deformation, functional coatings, electrophoretic deposition	

316LVM stainless steel sternal wires (SW) are widely used in cardiothoracic surgery for chest closure. However, in the aggressive environment of the human body, SWs are likely to corrode without a protective coating. This can lead to the release of harmful chromium and nickel in the surrounding tissues or, worse, SW rupture with potentially life-threatening complications, such as heart lacerations. SW degradation is caused by several factors, like chloride attack promoted by the creation of confined areas (e.g., at the chest bone/SW interface), plastic deformation due to the placement of SW around the bone, and tensile stress. Moreover, after implantation, the patient's immune system unavoidably triggers an acute inflammation episode during which leukocytes generate reactive oxygen species (ROS), such as H<sub>2</sub>O<sub>2</sub> and radicals, that also contribute to the SW deterioration. Hence, novel protective coatings need to be developed to withstand the harsh SW operative conditions (in particular, during inflammation phases).

This project is funded by the Marie Skłodowska-Curie Actions (Postdoctoral Fellowship).

Project aims:

- Investigating in vitro degradation of uncoated 316LVM SW in physiological solution involving simultaneously multiple degradation factors, notably plastic deformation, H<sub>2</sub>O<sub>2</sub> attack, confined areas...
- Developing zein-bioglass-based protective coatings containing ROS scavengers using electrophoretic deposition.
- Assessing the anti-corrosion and anti-ROS performance as well as the mechanical stability of the coatings as a function of the synthesis parameters at various levels of wire deformation.

## SURFACE PROTECTION

Project Title: <b>Novel approaches for investigating local corrosion and mechanical degradation of multiphasic alloys</b>		Acronym: <b>LoCoMecha</b>
Research area: <b>Surface protection, Medical implants</b>	Project period: <b>01/01/2023 – 31/12/2026</b>	
Research leader: <b>Michel Prestat &amp; Flavien Vucko</b> michel.prestat@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>Public funding (ANR)</b>	
	Keywords: Titanium implants, fatigue corrosion, additive manufacturing, materials modelling	

Titanium and its alloys are among the most widely used non-biodegradable materials for implants in the human body. The corrosion resistance of titanium is mainly attributed to the presence of a thin passive layer on its surface that degrades in the presence of oxidizing species, such as oxygen peroxide (H<sub>2</sub>O<sub>2</sub>), leading to the device degradation and release of its constituents in the surrounding tissues. H<sub>2</sub>O<sub>2</sub> is produced by the immune system during inflammatory episodes and is also utilized by surgeons for tissue disinfection during operation. A recent study of the French Corrosion Institute revealed that Ti6Al4V, a popular  $\alpha+\beta$  alloy, exhibits a phase-specific degradation in H<sub>2</sub>O<sub>2</sub>-containing solution with a thick oxide layer growing on the  $\alpha$  phase and a dissolution of the  $\beta$  phase, leading to the formation of undesired cracks.

By combining experimental and modelling approaches, the LoCoMecha project ambition is to gain insights into the processes at play in the degradation of Ti6Al4V without and with external mechanical load (fatigue corrosion).

This project is carried out in collaboration with the Laboratoire de Réactivité de Surface (Université Paris Sorbonne, France), the Institute of Computational Physics (Zurich University of Applied Sciences, Switzerland), the Thermomechanical Metallurgy Lab (Swiss Federal Institute of Technology Lausanne, Switzerland).

**Project aims:**

- Understanding the phase-specific mechanisms of Ti6Al4V corrosion in H<sub>2</sub>O<sub>2</sub>-containing physiological electrolyte by using global and local electrochemical methods.
- Assessing the impact of  $\beta$  phase cracks on the mechanical properties of the alloy.
- Investigating the effect of the various microstructures prepared by additive manufacturing on the Ti6Al4V corrosion behavior.

## BUILDING AND INFRASTRUCTURE

<b>Project Title:</b> <b>Crevice Corrosion Mitigation Technology</b>		<b>Acronym:</b> <b>CCMT</b>
<b>Research area:</b> <b>Building and Infrastructure, Coatings</b>	<b>Project period:</b> <b>01/06/2022 – 01/06/2026</b>	
<b>Research leader:</b> <b>Björn Tidbeck</b> Bjorn.tidbeck@ri.se Tel: +46 72 734 08 17	<b>Source of funding:</b> <b>MRC Corrosion Protection</b>	
	<b>Keywords:</b> Life extension of painted steel, Maintenance strategy	

The stretch goal of this project is to extend the life of existing steel structures and reduce future maintenance needs for new steel structures. Bridges with an expected lifespan of 120 years, generally needs to be repainted or repair-painted at least three times during their lifespan. During such maintenance work, the entire steel surface of the bridge is often treated as per the current due diligence praxis. However, we know from experience that crevice corrosion in bolted connections, riveted web constructions, bridge bearings and stay cables often constitute weak points with increased risk of corrosion.

The initiative to this project is to investigate if the bulk of such maintenance work can be reduced by focusing on the above-mentioned problem areas. The methodology of this study is to perform a state of the art focusing on prevention of crevice corrosion on low alloyed steels, including weathering steels, treatment of ongoing crevice corrosion on existing steel and proactive maintenance on structures susceptible to crevice corrosion.

The study explains theoretical treatment options and surveys alternative treatment options that have been employed by asset owners outside the Swedish market. The study also includes a collection of case studies where alternative treatment protocols have been tested and can be evaluated after exposure on infrastructural assets in field after up to 30 years in service.

The planned continuation of this project includes corrosion testing of promising alternative corrosion protection strategies. And proof of concept studies of new ideas for proactive maintenance that this study has resulted in.



Figure 1. To the left: cross sectional beam with pack rust and ongoing crevice corrosion. To the right: edge beam with

**Project aims:**

- Evaluate technology to extend technical life of existing structures with crevice corrosion.
- Reduce future maintenance need for both new builds and existing steel structures.
- Perform corrosion testing and follow up case studies with crevice corrosion

## BUILDING AND INFRASTRUCTURE

Project Title: <b>Influence of distance from the sea on degradation of coil-coated materials</b>		Acronym: <b>SealDis</b>
Research area: <b>Building and Infrastructure, Coil coating</b>	Project period: <b>01/01/2017 – 31/12/2026</b>	
Research leader: <b>Nathalie Le Bozec</b> nathalie.lebozec@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>MRC Coil Coated Steel Materials</b>	
	Keywords: Coil coated steel, chloride deposition	

Airborne salinity plays a relatively significant role in the degradation of metallic infrastructures. Empirical relationships have been found between chloride deposition onto surfaces and corrosion rates [1]. The deposition of marine aerosols is the primary source of chlorides which concentration and deposition rates tend to decrease rapidly when increasing the distance to the seashore. Aerosols concentration and corrosion rates depend on the nature of the aerosol sources being very high close to surf and moderate near calmer waters of bays and estuaries. Other factors influencing the aerosol concentration are the intensity and direction of prevailing wind, the topography of the land.

If the effect of chloride deposition is rather well documented on the corrosion of bare metals such as pure zinc, no systematic study on the influence of the distance to the sea on the degradation of coil coated steel materials has been carried out, especially when it concerns Zn-Mg-Al metallic coating as well as new chrome-free technologies commercially available. From an on-going project at Institut de la Corrosion where the outdoor performance of some coil-coated steel materials (prepared in laboratory) was assessed at various distances from the seashore, it was shown that the edge creep increased with decreasing distance to the sea and increasing chloride deposition.

**Project aims:**

The goal of the project is thus to assess the degradation of a large number of commercially available coil coated materials as a function of chloride deposition and distance from the seashore. In addition, the performance of identical coil coating systems applied on various metallic coatings will also be studied.

## BUILDING AND INFRASTRUCTURE

<b>Project Title:</b> <b>Outdoor Corrosion Performance of Prepainted Galvanised Steel – A long term field exposure</b>		<b>Acronym:</b> <b>WorldCoil 3</b>
<b>Research area:</b> <b>Building and Infrastructure, Coil coating</b>	<b>Project period:</b> <b>01/04/2023 – 30/06/2026</b>	
<b>Research leader:</b> <b>Nathalie LeBozec</b> nathalie.lebozec@institut-corrosion.fr Tel: +33 2 98 05 15 52	<b>Source of funding:</b> <b>Cost shared industry</b>	
	<b>Keywords:</b> Prepainted steel, outdoor exposure, marine atmosphere, distance to the sea	

Long term outdoor exposures have to be conducted to fully evaluate the corrosion performance of prepainted materials upon corrosivity classes since thin organic protective layer must withstand very harsh conditions in various outdoor applications. This is particularly true with the evolution of coating technology for example those with a reduced environmental impact, such as coatings with reactive biorenewable diluents, but also any changes in the process of coil-coating as well as in the coating formulation.

Two large field exposure programmes of prepainted galvanised steel materials have been conducted at the French Corrosion Institute (FCI) since 2007. The first project that was performed over 8 years e.g. between 2007 and 2015 included 7 sites worldwide with marine temperate, marine industrial, marine tropical and acid rain sites. Conventional prepainted galvanised steel Zn-0.2Al, Zn-5Al and Zn-55Al materials were selected, most of them including chromated pre-treatments and primers. With the development of new zinc-alloy coated steel and the transition from chromate-based systems to fully chrome-free solutions, a second outdoor exposure programme including a new set of commercially available coil coated materials was started in 2015 for a total duration of 6 years. Most of the systems were fully chrome-free and included Zn-Al-Mg coatings in addition to conventional Zn-0.2Al and Zn-55Al substrate. Valuable data were obtained from these exposure programmes. In particular, the second project highlighted the need to take into consideration the quality of the backcoat that was highly degraded in some sites influencing thus the corrosion of the front side. It was also concluded that a larger number of prepainted systems (based on Zn-0.2Al which is commonly produced by the Coil-Coater) should be carefully selected and tested in outdoor sites, allowing a larger statistical analysis of the data. Moreover, the distance to the seashore in a similar geographical location without change in elevation shall also be considered to assess how the chloride load affects the degradation of the materials (e.g., all sites being at the seawater level).

**Project aims:**

- To test the long-term durability and corrosion performance of prepainted galvanised steel materials in various atmospheric sites in marine environment.
- To study the influence of the distance to the seashore.
- To better understand the role of different climatic parameters and corrosiveness in the degradation of coil coated material and to provide a full statistical analysis.

## BUILDING AND INFRASTRUCTURE

Project Title: <b>Testing the durability of repair solutions for prepainted steels</b>		Acronym: <b>RepairCoat</b>
Research area: <b>Building and Infrastructure, Coil coating</b>	Project period: <b>01/01/2020 – 31/12/2026</b>	
Research leader: <b>Nathalie Le Bozec</b> nathalie.lebozec@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>MRC Coil Coated Steel Materials</b>	
	Keywords: Coil-coated steel, Repair solution, outdoor exposure, accelerated tests, mechanisms	

Prepainted steel materials are widely used in the construction of building industry. During service life, their durability is affected by weathering conditions in particular when exposed to marine and/or industrial environments. This may result in noticeable underpaint corrosion at defects in the paint such as cut-edges or scribes, for examples. These degradations will obviously propagate with ageing time at a rate that will depend upon the system e.g. metallic coating, surface treatment and organic paint, and the corrosiveness of the environment. Repair solutions are available at paint suppliers for treating such damages and thus improving the life durability of the materials. However, the efficiency of such solutions is not well-known. Thus, there is a need to test them under different conditions including laboratory test and field exposure, as well as to better understand their mechanisms of protection.

**Project aims:**

- To test the durability of repair solutions on various prepainted steel materials in laboratory test and field exposure.
- To compare the efficiency of the repair solution upon the metallic coating
- To compare the efficiency of the repair solution upon the chemical nature of the organic coating
- To better understand the mechanism of protection of the repair solutions

## BUILDING AND INFRASTRUCTURE

<b>Project Title:</b> <b>Degradation of coil-coated materials under extreme conditions</b>		<b>Acronym:</b> <b>CoilXtreme</b>
<b>Research area:</b> <b>Building and Infrastructure, Coil coating</b>	<b>Project period:</b> <b>01/01/2021 – 30/06/2028</b>	
<b>Research leader:</b> <b>Nathalie Le Bozec</b> nathalie.lebozec@institut-corrosion.fr Tel: +33 2 98 05 15 52	<b>Source of funding:</b> <b>Cost shared industry</b>	
	<b>Keywords:</b> Prepainted materials, weathering degradation, extreme outdoor conditions	

The degradation of coil-coated materials in field is a complex process depending on the panel orientation, the atmosphere at a given field site, the coating thickness, the paint chemistry and physical properties (such as type and thickness of the metallic coating, pretreatment, anticorrosive pigment formulated in the primer etc...). Each atmospheric exposure site has a unique blend of environmental stresses. It should also be noticed that each material will answer differently to a given environmental factor. The sites differ in the amount of ultraviolet light (UV), overall temperature, daily temperature cycles affecting the time of wetness, relative humidity, precipitation, deposition rates of atmospheric contaminants such as chloride, SO<sub>2</sub>, and dust etc. Although the effect of some of these parameters on the corrosion of coil-coated materials is known, there are many unclear aspects. In addition, trustable data on microclimate conditions are missing. Several exposure programs have been conducted at FCI in the last 15 years. Worldcoil I and Worldcoil II were conducted at different sites worldwide. The focus of these projects was on edge creep and creep from scribe rather than on degradation due to weathering. Even if these projects gave important information on the degradation of coil coating materials in different climatic conditions, sites of extreme conditions (related for instance to weathering and/or extreme temperature) were not covered in these studies. In another project conducted at IC, the mechanisms of blistering have been studied and compared to field data. Even though cut-edge creep and blistering are the most common defects when considering coil-coating materials performance, it is also important to take into account the weathering of the paint system. Weathering is a joint action of ultraviolet radiation, heat, oxygen, humidity and chemicals species. These agents can induce physical and chemical changes in the polymer. Indeed, the weathering of the paint can affect the paint properties and thus changes water or electrolyte transport through the organic coating and consequently the tendency to blistering. It should also be noticed that the different weathering parameters can also induced stresses in the top coat and thereby largely influence the transport properties of for instance water.

**Project aims:**

- To expose and test different coil coated materials in different weathering sites (with high UV, humidity and pollution)
- To perform different laboratory test commonly used to evaluate the performance to weathering of coil coated materials
- To compare the results of the laboratory test and field tests
- To better understand the role of different climatic parameters in the degradation of coil coated material with the final aim to design more appropriate testing conditions for simulation of weathering conditions.

## BUILDING AND INFRASTRUCTURE

<b>Project Title:</b> <b>Corrosion performance of new emerging and energy saving curing technologies for coil coating</b>		<b>Acronym:</b> <b>EnSaveCoat</b>
<b>Research area:</b> <b>Building and Infrastructure, Coil coating</b>	<b>Project period:</b> <b>01/01/2023 – 31/12/2026</b>	
<b>Research leader:</b> <b>Nathalie Le Bozec</b> nathalie.lebozec@institut-corrosion.fr Tel: +33 2 98 05 15 52	<b>Source of funding:</b> <b>MRC Coil Coated Steel Materials</b>	
	<b>Keywords:</b> Curing technology, Energy saving, Radiation curing, UV, E-Beam	

Due to the actual situation on the energy sector linked to the war in Ukraine, there is a request from the EU and national authorities to save energy. This is crucial with respect to the rising cost of gas and electricity. Energy is highly consumed in surface treatment processes used in coil coating in a variety of ways such as process solution heating and cooling, paint curing, drying of the part etc. It is believed that the new request in term of energy saving will lead to new products or/and new processes that would need to be characterized and tested regarding their corrosion properties for instance.

In the field of coil coating industry, several ways of saving energy can be identified by using: Radiation curing techniques (for instance UV, E-beam..), Induction and IR or NIR curing techniques, Low PMT paints.

In this project, several energy saving technologies will be identified and used to cure the coatings applied on galvanised steel substrate. The materials will be characterized in both laboratory conditions and outdoor exposure to assess their performance versus conventionally thermal cured systems.

**Project aims:**

- To identify energy saving curing technologies of interest.
- To characterize the corrosion performance of energy-saving-cured systems in laboratory tests.
- To assess the long-term performance of energy-saving-cured systems in field exposure.
- To compare the corrosion performance of energy-saving-cured systems to thermal-cured prepainted steel.

## BUILDING AND INFRASTRUCTURE

Project Title: <b>Corrosion in agriculture environments</b>		Acronym: <b>FARM</b>
Research area: <b>Building and Infrastructure, Coil Coating</b>	Project period: <b>01/01/2018 – 31/03/2026</b>	
Research leader: <b>Nathalie Le Bozec</b> nathalie.lebozec@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>Cost shared industry</b>	
	Keywords: Ammonia, coil coating	

There are many potential causes of corrosion in animal buildings. Animals exhale large quantities of moisture into the air and create high relative humidity in the building if the moisture is not properly vented. High humidity increases the potential for condensation. In addition ammonia may be found in large quantities in animal buildings. Ammonia is released from manure and urine, especially during storage and decomposition. Levels could exceed 50 ppm with lowered winter ventilation rates and reach 100 to 200 ppm in poorly ventilated buildings. Additional corrosive agents are acids, and salts (from silage and feed residues, cleaning agents, fertilizers, and preservatives), mechanical destruction and bacteria causing microbially induced corrosion.

Project aims:

- To study the material performance of metallic coating in both liquid and atmospheric environments in a selected animal farming.
- To evaluate new coil coating materials with respect to these environments.

## BUILDING AND INFRASTRUCTURE

Project Title: <b>Degradation of coil coated materials under photovoltaic (PV) modules</b>		Acronym: <b>SolarCoil</b>
Research area: <b>Building and Infrastructure, Coil Coating</b>	Project period: <b>01/11/2025 –31/12/2028</b>	
Research leader: <b>Nathalie LeBozec</b> nathalie.lebozec @institut-corrosion.fr Tel: +33 298 05 15 52	Source of funding: <b>Cost shared industry</b>	
	Keywords: Coil Coated Steel, PhotoVoltaic, Outdoor atmosphere	

As the push for renewable energy solutions gains momentum globally (in particular in South Europe) reliance on solar roofing panels is expected to continue to increase on both new and existing buildings of different types (agricultural buildings, warehouse, industrial building, offices ..). In the case of constructions made of prepainted materials, the durability of the prepainted roof should be at least equal to that of the PV modules e.g. 25 to 30 years. This represents a construction challenge when installing PV modules due to different warranties. Hence, this may require the removal and reinstallation of the PV with replacement of the roof, forcing owners to incur not only the costs of new roofing materials and labor, but also for the reinstallation of the PV panels. It is indeed critical to mount PV modules on existing roofs. PV panels can be installed using different types of roof mounts with or without penetration mounting and using different mounting systems.

PV panels installed on prepainted steel roof, shield the roof from the sun and prevent beneficial washing from rainfall. Areas on the roof directly beneath the PV panels are considered to be unwashed and may be subject to accelerated corrosion due to an accumulation of dirt, salt and other airborne contaminants, which may retain moisture for extended periods due to condensation or high humidity. Upon the design of the roof, different mounting systems may be used for assembling the PV modules creating different types of geometries between the PV module and the coil coated roof. Hence, it may influence the microclimate (T, RH, condensation) in the interstice between PV and prepainted roof.

Under PV modules, a large part of the surface is unwashed and may accumulate dirt, salts or any airborne substances that may have a detrimental impact on the corrosion resistance of prepainted steel materials. As the life duration of PV modules is expected to be at least 25 to 30 years, prepainted steel materials underneath shall also endure similar duration which require the choice of an adapted product for such conditions.

There is thus a need to study the conditions underneath PV modules and the behaviour of prepainted steel materials upon the geometry of the assembly.

Project aims:

- To evaluate the possible degradations of coil coated materials under PV panels upon mounting designs
- To collect the microclimatic data between the PV panel and the coil coated sheet
- To define guidelines for good practice in this field

## BUILDING AND INFRASTRUCTURE

Project Title: <b>Data base on the corrosion performance of coil coated steel materials</b>		Acronym: <b>Coildatabase 2</b>
Research area: <b>Building and Infrastructure, Coil coating</b>	Project period: <b>01/01/2025 – 31/12/2027</b>	
Research leader: <b>Nathalie Le Bozec</b> nathalie.lebozec@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>MRC Coil Coated Steel</b>	
	Keywords: Database, coil coated steel, outdoor exposures, corrosion tests, weathering tests	

Valuable data were obtained in CoilDatabase 1 project during the period 2017-2025 on a set of 13 commercial prepainted galvanised steel and zinc materials including 8 Z275, 1 Z100, 1ZM, 1AZ, 1 AM and 1 Zn substrates. Data from various laboratory tests (corrosion, weathering, blistering) and long-term outdoor exposures in marine and rural environments in temperate region as well as in marine-tropical atmosphere were collected and summarized in a previous project, constituting a unique database on commercially available products from 2017.

Since 2017, new products have obviously been developed at coil coaters and are available on the market. Thus, it was decided to select newly available prepainted materials to build a new database on 2025 commercial products. A larger number of materials will be selected for the new project.

**Project aims:**

The aim of the project is to build a new database on a set of commercial coil coated materials from 2025 based on results from field exposures as well as exposure in various corrosion testing or weathering tests. This database may be used to predict the corrosion behavior of coil coated steel materials.

## BUILDING AND INFRASTRUCTURE

Project Title: <b>Accelerated Corrosion Test for Coil Coated Aluminum</b>		Acronym: <b>ACT-AI</b>
Research area: <b>Building and Infrastructure, Coil coating</b>	Project period: <b>01/03/2018 – 30/06/2027</b>	
Research leader: <b>Nathalie Le Bozec</b> nathalie.lebozec@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>Industrial funding</b>	
	Keywords: Coil-coated aluminum, Accelerated tests, marine atmosphere	

The development of prepainted metal products for the building and construction market usually requires prolonged exterior exposure studies in order to validate product performance. An accelerated corrosion test that correlates with exterior exposure studies would enable the coil coated industry to shorten their development time for new products and reduce the cost of their research programs.

During the last 10 years, some efforts have been made by the Steel Industry for developing better reliable corrosion test for prepainted steel products in order to replace the conventional neutral salt spray test that is known to fail in reproducing real degradation. A project sponsored to ECCA is on-going at the French Corrosion Institute (FCI) to optimize the testing conditions on the basis of the so-called Test 1A.

Considering coil coated aluminum products, there is also a need to develop accelerated testing conditions that simulate service conditions in better way than the acetic salt spray test (ASST) currently used by the industry. Since 2008, some projects under the frame of ECCA were conducted at SINTEF in particular with the aim to develop an accelerated corrosion test for coil coated aluminum. The resulted test was able to reproduce similar degradations e.g. filiform corrosion from scribes or cut-edges. They were some limitations to the work carried out in this program and it was agreed that further development activity was required.

ECCA: European Coil Coated Association

### Project aims:

The aim is to develop an accelerated corrosion test for prepainted aluminum products that correlates with exterior weathering performance. The test must be able to be used in commercially available equipment and would become the standard for the coil coated aluminum industry.

## BUILDING AND INFRASTRUCTURE

Project Title: <b>Partial repairs of concrete structures - Methodology to ensure extend-service life</b>		Acronym: <b>BBTCORR</b>
Research area: <b>Building and Infrastructure, Corrosion in concrete</b>	Project period: <b>01/06/2023 – 31/03/2026</b>	
Research leader: <b>Bror Sederholm</b> bror.sederholm@ri.se Tel: +46 73 512 78 44	Source of funding: <b>Industrial funding /Public funding (Swedish Road Administration)</b>	
	Keywords: Corrosion, concrete structures, chloride environments, repair materials	

Both in Sweden and Norway, the Swedish Transport Administration and the National Road Administration have drawn attention to the fact that concrete damage caused by reinforcement corrosion occurs locally. The problem has also come to the fore within the nuclear power industry in, among other things, cooling water ways. This has meant that the question of the choice of suitable repair methods has become relevant to minimize traffic disruptions at the Swedish Transport Administration and operational disruptions within the nuclear power industry. It will be important to avoid traffic and operational disruptions in above all road tunnels and cooling waterways where local repairs are and will be a used repair method for concrete structures. According to the Swedish Transport Administration, local repairs are made to bridge piers, bridge slabs, retaining walls and edge beams and retaining walls. There is uncertainty regarding the choice of repair material and methodology to avoid damage in the transition zone between repaired and original concrete. Previously carried out local repairs on, among other things, Öland's bridge, have proved to be not permanent.

In the project, it is planned to test the corrosion protection ability of different repair materials using a laboratory method that was previously developed. In connection with the testing, the chloride-binding properties of the repair materials and the resistivity of the repair material are also analyzed. The properties are considered important to achieve a permanent repair.

The chlorides can be transported from the old chloride-contaminated concrete to the boundary layer between repair and old concrete, which can be one of the reasons why new corrosion can start. It is therefore important that the repair is carried out in the right way to prevent the chloride levels from increasing in certain places along the reinforcement.

**Project aims:**

- The aim of the project is to develop suitable repair materials to avoid corrosion in the existing concrete structure using permanent local repairs.
- The goal of the project is to show which types of repair materials are most suitable to be used to permanently repair localized concrete damage caused by reinforcement corrosion in chloride-containing environments.

## BUILDING AND INFRASTRUCTURE

<b>Project Title:</b> <b>Development of measurement method to determine the risk of necking on steel piles</b>		<b>Acronym:</b> <b>BBTPILE</b>
<b>Research area:</b> <b>Building and Infrastructure, Corrosion in soil</b>	<b>Project period:</b> <b>01/09/2023 – 31/12/2026</b>	
<b>Research leader:</b>  <b>Jonas Engblom</b> jonas.engblom@ri.se Tel: +46 72 546 2171	<b>Source of funding:</b> <b>Industrial funding /Public funding (Swedish Road Administration)</b>	
	<b>Keywords:</b> Corrosion in soil, Infrastructure, Material efficiency, Piling	

Steel pilings are, after concrete pilings, the most used type of piling in Sweden. The most common method of preventing corrosion to ensure the technical lifetime of the piling is through the use of a corrosion allowance, which means an over-dimensioning of the pilings. This over-dimensioning is based on empirical values from exposure studies, from which the corrosion rate has been extrapolated. When high corrosion rates have been recorded, these has been limited to a vertically restricted area, a phenomenon commonly referred to as "necking". Despite this, the corrosion allowance for the entire piling has been based on the corrosion rate of this small area. In a previous project, a method for assessing the risk of occurrence of necking has been developed and compared with long time exposures with good results. In the planned project, the method will be further developed to improve practical use as well as the scientific value. The ambition is to enable a method that already in the planning stage of a construction project can assess if there is a risk of necking or not. If there is a risk, additional corrosion protection, or increased corrosion allowance, can be applied to the critical part of the piling. Dimensioning the corrosion allowance based on the need contributes not only to safer construction, but also to potential material savings. These material savings are planned to be calculated using LCA in the end stage of the project.

**Project aims:**

- Validation of a new type of sensor designed to detect small aeration cells (necking).
- Determination of proper field application, such as installation time, time of the year for installation, temperature fluctuations, etc.

## BUILDING AND INFRASTRUCTURE

<b>Project Title:</b> <b>Coating ageing of buried structures in environments chemically affected by the cathodic protection – effect of alkaline interface</b>		<b>Acronym:</b> <b>Coatage II</b>
<b>Research area:</b> <b>Building and infrastructure, Corrosion in soil</b>	<b>Project period:</b> <b>01/01/2024 – 31/12/2026</b>	
<b>Research leader:</b> <b>Krystel Pélissier &amp; Erwan Diler</b> krystel.pelissier@institut-corrosion.fr erwan.diler@institut-corrosion.fr Tel: +33 2 98 05 15 52	<b>Source of funding:</b> <b>Cost shared industry</b>	
	<b>Keywords:</b> FBE, 3LPE, Liquid Epoxy, cathodic protection, EIS, water uptake, Glass Transition temperature	

The corrosion of buried structures is usually mastered by the combination of organic coatings and cathodic protection (CP). However, detrimental interaction between these two protections can be observed on site either by the induced cathodic disbondment or by the chemical aging of the coating due to the local environment (induced by the CP).

In soil, under CP, the limited species diffusion and the possibly high current demand can lead to pH as high as 14 at the vicinity of the defect. Such environment also containing oxygen radicals might be particularly severe for organic coatings. In a study performed at IC, old disbonded coatings (hydrocarbons and Fusion Bonded Epoxy) were characterized by electrochemical impedance spectroscopy (EIS). The obtained results show that with time the coating resistance strongly decrease. This behavior was reproduced under CP simulated conditions in laboratory on industrial coatings. Additional work performed at IC have demonstrated the significance of taking into account alkaline ageing of coating when considering the overall performance of the coating when considering LE, FBE and 3LPE.

In this project, industrial coatings will be exposed during several months to environment representative of CP in soils. The coating resistance and/or aging will be characterized by a combination of methods: EIS and water uptake on free membrane and coated steel. In addition, coating delamination susceptibility to alkaline ageing will be assessed on specimens with unprotected edges and on coating with circular defects.

**Project aims:**

- To study the kinetic of coating degradation as a function of the pH and the temperature.
- To assess coating delamination due to alkaline ageing on coated steel.
- To better understand degradation and disbondment mechanisms due to alkaline ageing.
- To propose a representative accelerated tests for organic coating development and qualification, more resistant to alkali-induced cathodic protection environment.

## BUILDING AND INFRASTRUCTURE

Project Title: <b>Worldwide exposures: Determination of corrosion in soil</b>		Acronym: <b>Worldsoil</b>
Research area: <b>Building and infrastructure, Corrosion in soil</b>	Project period: <b>01/01/2022 – 31/12/2027</b>	
Research leader: <b>Abdelkader Meroufel &amp; Dominique Thierry</b> Abdelkader.meroufel@ri.se Tel: +46 73 047 2263	Source of funding: <b>Cost shared industry</b>	
	Keywords: Corrosion in soil, worldwide exposure, metallic coatings, stainless steel	

The corrosion of ferrous metals in soils is a major problem for owners and managers within the infrastructure and energy sectors, such as water, sewerage, oil and gas distribution systems, solar energy parks etc.

The study of the corrosion of buried pipes has a long and substantial history. Soil is a complex environment involving solid particles, gas and liquid phases. Corrosion in soils is a multiscale process and it is believed to be controlled both by the microenvironment (film/droplet formation, diffusion/migration of water, oxygen, and other species) and the macro environment (rain and temperature).

In addition, due to the large number of parameters that influence corrosion in soil, it is rather difficult to fully simulate field conditions at the laboratory scale. Hence, the present project will focus on field exposures of materials in soils with different characteristics. The project will include sites with high and moderate temperatures and high and low moisture content. The project will focus on condition where cathodic protection is not applied. Following the initial results of 2 years exposure, the project will continue to obtain longer time corrosion data and materials behaviour.

Project aims:

- To evaluate the performance of different materials and coatings used for soil applications.
- To assess the risk of preferential soil corrosion attack on ZnAlMg coatings.
- To generate data on a worldwide basis that could be used as input data in modelling.

## BUILDING AND INFRASTRUCTURE

<b>Project Title:</b> <b>Development of accelerated laboratory soil corrosion testing method</b>		<b>Acronym:</b> <b>AccelabCorr</b>
<b>Research area:</b> <b>Building and infrastructure, Corrosion in soil</b>	<b>Project period:</b> <b>01/01/2024– 31/12/2027</b>	
<b>Research leader:</b> <b>Abdelkader Meroufel &amp; Dominique Thierry</b> Abdelkader.meroufel@ri.se Tel: +46 73 047 2263	<b>Source of funding:</b> <b>Cost shared industry</b>	
	<b>Keywords:</b> Soil corrosion, sensors, laboratory exposure, metallic coatings	

Soil corrosion remains one of the complex phenomena facing buried metallic structures. This is due to the involvement of different variables with different natures i.e. chemical, physical, microbiological. Different approaches of soil corrosion acceleration in laboratory are described in literature including exposure of materials to soil simulated solution electrolyte, cycling certain parameters (wet/dry cycles). These methods can have number of challenges of representativity or parameters control when it comes to the heterogenous and complex soil. A third method that may be promising is a parametric study where an optimization of key corrosion factors can be conducted step wise. This method offers the advantage of using natural soil, ease of implementation and better control of parameters under laboratory conditions. The final obtained corrosion data will be managed using appropriate mathematical/statistical or Artificial Intelligence (A.I) tools.

**Project aims:**

- To develop a reliable and representative method to study soil corrosion in short time to overcome the limitation of long field exposures in natural soils.
- To generate laboratory corrosion data in natural soils with different representative conditions.
- To develop a mathematical/statistical model to manage soil corrosion data obtained in both accelerated lab method and field data from Worldsoil project.
- To validate the laboratory method through a round robin test via the involvement of different partners upon the availability of facilities.
- To propose a testing method that could be the first step in a recognize international standard to test metallic materials in soil under controlled laboratory conditions.

## BUILDING AND INFRASTRUCTURE

Project Title: <b>Worldwide exposure of metallic coated steel panels</b>		Acronym: <b>Worldcoat 2</b>
Research area: <b>Building and infrastructure, Construction</b>	Project period: <b>01/01/2017 – 31/12/2027</b>	
Research leader: <b>Nathalie Le Bozec</b> nathalie.lebozec@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>Cost shared industry</b>	
	Keywords: Zinc coated steel, field exposure	

In 2011, a project was initiated at the French corrosion institute with the aims to define the corrosion behavior of hot-dip galvanized steel, ZnAl and ZnAlMg coated steel at 14 different field stations worldwide. 1, 2, 4- and 6-years data have been collected.

In addition, analyses of corrosion products have been performed after 2 and 4 years of exposure.

As indicated before although the project has generated very valuable results, there are still questions that remain. For instance, as the corrosion was highly localized on all metallic coatings, the measurements of mass loss are questionable and may not reflect the localized corrosion observed on all coatings.

In addition, new metallic coatings with addition of Al and Mg have been introduced recently on the market and were not included in the first investigation.

Project aims:

- To obtain the long-term (e.g. up to 10 years) behavior of ZnAl and ZnAlMg coated steel (in particular with respect to red rust) and compare it with hot-dip galvanized steel.
- To obtain a full picture of the performance of ZnAl and ZnAlMg coated steel worldwide.

## BUILDING AND INFRASTRUCTURE

<b>Project Title:</b> <b>Evaluation of corrosion and bi-metallic corrosion of fasteners for solar modules fasteners</b>		<b>Acronym:</b> <b>SolarBolting</b>
<b>Research area:</b> <b>Building and Infrastructure, Construction</b>	<b>Project period:</b> <b>01/11/2025 – 31/12/2028</b>	
<b>Research leader:</b> <b>Nathalie Le Bozec</b> nathalie.lebozec@institut-corrosion.fr Tel: +33 298 05 15 52	<b>Source of funding:</b> <b>Cost shared industry</b>	
	<b>Keywords:</b> Fasteners, Galvanic Corrosion, Outdoor atmosphere	

Renewables grow rapidly in all scenarios, with solar energy at the center of this new constellation of electricity generation technologies. Solar energy can generate heat and electricity, giving rise to two technologies: solar thermal power that collects and transforms sunlight into heat and then often into electricity; and photovoltaic (PV) technology which converts sunlight directly into electricity.

The most common corrosion issue in PVs is atmospheric corrosion of the metallic components of the mounting system (aluminium, steels, stainless steel, etc.). The effects of climate, atmospheric pollution, sea/salt spray cannot be neglected because they may lead to significant degradations. Bi-metallic corrosion is a specific problem because most of the racking system components and solar module frames are made of aluminium alloys, but some bolts and nuts are made of stainless steel, galvanized steel and other materials that may be more noble compared to the aluminium frame.

In general, fasteners are in direct electrical contact to different materials (e.g. such as aluminium 6xxx, zinc magnesium aluminium coated steel and others). This may create a potential galvanic coupling between the fasteners and the other materials. In mild conditions such as C3 (far from the seashore), the only potential electrolytic material that can be present is rainwater or dew. Both forms of water are poor electrolytic materials since they do not contain much salt and ions which would make them conductive. Hence, the reaction will be limited at the point of contact. However, under more aggressive conditions, (e.g. C5 sheltered and unsheltered), the risk of galvanic corrosion is generally not negligible and needs to be quantified.

Thus, there is a need to evaluate different carbon steel bolting alternatives (e.g. galvanized steel, zinc flake and ZnNi) as well as stainless steel bolting in marine atmospheric conditions both with respect to corrosion and risk for bi-metallic corrosion when coupled to other materials.

**Project aims:**

- To assess the corrosion of different zinc coated steel based and stainless steel fasteners in different environments
- To evaluate the risk of bi-metallic corrosion of various zinc coated steel based and stainless steel fasteners when coupled to materials generally used for solar frame structure (e.g. aluminium, zinc aluminium magnesium coated steel, stainless steel...)

## BUILDING AND INFRASTRUCTURE

Project Title: <b>Quaternary zinc-based sacrificial coatings for steel</b>		Acronym: <b>QUAZCOAT</b>
Research area: <b>Building and Infrastructure, Transport Construction</b>	Project period: <b>01/09/2026 – 31/08/2029</b>	
Research leader: <b>Nathalie Le Bozec , Dominique Thierry</b> nathalie.lebozec@institut-corrosion.fr dominique.thierry@ri.se	Source of funding: <b>European funding (RFCS)</b>	
	Keywords: ZnAlMgSi, microstructure, corrosion, pretreatments, paint	

While ZnAlMg (ZM) coatings provide significant improvement over traditional Zn coatings applied on steel, further developments are required to increase the corrosion resistance (specifically at cut edges, in confined areas and in paint/coating defects), to improve the compatibility with current surface treatment methods and to mitigate formability aspects due to coarser microstructure and presence of large brittle phases preventing wider applicability in the coil-coating and automotive sectors.

The alloying with silicon is believed to solve several shortcomings of ZM coatings linked to their coarse and heterogeneous microstructures and lead to significantly broader acceptance of this new family of coatings with superior corrosion resistance.

**Project aims:**

- To develop new quaternary ZnAlMgSi (ZM-Si) coatings, one primarily for automotive applications and the other for building applications.
- To improve the corrosion resistance compared to ZM by at least 30 % in view of mass loss and time to red rust.
- To identify the combination of Si-alloying and specific production parameters to achieve maximal microstructure refinement.
- To demonstrate the benefits of the uniform microstructure in view of better formability and other properties relevant for principal areas of end-user applications.

## BUILDING AND INFRASTRUCTURE

Project Title: <b>The International Co-operative Programme on Effects on Materials including Historic and Cultural Monuments</b>		Acronym: <b>ICP Materials</b>
Research area: <b>Building and Infrastructure, Cultural Heritage</b>	Project period: <b>01/01/1987 - Undefined</b>	
Research leader: <b>Johan Tidblad</b> johan.tidblad@ri.se Tel: +46 10 228 48 78	Source of funding: <b>Public funding (UN and The Swedish Environmental Protection Agency)</b>	
	Keywords: Air pollution, Atmospheric corrosion, Atmospheric soiling, Atmospheric degradation, Cultural heritage	

The International Co-operative Programme on Effects on Materials, including Historic and Cultural Monuments (ICP Materials) started in 1985. It was initiated in order to provide a scientific basis for new protocols and regulations developed within the Convention on Long-range Transboundary Air Pollution.

**Project aims:**

- Perform a quantitative evaluation (dose-response functions) of the effects of multi-pollutants such as S and N compounds, O<sub>3</sub> and particles as well as climate parameters on the atmospheric corrosion and soiling of important materials, including materials used in objects of cultural heritage.
- Describe and evaluate long-term corrosion and soiling trends attributable to atmospheric pollution in order to elucidate the environmental effects of pollutant reductions achieved under the Convention and in order to identify extraordinary environmental changes that result in unpredicted materials damage.
- Use the results for policy purposes for the benefit of the Convention by i.a. mapping areas with increased risk of corrosion and soiling and for calculation of cost of damage caused by deterioration of materials.

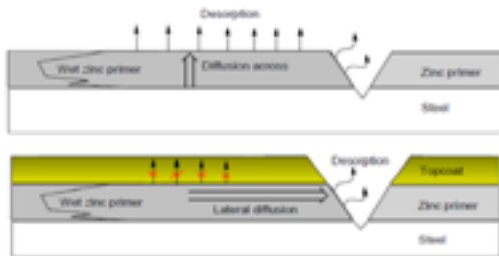
## BUILDING AND INFRASTRUCTURE

<b>Project Title:</b> <b>Plastic Free Corrosion Protection for CX -environments</b>		<b>Acronym:</b> <b>PFCX plastic free</b>
<b>Research area:</b> <b>Building and Infrastructure, Paint</b>	<b>Project period:</b> <b>01/01/2021 – 31/12/2027</b>	
<b>Research leader:</b> <b>Björn Tidbeck</b> Bjorn.tidbeck@ri.se Tel: +46 72 734 08 17	<b>Source of funding:</b> <b>MRC Corrosion Protection + FC</b>	
	<b>Keywords:</b> Environmentally sustainable coatings, Microplastics	

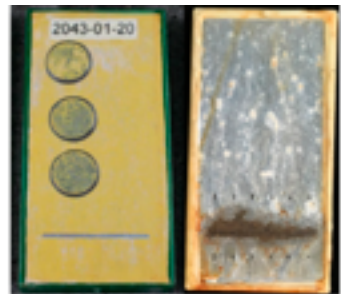
During 1972-1973, NASA carried out an extensive investigation comprising 200 different coating systems based on zinc rich coatings. One of the conclusions from the study was that zinc rich coatings perform better without topcoats. One possible mechanism explaining this result may be that water ingress into the zinc primer may degrade the primer prematurely in multicoat systems. And a better approach may be to use a topcoat with higher water permeability, see Figure 1.

In this study, alternative topcoats for zinc silicates will be trialed in an attempt to develop a completely inorganic, two coat CX system. It is envisioned that such a system would not attribute a source of microplastics whilst offering increased durability, lower VOC emissions, less chemical hazards, and less risk of fire compared to traditional systems based on epoxy and polyurethane.

The project has been preceded with a study on microplastic emissions from marine coatings. Initial trials have been very promising, see figure 2. This project includes more extensive evaluation by both accelerated and outdoor corrosion testing in CX environments.



**Figure 1.** Drying of a zinc silicate without topcoat vs a silicate with topcoat



**Figure 2.** Initial trials after CX testing  
 To the left: silicate topcoat. To the right reference

Project aims:

- To develop a plastic free coating system for CX/ offshore environments
- To develop a CX coating system with reduced VOC emissions, chemical hazards and Risk of fire.
- To develop a CX coating system with reduced cost.

## BUILDING AND INFRASTRUCTURE

<b>Project Title:</b> <b>Network for materials and Products in contact with drinking water</b>		<b>Acronym:</b> <b>Drinking water network</b>
<b>Research area:</b> <b>Building and Infrastructure, Water distribution</b>	<b>Project period:</b> <b>01/01/2025 – 31/12/2026</b>	
<b>Research leader:</b> <b>Charlotta Obitz</b> charlotta.obitz@ri.se Tel: +46 10 228 48 62	<b>Source of funding:</b> <b>Cost shared industry</b>	
	<b>Keywords:</b> Drinking water, Materials, Products, Legislation	

This network gathers relevant actors along the drinking water chain, such as manufacturers, industry associations, drinking water suppliers, authorities, and researchers, who are interested in the topic of materials and products in contact with drinking water.

The network offers the opportunity to exchange knowledge about current legislation, up-to-date research, industrial challenges as well as material and product development. The network maintains close contact with the European Commission and national authorities on the new legislation and approval systems for materials and products in contact with drinking water. We also regularly invite other European stakeholders to present at our seminars (RTOs, industries, water suppliers) and exchange ideas and best practices in the field.

Our members get the opportunity to meet annually through two seminars. We also send a newsletter every year where essential information regarding materials and products in contact with drinking water is given. The network raises members' questions and needs in the area of materials and products in contact with drinking water.

**Project aims:**

- Have up-to-date information about legislation, regulations, industry challenges, research, and material and product development.
- Exchange of experience in this area.
- Develop contacts with other stakeholders incl. Authorities.
- Possibility to present your own innovations and research.

## BUILDING AND INFRASTRUCTURE

<b>Project Title:</b> <b>Impact of heat tinted oxides from welding operation on the localized corrosion susceptibility of stainless-steel alloys</b>		<b>Acronym:</b> <b>SSweld</b>
<b>Research area:</b> <b>Building and infrastructure, Water distribution</b>	<b>Project period:</b> <b>01/03/2022 – 01/12/2026</b>	
<b>Research leader:</b> <b>Charles Leballeur</b> charles.leballeur@institut-corrosion.fr Tel: +33 2 98 05 15 52	<b>Source of funding:</b> <b>Cost shared industry</b>	
	<b>Keywords:</b> Stainless steel, welding, localized corrosion, chloride.	

Stainless steel alloys are widely used in different sector of activity involving all kind of water transportation, from drinking water application to seawater desalination. For all these applications, welding of stainless-steel products is very common. If the good practices for welding of stainless steel are widely known, the operating conditions can sometimes make them difficult to apply. End-user feedback has shown that numerous cases of pitting corrosion at welded areas are due to improper welding operation. Indeed, operating conditions can lead to difficulty to apply a perfect inerting which lead to the formation of heat tinted oxides. These oxides are known to potentially reduce the corrosion resistance of stainless steel. Pickling & repassivation of inner welding surfaces can be a solution to recover stainless steel corrosion properties. However pickling operations are sometimes not possible due to field constraints. Some authors have considered the existence of a chromium depleted zone beneath the oxide as the main cause of an observed decrease in corrosion resistance. However, other authors disagree and suggested other mechanisms explaining the presence or lack of a chromium-depleted zone. One practical factor often correlated to the corrosion resistance is the color of the tint. According to von Moltke et al, the color of the oxide is only an indication of the thickness of the oxide, not the composition or the corrosion resistance. In contrast, Kearns connected the corrosion resistance to the color of the heat tint, finding that a rose-colored tint had lower corrosion resistance than the straw colored. Enrichment of iron in the outermost oxide as well as in oxides above a certain thickness has been shown to decrease the corrosion resistance of stainless steels with heat tints in chloride environments. Standard AWS D18.2 classified different levels of tinted oxides as a function of the residual oxygen level from purging gas operation during welding. However, no relevant information can be found in the literature regarding the magnitude of tinted oxides on the corrosion resistance of stainless steel (i. e. lack of quantified engineering diagrams based on corrosion testing). Therefore, there is an interest to quantify the corrosion resistance decrease of stainless-steel welds as a function of the residual tinted oxides (i. e. as function of inerting quality).

For this study the corrosion susceptibility of selected stainless-steel grades will be investigated as a function of the heat tint levels achieved from controlled welding operation at different oxygen levels. Testing will be conducted with different chloride concentrations adapted to tested grades, with the aim to provide guidelines for the use of welded stainless steel with residual oxides in service conditions. The global aim is to provide engineering data and scientific knowledge to decide acceptable welding results when not achieved in perfect inerting conditions.

**Project aims:**

- Assess the corrosion resistance of different stainless-steel grades in chloride containing solution as a function of the controlled heat tinted levels
- Determine criteria of acceptance for weld discoloration in term of corrosion resistance
- Characterize the passive films properties to better understand the detrimental factors to be regarded.

## BUILDING AND INFRASTRUCTURE

Project Title: <b>Data base building for the use of stainless steels and Ni-base alloys in brines and Industrial water</b>		Acronym: <b>Brines and Water</b>
Research area: <b>Building and infrastructure, Water distribution</b>	Project period: <b>01/01/2025 – 31/12/2027</b>	
Research leader: <b>Charles Leballeur</b> charles.leballeur@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>MRC Brines and Waters</b>	Keywords: Stainless steel, nickel base alloy, industrial water, water distribution, brines, localized corrosion

Considering corrosion, the selection of stainless-steel grades and nickel base alloys for water immersion applications can be made as a function of the chloride content, temperature and pH. Engineering diagrams indicating the limit of use of the different grades are most of the time built from short term standard testing which are not always fully representative of long-term exposure and are most of the time conservative. Furthermore, it seems that there is a lack of data for crevice corrosion, especially for environments with high chloride content.

Therefore, there are some interests to challenge these engineering diagrams but also to refine them for specific environments (waters with very high chloride content for instance) or configurations (crevice corrosion) with the aim to provide reliable data base for material selection.

**Project aims:**

The main aim of this project is to provide useful and reliable data for the material selection of passive alloys in water-based electrolyte.

- The first task will consist of gathering data from literature and field experiences available (open literature and/data shared by partners).
- Then corrosion testing will be carried out to complete and/or refine the already database collected through the first task.
- Corrosion testing will mainly consist in mid- or long-term immersion tests. However, the reliability of short-term testing method will also be assessed by comparison with long-term testing.

## BUILDING AND INFRASTRUCTURE

<b>Project Title:</b> <b>Brass Replacement Alloys Validation Operations II</b>		<b>Acronym:</b> <b>BRAVO II</b>
<b>Research area:</b> <b>Building and infrastructure, Water distribution</b>	<b>Project period:</b> <b>03/Nov/2025 – 02/Nov/2028</b>	
<b>Research leader:</b> <b>Charlotta Obitz</b> charlotta.obitz@ri.se Tel: +46 73 088 76 75	<b>Source of funding:</b> <b>Public funding (Vinnova)</b>	
	<b>Keywords:</b> Brass, lead-free, circular economy	

BRAVO II aims to enable the sustainable industrial implementation of a lead-free brass ecosystem in Sweden and the Nordic region. The project addresses remaining technical and economic challenges identified in the BRAVO feasibility study and follows a joint roadmap toward a sustainable lead-free brass system by 2031. The Swedish brass industry is currently circular, with more than 90% of the material based on recycled content. To maintain this circularity in a lead-free system, the entire value chain must be optimized, and systems for separating lead from brass must be implemented. Efforts in alloy and process optimization using digital tools, laboratory testing, and industrial trials will contribute to the framework for a robust system. An innovation forum for machining will help solve technical challenges and minimize manufacturing costs. The project will integrate life cycle and cost analyses to ensure technical, environmental, and economic sustainability. The project deliveries will include business models, investment plans, and guidelines for material composition and manufacturing methods for a resilient production system. Through broad collaboration between industry, researchers, and authorities, the project will contribute to fulfilling the EU Drinking Water Directive without negatively impacting other aspects. This also strengthens the Nordic industry's competitiveness and supports the phase-out of lead from society. By the end of the project, the transition will be partially implemented, with plans in place for full implementation by 2031.

**Project aims:**

The overall objective of the project is the full-scale implementation of a sustainable and economically viable circular industry for lead-free brass alloys in Sweden and the Nordic region. The project BRAVO II contributes to the following goals, identified in the feasibility study and presented in the road map for the transition of the brass industry:

- Establish a comprehensive and validated business model and commercialization strategy for a circular lead-free brass industry in Sweden and the Nordic region, integrating techno-economic analysis (TEA) and life cycle assessment (LCA) to ensure environmental, societal, and economic viability.
- Develop and deliver a detailed implementation and investment plan for industrial-scale lead removal technologies, including facility design and decision-support tools for adoption across the value chain.
- Define and propose material specifications, both compositions and process parameters for lead-free brass alloys, ensuring optimized mechanical properties, corrosion resistance, and system robustness under variable production conditions.
- Create a centralized data bank documenting the performance of lead-free brass alloys in diverse water qualities and under different machining and production methods, to support informed material selection and product design that can be used in the companies' transition process.

## BUILDING AND INFRASTRUCTURE

Project Title: <b>Brass Streams for Optimal Use and Zero Loss</b>		Acronym: <b>BRAZERO</b>
Research area: <b>Building and infrastructure, Water distribution</b>	Project period: <b>15/11/2025 – 15/11/2027</b>	
Research leader: <b>Charlotta Obitz</b> charlotta.obitz@ri.se Tel: +46 73 088 76 75	Source of funding: <b>Public funding (Swedish Energy Agency)</b>	
	Keywords: Brass, drinking water, alloy development	

The BRAZERO project aims to enable a sustainable transition to lead-free brass in the Swedish brass industry by addressing the most urgent challenges linked to that transition, which are optimizing recycling flows and defining acceptable levels of residual elements in alloys. The background is new EU requirements for lead-free materials in drinking water products from 2027, which requires extensive developments within the industry. The project focuses on ensuring continued circularity and low climate impact in production. Through four work packages, the project will develop material flow models, guidelines and technical solutions for robust, recycling-friendly alloys. The results are utilized by a broad Nordic consortium representing the entire value chain and disseminated to the industry, authorities and standardization bodies. The project contributes to sustainable resource use, strengthened competitiveness and reduced lead exposure in society.

**Project aims:**

- An external analysis (mapping of relevant laws and international status) and analysis of obstacles and opportunities for implementing the project results as well as a clear description of today's material flows between the various main actors in Sweden for brass materials with a focus on water system applications. This will be completed in May 2026 and presented at a workshop in June 2026.
- One/several charts of acceptable levels of residual elements in recycled raw materials to guarantee sufficient final properties and producibility, completed in September 2027.
- A decision basis for optimized scrap and material flows and an optimized ecosystem for lead-free brass. This will be the final result of the project, which will be completed in October 2027 and presented in a seminar in November 2027.

## BUILDING AND INFRASTRUCTURE

Project Title: <b>Dissolution and corrosion of brass – influence of temperature and water quality</b>		Acronym: <b>DissCorr</b>
Research area: <b>Building and infrastructure, Water distribution</b>	Project period: <b>1/2/2025 – 30/06/2026</b>	
Research leader: <b>Charlotta Obitz</b> charlotta.obitz@ri.se Tel: +46 73 088 76 75	Source of funding: <b>MRC Brass Alloys</b>	
	Keywords: Brass, drinking water, AESEC, dissolution	

Atomic Emission Spectroelectrochemistry (AESEC) is a relatively new technique that enables quantitative monitoring of corrosion processes in different media under various accelerated scenarios. AESEC complements traditional electrochemical measurements by providing kinetic information about electrochemical reactions while simultaneously measuring the elemental dissolution from the material. In the literature, the technique has been used to study the corrosion mechanism of dezincification in several alloys in a synthetic water environment. These studies conclude that the most probable dezincification mechanism is the so-called “dissolution–re-deposition mechanism.”

With AESEC, we see potential to monitor metal leaching during a standard electrochemical polarization curve—an approach used to accelerate corrosion — allowing the most likely corrosion mechanism to be determined under the different test conditions and how it is linked to dissolution of metals to the water. Dissolution of metals to the water is of high importance for drinking water applications. The link between dissolution of metals and corrosion is currently missing in the evaluation of drinking water contact materials.

### Project aims:

The objective is to evaluate AESEC as a potential method for assessing corrosion and leaching behaviour of materials within the framework of an accelerated test, and to identify the dominant corrosion mechanisms under the various test conditions. Specifically, the aim is to study the following:

- The difference in corrosion mechanisms between standard tap water (TW3) and desalinated seawater.
- The difference in corrosion mechanisms between warm water (55 °C) and cold water.
- How, and if, the method can support the evaluation of different brass alloys in various applications and water qualities.
- A comparison of metal dissolution results with data from the NEWLEAF rig test in order to correlate this method with non-accelerated processes.

## BUILDING AND INFRASTRUCTURE

Project Title: <b>Stress corrosion cracking of brass components – influence of applied torque</b>		Acronym: <b>SCCBrass</b>
Research area: <b>Building and infrastructure, Water distribution</b>	Project period: <b>1/01/2026 – 1/01/2027</b>	
Research leader: <b>Charlotta Obitz</b> charlotta.obitz@ri.se Tel: +46 73 088 76 75	Source of funding: <b>MRC Brass Alloys</b>	
	Keywords: Brass, drinking water, stress corrosion	

The background to SCCBrass are reoccurring discussions among the MRC partners on relevant risk factors for cracks in brass products. Brass alloys are in general susceptible to stress corrosion cracking if both corrosive environment and stresses are present. Within the project, two different alloys will be tested at four different torques in ammonia environment according to ISO 6957. After testing will the different components be visually inspected and the number of cracks and cracks length will be evaluated in cross sections. The results will also be compared to another study conducted within the BRAVO project focusing on the internal stresses and stresses associated with machining.

**Project aims:**

- Evaluate and define a critical stress level based on the applied torque on brass products.
- Evaluate the impact of the applied torque versus internal stresses from machining and other process steps. These results will be received upon collaboration with the BRAVO II project.
- Contribute to installing recommendations for durable water installations.

## MARINE MATERIALS

Project Title: <b>Full-Scale Experiments to Determine the Long-term Effect of Cathodic Protection on Disbondment of 3LPP-coated tubes at bare zones (Bare Field Joint applications)</b>		Acronym: <b>BFJ</b>
Research area: <b>Marine materials, Cathodic protection</b>	Project period: <b>01/02/2022 – 01/09/2026</b>	
Research leader: <b>Nicolas Larché</b> nicolas.larche@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>Cost shared industry</b>	
	Keywords: Cathodic disbondment, bare field joints, cathodic protection, seawater, seabed, heat flux	

To reduce drastically the cost of field operations, it may be considered to eliminate field joint coating completely on pipelines coated with an anti-corrosion coating such as three-layer polyethylene or polypropylene, regarding that bare areas are protected with cathodic protection (CP). This raises the question whether CP will lead to significant disbondment and at which rate.

Institut de la Corrosion developed a test methodology to evaluate CP-induced cathodic disbondment of full scale tubes in natural seawater and in natural seabed, with temperature control inside tubes.

In this new project the cathodic disbondment rate of bare zone of 3LPP-coated tubes will be investigated in natural seawater and in seabed, at different internal temperatures from 25°C to 90°C.

Full-scale tube lengths of diameter 8" are tested. The disbondment rates and associated mechanisms will be studied for exposure durations from 6 to 24 months. The results from full-scale bare zones will be compared to commonly used artificial defects used in standards.

**Project aims:**

The main aim of the project is to quantify the actual disbondment rates of full-scale tube bare field zones under CP, exposed under different conditions in seawater and in seabed.

## MARINE MATERIALS

Project Title: <b>Industrial upscale of surface protection system &amp; fibre optic-based condition monitoring for the Seasnake MVC</b>		Acronym: <b>SEASNAKE+</b>
Research area: <b>Marine materials, Coatings</b>	Project period: <b>15/12/2023 – 15/12/2026</b>	
Research leader: <b>Katarina Bokström</b> Katarina.bokstrom@ri.se Tel: +46 10 228 4960	Source of funding: <b>European funding (Swedish Energy Agency)</b>	
	Keywords: antifouling, shape sensing, connecting devices, energy transport, Marine technology sensors and instrumentation, Cables and pipelines	

### Abstract

The main objective of SEASNAKE+ is to scale-up and demonstrate (TRL6-7) the dynamic medium voltage cable (dMVC) with improved lifetime by easy clean paint; in-line in-situ paint application chamber; in-situ cleaning robot; giving to the cable new and scalable protection system and monitoring system. The SEASNAKE+ dMVC will be validated first at small scale in nearshore condition in two different sites (Swedish west coast and Mediterranean Sea) and once the full-scale prototypes will be ready, in a real ocean environment in the Mediterranean Sea. SEASNAKE+ objectives and activities are based upon the learnings and proof-of-concept (TRL4) of a new lightweight (no armoring) and flexible cable carried out within the previous SEASNAKE.

SEASNAKE+ expands those efforts on European level as key gaps and opportunities have been identified during the projects for scaling up the production and integrate the protection system application into the production, along with new sophisticated and innovative ways to measure cables movement (shape sense) and failure modes in an integrated fiber optic solution.

#### Project aims:

- Increase economic viability by reducing the Levelized Cost of Energy (LCoE)
- Scale up of surface treatment solutions in the production.
- Implement predictive conditioning solutions in the cable design.
- Minimised Environmental Impact & Increased Availability (reliability, maintainability and survivability)
- Demonstration of dynamic cable solutions.

## MARINE MATERIALS

Project Title: <b>Improved, environmentally friendly and plastic free coating systems for offshore corrosion mitigation</b>		Acronym: <b>Green CX Coatings</b>
Research area: <b>Marine materials, Coatings</b>	Project period: <b>01/01/2023 – 31/12/2025</b>	
Research leader: <b>Krystel Pélissier</b> krystel.pelissier@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>MRC Paint and Lining for Steel</b>	
	Keywords: ISO 12944-6, Low VOC, polysiloxane, zinc ethyl silicate	

The application of coatings is an inescapable measure in the constant struggle against material ageing and corrosion. Several measures can be applied to delay corrosion phenomena, but the application of anticorrosive coatings remains one of the best options. The protective coating industry is in constant evolution mostly due to two major driving forces, i) the constant need of improvement of anticorrosive solution for long term performance (and ultimately less maintenance) and ii) the constant evolution of the market regulation (environmental, health) due to a general awareness of the impact of this industry sector. This constant evolution leads to the development of new anticorrosive technologies through the use of novel approach such as reduced content of Volatile Organic Compounds (VOCs) in the formulation. However, no tangible feedback still exists for this type of new technologies despite their increased incorporation in anticorrosive coating architectures (primer, intermediate, topcoat). Even though their low VOCs characteristics make them attractive in terms of environmental concerns, end users are still cautious when considering their uses, regardless of their potential good performance. Indeed, for example, high solid polysiloxane technology is considered as an interesting alternative to traditional polyurethane topcoat when the stability to weathering is considered. However, few studies exist on the performance (corrosion in addition to weathering) of this kind of topcoats tested in field exposure. Another example of low VOCs coating which can be quoted is the use of waterborne zinc silicates. Studies conducted within RISE in the MRC Corrosion Protection have demonstrated the good performance of this type of primer when they were designed as a single coat system. This good behavior was observed both in accelerated testing and in field exposure. One of the drawbacks of this kind of system is the difficulty to design a multi-coat system where the waterborne zinc silicate primer is topcoated. Indeed, their good anticorrosive performance can be lost due to an incompatibility with the topcoat. In light of these findings and observations, a project on topcoats for waterborne zinc silicate will be launched within MRC Corrosion Protection in 2023. A unique opportunity to collaborate between the MRC Paint and the MRC Corrosion Protection is arising when both problematics can be studied together.

Project aims:

- To test different plastic free topcoats for zinc silicate technologies and to assess their performance for C5 and CX atmospheres.
- To assess polysiloxane performance and compare it with traditional polyurethane technology for C5 and CX atmospheres.

## MARINE MATERIALS

Project Title: <b>Biofilm-Induced corrosion of metal structures for Aquaculture Application and development of Adapted Corrosion Sensors for Optimized Maintenance</b>		Acronym: <b>SeaCHEM-DC2</b>
Research area: <b>Marine materials, monitoring and sensors</b>	Project period: <b>01/06/2023 – 01/06/2026</b>	
Research leader: <b>Mohammad Hassanzadeh</b> mohammad.hassanzadeh@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>Public Funding (HORIZON)</b>	
	Keywords: Seawater corrosion, biofilm, fatigue-corrosion, stainless steels, sensors, offshore seaweed aquaculture	

The European Seachem DN project involves a total of 10 doctoral candidates (DC1-10) working on a same global challenge about offshore cultivation and valorization of seaweed. This international training program, encompassing 7 intersectoral partners (5 academic, 1 non-academic) in 4 countries, focuses on innovative technological developments across a range of interdisciplinary fields such as construction engineering, materials science, (micro-)biology, (bio-)chemical engineering, environmental biotechnology and machine learning. The main scientific goal of SeaChem project is to uplift the underdeveloped EU seaweed aquaculture by developing and implementing the next generation of offshore cultivation technologies and advanced extraction processes, thus maximizing the value chain of offshore grown seaweed.

The doctoral candidate DC2 at Institut de la Corrosion will study biofilm-induced corrosion of metal structures for offshore seaweed aquaculture application, and development of adapted corrosion sensors for optimized maintenance. It includes the study of fatigue under crevice corrosion. Results will be combined and linked to DC3 (Mapping of corrosion around marine structures). The overall objective is to gain increased knowledge on biofilm-induced corrosion of stainless steels for seaweed aquaculture application and development of adapted corrosion sensors.

**Project aims:**

The main objective is to identify and analyse main corrosion risks that can be encountered in the concerned metal structures and to define, use and develop monitoring technologies for optimized maintenance regarding corrosion aspects.

## MARINE MATERIALS

<b>Project Title:</b> <b>Environmental Impact of Material corrosion and Anti-corrosion Systems in Offshore Seaweed Aquaculture</b>		<b>Acronym:</b> <b>SeaCHEM-DC4</b>
<b>Research area:</b> <b>Marine materials, monitoring and sensors</b>	<b>Project period:</b> <b>01/02/2023 – 01/02/2026</b>	
<b>Research leader:</b> <b>Caya de Leeuw Van Weenen</b> caya.de.leeuw.van.weenen@institut-corrosion.fr Tel: +33 2 98 05 15 52	<b>Source of funding:</b> <b>Public Funding (HORIZON)</b>	
	<b>Keywords:</b> Environmental impact, Offshore seaweed aquaculture, monitoring, corrosion and anti-corrosion systems, pollution, e-DNA	

The European Seachem DN project involves a total of 10 doctoral candidates (DC1-10) working on a same global challenge about offshore cultivation and valorization of seaweed. This international training program, encompassing 7 intersectoral partners (5 academic, 1 non-academic) in 4 countries, focuses on innovative technological developments across a range of interdisciplinary fields such as construction engineering, materials science, (micro-)biology, (bio-)chemical engineering, environmental biotechnology and machine learning. The main scientific goal of SeaChem project is to uplift the underdeveloped EU seaweed aquaculture by developing and implementing the next generation of offshore cultivation technologies and advanced extraction processes, thus maximizing the value chain of offshore grown seaweed.

The topic for the doctoral candidate DC4 at Institut de la Corrosion is about the environmental impact of material corrosion and anti-corrosion systems involved in offshore seaweed aquaculture, both in terms of seawater pollution and seaweed quality. The main objective is to define, use and develop monitoring technologies for material and pre-existing structures as well as seaweed cultivation/harvesting structures. The monitoring science development will focus on increasing capabilities to both follow and predict materials corrosion and environment specific characteristics. Among others, the monitoring techniques to be explored and developed will be based on image analysis, environmental sensors and also on biomarkers such as e-DNA analysis. The obtained information can then be used in the probabilistic analysis for go/no-go decisions on O&M activities and to define optimal conditions for seaweed cultivation. The deterioration of materials and fouling/algae formation are related to the environment (pH, salinity, temperature etc) which means that DC4 will also gather data on environmental indicators including eDNA, to understand the environment that nurture the seaweed production that will contribute to the European and International Ocean Governance (IOG) ambitions for our oceans to be clean and healthy, resilient, productive and understood. The DC will share data with the other DC candidates of the seaCHEM project. The eDNA analysis could be combined with image of algae cultivation/growth rate/ to predict optimal environmental envelope for seaweed cultivation (using one or several biomarkers).

**Project aims:**

Define and use novel monitoring technologies and/or developed methodology to quantify the environmental impact of corrosion and anti-corrosion systems in seaweed aquaculture and to predict the optimal environmental envelope for seaweed cultivation.

## MARINE MATERIALS

<b>Project Title:</b> <b>Impact of seawater treatment on corrosion resistance of stainless steel and nickel base alloys</b>		<b>Acronym:</b> <b>Treated seawater</b>
<b>Research area:</b> <b>Marine materials, Offshore</b>	<b>Project period:</b> <b>01/01/2024 – 31/12/2026</b>	
<b>Research leader:</b> <b>Charles Leballeur</b> charles.leballeur@institut-corrosion.fr Tel: +33 2 98 05 15 52	<b>Source of funding:</b> <b>MRC Marine Corrosion</b>	
	<b>Keywords:</b> Stainless steel, Marine, offshore, crevice corrosion, dissolved oxygen, chlorination	

Low grade stainless steels and nickel base alloys with PREN < 40 are not recommended for seawater applications. They are known to be susceptible to localized corrosion in chloride-containing electrolytes. However, the use of these alloys can be considered under specific condition. For instance, in seawater injection well, low or very low dissolved oxygen content is reached. Under this specific condition, some low grades alloys have shown to be corrosion free at dissolved oxygen level below 20 ppb. For some applications, varying dissolved oxygen level can be encountered. Therefore, there is an interest to assess the behavior of different materials in natural seawater with reduced dissolved oxygen level. The corrosion susceptibility of several stainless steels and nickel base alloys as a function of the dissolved oxygen level have been investigated in a previous program and allowed to get relevant results. For additional treatment such as biocide treatment. Chlorination which is the most used biocide treatment is well known to increase the oxidant power of water and thus to increase the risk of corrosion initiation of stainless steel. Therefore, interaction between deaeration (fully or partially) and chlorination can significantly impact the localized corrosion resistance of stainless-steels and nickel base alloys. The impact of such treatment will be investigated for several alloys from low grade to highly corrosion resistant alloys.

**Project aims:**

- Assess the crevice corrosion susceptibility of different stainless-steel grades in aerated and deaerated seawater with and without biocide treatment.
- Complete existing guidelines (collected from previous studies) for material selection in treated seawater involving deaeration and chlorination.

## MARINE MATERIALS

Project Title: <b>Definition and optimization of a short-term testing adapted to crevice corrosion of passive alloys II</b>		Acronym: <b>ShortCrev II</b>
Research area: <b>Marine materials, Offshore</b>	Project period: <b>01/01/2024 – 31/12/2026</b>	
Research leader: <b>Charles Leballeur</b> charles.leballeur@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>MRC Marine Corrosion</b>	
	Keywords: Stainless steel, Marine, offshore, crevice corrosion, test method	

Commonly used quality control test such as standardized short term electrochemical test G61, G48 or G150 are not fully adapted to predict crevice corrosion results for stainless steel in seawater, particularly of corrosion resistant alloys (CRAs). From the experience of the French Corrosion Institute, immersion tests in simulated environments and involving crevice formers (ISO18070) are more suitable. The drawback of such testing performed at OCP is the time of test which is rather long (3 to 6 months).

Therefore, there is an interest to develop a new test method allowing to characterize the actual crevice corrosion resistance of stainless steels alloys in seawater within short or mid duration. A first program has allowed to define a test method consisting of successive steps at polarization of the material combined with the use crevice former as defined in ISO18070. The first results obtained with this method on duplex and superduplex have shown satisfying results with a good correlation to results obtained from long-term testing.

As a continuation of this program, further qualifications of the test method will be performed. The aim of this project will be to validate the relevancy of the results obtained with this method on additional alloys. The possibility to use this test method in synthetic seawater instead of natural seawater will also be investigated.

**Project aims:**

- Confirm the relevancy of the test method by testing different alloys
- Assess the possibility to use synthetic seawater with the test method proposed.

## MARINE MATERIALS

Project Title: <b>Assessment of low grade alloys in natural seawater</b>		Acronym: <b>LowPREN SW</b>
Research area: <b>Marine materials, Offshore</b>	Project period: <b>01/01/2024 – 31/12/2026</b>	
Research leader: <b>Charles Leballeur</b> charles.leballeur@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>MRC Marine Corrosion</b>	
	Keywords: Stainless steel, Nickel base alloys Marine, offshore, crevice corrosion, pitting corrosion, seawater, biofilm	

It is widely admitted that stainless steels and nickel base alloys with PREN lower than 40 are not suitable for seawater applications. Nevertheless, for specific applications, a moderate or at least a lower risk of localized can be expected. For instance, during pre-commissioning operations, the material can be exposed to seawater for short periods in stagnant or with very low renewal rate. The seawater renewal rate is expected to impact the development of biofilm and thus the so-called ennoblement, knowing for its detrimental effect on the corrosion resistance of passive alloys. The impact of temperature is also known to affect the risk of localized corrosion initiation, as well as the geometrical condition. Crevice corrosion is the first root cause of corrosion failure for passive alloys. However, some applications can be exempt of geometry leading to crevice corrosion. Under this condition, the main risk is pitting corrosion which imply a lower risk of corrosion initiation. Therefore, the use of some of these “low grades” can be reconsidered depending on the actual environmental condition.

The content of this project will be to assess the pitting and crevice corrosion risk of selected alloys (stainless steels and nickel base) in natural seawater at different temperature ranging from 11 to 25°C. The impact of the renewal condition compared to stagnant or confined condition could also be investigated. New alloys, candidate for seawater applications will also be assessed.

Project aims:

- Assess the pitting and crevice corrosion risk of several candidate alloys in natural renewed seawater for temperatures ranging from 11 to 25°C.
- Assess the impact of stagnant and/or various seawater renewal rate on the ennoblement induced by biofilm settlement and thus on the localized corrosion risk.

## MARINE MATERIALS

<b>Project Title:</b> <b>Next generation Marine Materials for Resilient Offshore Renewable Energy Devices</b>		<b>Acronym:</b> <b>MORE</b>
<b>Research area:</b> <b>Marine materials, Offshore</b>	<b>Project period:</b> <b>01/12/2023 – 01/12/2026</b>	
<b>Research leader:</b> <b>Matthieu Tomas</b> Matthieu.tomas@ri.se Tel: +46 73 056 6112	<b>Source of funding:</b> <b>European funding (Swedish Energy Agency)</b>	
	<b>Keywords:</b> Energy, Tribocorrosion, Multi-degradation	

MORE proposes the creation of a new robust methodology with improved tools for material selection and validation to harmonize testing procedures able to generate the next generation of materials for Offshore Renewable Energy (ORE) devices to overcome the present energy and environmental challenges.

The MORE project will focus on harmonizing small- and large-scale multi-degradation rigs, to create a fast track for validation of materials, starting from, but not limited to, metallic materials and metal coatings typically suffering tribocorrosion and multi-degradation (passive metals), to enable the industrial uptake of these methods. MORE will demonstrate a multi-degradation validation pathway for materials and subcomponents to be used as a case study in the offshore renewable energy sector. While innovative marine renewable energy device technologies are gaining popularity, the technicalities of operating them in hostile environment remain complex and challenging, jeopardizing the deployment of these very important technologies for the future generations.

MORE aims at enhancing zero emission power technologies (CETP Challenge 2): wave energy has demonstrated a more efficient use of the surface area compared to wind turbines. By improving the material use in the systems and by developing better material qualifying protocol the MORE project aims at lowering technology production costs.

**Project aims:**

- Knowledge transfer from offshore O&G currently used solutions, material selection and testing protocols, to offshore Renewable Energy power technologies.
- To develop a new testing methodology based on realistic and accelerated testing techniques simulating many years of actual operation that support and enforce go/no-go decisions on components and subsystems designed at early TRLs.
- Scale up and demonstrate the reliability of the new proposed testing methodology leading to a better material selection, resulting in a lower LCOE (5-10%) via substantial reduction of maintenance costs.
- To produce a first-of-a-kind practical implementation of the novel testing methodology for material selection and validation for critical subsystems common to offshore renewable energy devices.
- To establish new testing recommendations, guidelines and recommended practices for standardisation thus providing an important toolbox for enhanced material technology developments, qualification testing and system design.
- The case studies will evaluate the practical applicability and impact of the new material selection methodology both for cross-cutting environmental challenges and for critical components in wave energy technologies in both user cases.

## MARINE MATERIALS

<b>Project Title:</b> <b>Laser-Optimized Technologies for Utilization of Structured surfaces in Power Take-Offs</b>		<b>Acronym:</b> <b>LOTUS-PTO</b>
<b>Research area:</b> <b>Marine materials, Offshore</b>	<b>Project period:</b> <b>01/12/2025 – 30/11/2028</b>	
<b>Research leader:</b> <b>Matthieu Tomas</b> matthieu.tomas@ri.se Tel: +46 73 056 6112	<b>Source of funding:</b> <b>European funding (Swedish Energy Agency)</b>	
	<b>Keywords:</b> Marine Materials, Offshore Renewable Energy, Biofouling, biomimicry, AI, laser	

The LOTUS-PTO project proposes to explore the novel technology of laser surface texturing to decrease biofouling and enhance tribological performance of critical components in wave and tidal energy such as the PTO (power take-off) systems. For wave and tidal energy to become a part of the clean energy transition it is pivotal to ensure efficiency, cost-effectiveness, and durability of the PTO subsystem. In that context, LOTUS-PTO will use a biomimicry approach and produce structured material inspired by nature's designs of advanced superficial nanostructures present on the surface of the lotus leaf and many marine organisms. The bioinspired surfaces will be evaluated for their antifouling, tribological and hydrodynamic performance. Novel antifouling assessment techniques (computer vision and machine learning models) will be developed and utilized in lab and field settings to evaluate the state of both micro- and macro-fouling progression onto these surfaces.

LOTUS-PTO will crosscut offshore renewable technologies with material design that reduce costs through a nontoxic strategy to improve biofouling management and through optimized tribological performance. Additionally, LOTUS-PTO will take knowledge on the technology of creating biomimicry inspired surface structures using laser power from an experimental proof of concept level to where it is validated in an ocean environment.

**Project aims:**

- The project expects a 10% reduction in drag and a 5% increase in power output for wave and tidal energy converters.
- The new antifouling and tribological surface treatment will slow down degradation and cut maintenance costs by around 10%.
- By using AI and computer vision it will be possible to monitor both biofouling and tribological wear in real time (hourly basis).
- The project aims for a 50% reduction in biofouling accumulation compared with standard surfaces.
- Less wear and slower biofouling accumulation will improve the PTO systems lifespan - particularly for the sealing element, with a 15% increase in lifetime expected.

## MARINE MATERIALS

Project Title: <b>Kristineberg Innovation Center</b>		Acronym: <b>KSB IC</b>
Research area: <b>Marine materials, Offshore</b>	Project period: <b>01/10/2025 – 30/09/2026</b>	
Research leader: <b>Emiliano Pinori</b> Emiliano.pinori@ri.se Tel: +46 73 02 43 491	Source of funding: <b>Public funding</b>	
	Keywords: Blue Economy, Test Arena, SME,	

### **Kristineberg Innovation Center - A platform for the blue economy**

Kristineberg Innovation Center establishes an innovation environment for the blue economy in Sweden. Companies, academia, and business support organizations gather on a shared platform where marine solutions are developed, tested, and scaled.

The initiative focuses on three areas: advanced materials, marine robotics and autonomous systems, and seafood. Together, they enable sustainable food production from the sea, materials innovation, and new technologies for offshore monitoring, operation, and maintenance.

#### **For small and medium-sized enterprises**

Many SMEs in the marine and maritime sectors lack in-house R&D resources.

Kristineberg provides access to marine test and demonstration environments, research expertise, and structured collaboration – without requiring companies to build this capacity themselves.

By combining infrastructure and expertise, the path from idea to market is shortened. Companies can develop, validate, and refine their solutions, strengthening competitiveness regionally and internationally.

#### **For academia and research actors**

The center strengthens links between research and industry needs. Results can be applied more quickly, new collaborative projects launched, and interdisciplinary partnerships developed – enhancing both research quality and societal relevance.

#### **For business support organizations**

Kristineberg provides a coordinated structure where advisory services, business development, and innovation support are directly connected to technical development and testing environments, increasing impact for companies within the blue economy.

#### **Part of Sweden's innovation system**

Kristineberg is being developed as a node in Sweden's innovation system for the blue economy through collaboration between RISE Research Institutes of Sweden, Chalmers University of Technology, KTH Royal Institute of Technology, and Innovatum Science Park.

#### **Project aims:**

The project supports the transition toward more sustainable use of ocean resources by strengthening innovation capacity, fostering cross-sector collaboration, and enhancing long-term competitiveness in the blue economy.

## MARINE MATERIALS

Project Title: <b>High grade alloy corrosion resistance and bacterial influence in Brazilian seawater</b>		Acronym: <b>CoRio</b>
Research area: <b>Marine materials, Offshore</b>	Project period: <b>01/05/2025 – 01/05/2027</b>	
Research leader: <b>Charles Leballeur</b> Charles.leballeur@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>Cost shared industry</b>	
	Keywords: Seawater, crevice corrosion, stainless steel, nickel alloys, brazil	

Stainless steels are widely used for different applications in seawater in the oil and gas and desalination industries. It is well known that due to biofilm settlement, the open-circuit potential (OCP) of stainless-steel shifts to the noble direction (ennoblement) when exposed to natural seawater. This phenomenon also occurred on other passive alloys such as nickel-based alloys. The other significant effect of the biofilm on metallic surfaces is a dramatic increase of the cathodic reduction efficiency (e.g. cathodic reduction of dissolved oxygen). For these reasons (potential increase and cathodic currents), the effect of the biofilm settlement on stainless steel is known to be one of the main factors affecting the risk of localized corrosion in terms of initiation and propagation. Therefore, the risk of corrosion initiation is dependent of this incubation period since no corrosion is expected before this ennoblement for CRAs. The OCP of superduplex stainless steel as a function of time in Brest (France, Atlantic Ocean) for different temperatures showed that the time before ennoblement decrease with temperature until a given threshold temperature for which the ennoblement is inhibited. In Brest, this threshold temperature is between 35 and 40°C. In a previous project, the same measurements have been performed in Brazil (Araial do Cabo, Rio, Atlantic Ocean) where the natural ambient temperature is higher. A similar impact of temperature on the OCP was noted when compared to Brest. These results tend to show that similar results are expected in Brest and Brazil (Rio region) as soon as the temperature is maintained at the same level. If this trend has been globally confirmed by corrosion testing performed in both sites, some significant differences have been observed for high grade alloys. Furthermore, no focus was put on the bacterial activity in the past projects. Therefore, there is an interest to assess the corrosion risk of new high grades at 30°C but also lower grades at ambient temperatures. Further investigation on the biofilm development in Brazil can also be of interest. It is therefore proposed to use a specific “biofilm module”, allowing to quantify the bacterial activity susceptible to impact the corrosion risk (developed in previous projects) in combination with bacterial analysis.

Project aims:

- Crevice corrosion testing of new high grades
- Biofilm ennoblement assessment
- Bacterial Characterization

## MARINE MATERIALS

<b>Project Title:</b> <b>Advancing Technological Leap in the Area of floating offshore wind turbines Needed for a Transition to Innovative Clusters of green energy</b>		<b>Acronym:</b> <b>ATLANTIC</b>
<b>Research area:</b> <b>Marine materials, Offshore</b>	<b>Project period:</b> <b>01/10/2025 – 01/12/2027</b>	
<b>Research leader:</b> <b>Charles Leballeur</b> charles.leballeur@institut.corrosion.fr Tel: +33 2 98 05 15 52	<b>Source of funding:</b> <b>Public funding Europe (HORIZON)</b>	
	<b>Keywords:</b> Wind, Renewable Energy Sources, Floating offshore wind turbine (FOWT), Energy security, EU sovereignty, supply chain	

Floating wind is essential to reach climate neutrality and cement Europe's leadership in renewables globally. While floating wind technology has been proven technically feasible through prototypes commissioned in the past few years, its industrialisation and competitiveness still need to be demonstrated. A key limitation of current floating wind projects is the lack of integrated optimization between turbines and floats, which leads to higher CAPEX and hinders commercial viability. Additionally, the absence of a European industrialisation framework for large-scale production and deployment of floating offshore wind turbines presents a challenge. Standardising manufacturing processes and optimizing logistics are critical to avoid bottlenecks by 2030.

In this context, ATLANTIC aims to drive a breakthrough in the sector by providing a holistic design solution, addressing both technology and European supply chains. The project will demonstrate a disruptive 5 MW floating unit with a pyramidal design, connected to the grid at Le Croisic, France. It will create a pathway to reach a Levelised Cost of Energy (LCOE) of 85€/MWh by 2030 (and 57€/MWh beyond 2035) with a carbon footprint <16 gCO<sub>2</sub>eq/kWh.

Over two years, extensive data monitoring from the pilot will allow for future optimization of industry-scale commissioning, addressing performance, environmental considerations, and future harbour logistics. It will also lay the ground for establishing a European supply chain to enable the large-scale production of floating offshore wind farms and enhance EU sovereignty. To achieve this ambitious objective, the industry-driven consortium of ATLANTIC gathers 13 entities from 6 different countries, including 4 industries and SMEs, 1 public-interest foundation, 6 research centers, 1 university and 1 regional organization.

The work performed at FCI will focus on the improvement of the corrosion management solution selected by EOLINK. FCI works on the optimisation of the cathodic protection system of Eolink's FOWT (through finite element model developed using Comsol Multiphysics), and assesses the corrosion rate based on data collected from sensors on the pilot. The corrosion on critical components such as the connection between the mooring chains, the float structure and the ballast compartments will be more specifically investigated.

**Project aims:**  
 Provide a holistic design solution, addressing both technology and European supply chain for FOWT.

## MARINE MATERIALS

Project Title: <b>Sustainable production, processing and modelling of durable additive manufactured materials for enhanced performance and long-term service in complex environments.</b>		Acronym: <b>DurAMat</b>
Research area: <b>Marine materials, Stainless steel</b>	Project period: <b>01/09/2023 – 28/02/2028</b>	
Research leader: <b>Dominique Thierry and Rodrigo Alvarenga</b> dominique.thierry@ri.se Tel: +33 6 76 80 66 76	Source of funding: <b>Public funding (Horizon)</b>	
	Keywords: AM, Stainless steel, marine corrosion, atmospheric corrosion	

Additive Manufacturing (AM) presents an opportunity for developing economic eco-friendly metal products with enhanced long-lasting performance. Metal AM covers a wide range of technologies where a three-dimensional metallic component is manufactured by adding layer-upon-layer of material, also better-known as 3D printing. AM technology builds on the rational use of raw materials (through optimized product design and re-use of feedstock, reduced use of chemicals and lowered waste of resources), increased energy efficiency (by decreasing post-processing and assembly efforts), economic savings (reduced labour, storage and logistics, and little need for multi-assemblies), and faster processing times.

The work performed at RISE is part of a Doctoral network (MSCA Horizon) coordinated by VUB (Belgium). The work at RISE will be focused on atmospheric and fatigue corrosion, including hydrogen embrittlement (HE), of duplex steel alloys for marine applications.

**Project aims:**

- To study AM duplex stainless steel with different heat treatments for different final applications including atmospheric (infrastructure) and marine conditions (energy sector)
- To evaluate the risk of corrosion fatigue and hydrogen embrittlement on AM duplex stainless steel using different heat treatments.

The consortium is formed by the following partners: Vrije Universiteit Brussel (VUB, coordinator), RISE, University of Göteborg. Guarantee, HelmholtzZentrum Hereon, Warwick University, Universidade NOVA de Lisboa, TU Dresden, Endures, Small Materials and Technologies, Lda, Christian Albrechts University of Kiel, OnderzoeksCentrum voor de Aanwending van Staal. OCAS NV.

## ENERGY

Project Title: <b>Next Generation Advanced Flexible Biomass Power Plants</b>		Acronym: <b>FlexGEN</b>
Research area: <b>Energy, Biorefinery and biomass</b>	Project period: <b>01/02/2023 - 01/02/2027</b>	
Research leader: <b>Rikard Norling</b> rikard.norling@ri.se Tel: +46 10 228 48 89	Source of funding: <b>Public funding (Swedish Energy Agency)</b>	
	Keywords: Corrosion, Combined Heat and Power, Renewable Energy	

The future renewable energy system will call for a flexible system with a plethora of different production means and energy storage to meet the demand for the security of supply and affordability. A large part will be non-dispatchable, such as wind and solar energy, and therefore require replacement capacity. Today's heat and power plants in Sweden cannot decouple the electricity and heat production. Hence there is a flexibility limitation coupled with the heat demand. This needs now to be decoupled. The first step in decoupling can be to introduce a condensing tail with a suitable set of valves and a heat sink. Further, the flexibility and efficiency can be increased with improved starting- and stopping capability, maximized load flexibility, and new advanced plant configurations.

Corrosion is one of the critical limiting factors to achieve this, in particular while maintaining an acceptable plant efficiency. It is well known that boilers using biomass or waste as fuel are challenged by high temperature corrosion. Biomass contains high amounts of corrosive species, primarily alkali metals and chlorine. These corrosive species initiate corrosion which can cause wall thinning and pitting, resulting in catastrophic failure of components, especially the boiler water walls and superheater tubes. Future power plants will require higher steam temperatures to increase energy efficiency in steam turbines. This change will impose new challenges on the materials along the whole system.

**Project aims:**

- To evaluate possible material options at hand. Reaching the targets may require coatings on high-strength materials or composite tubes, which will be evaluated.
- To find smart plant configurations that decouple positions with high corrosivity from high material temperatures and to identify next generation boiler material concepts suitable for these configurations.
- New plant configurations which include hydrogen firing in addition to biomass will be evaluated and the related new difficult material challenges caused by the changed gas composition and firing conditions will be investigated.

## ENERGY

Project Title: <b>Cathodic Protection influence &amp; modelling</b>		Acronym: <b>CPInfMod</b>
Research area: <b>Energy, Cathodic protection in soils</b>	Project period: <b>01/01/2023 – 31/12/2026</b>	
Research leader: <b>Erwan Diler</b> erwan.diler@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>MRC 12</b>	Keywords: Fusion Bonded Epoxy, Three-layer Polyethylene, Soils, cathodic protection, cathodic disbondment

In soils, protection against corrosion of buried metal structures is generally achieved using a combination of an organic coating and cathodic protection (CP). CP consists of lowering the corrosion potential of the structure to be protected using an external current (polarization). This polarization, when it reaches sufficiently electronegative potentials, reduces the residual corrosion rate to negligible values on the scale of the operating life of the structure (<10µm/year).

For buried structures, cathodic protection is usually operated most efficiently using impressed current. In a complex CP environment, several structures under cathodic protection may be present, in a relatively restricted area. When the CP of a structure is switch-off or when it is insufficiently polarized, influence phenomena can appear, with the appearance of stray currents through the (foreign) structure under influence.

The stray currents, generated by an external CP device, on a non-polarized foreign metallic structure depends on numerous parameters such as: the nature of the ground (water content, resistivity, texture), the type of coating and the types of defects, the location of the structures, the applied potential, and the current demand. The stray current amplitude is ruled by the ohm law and function of electric field in soil, the media resistivity and resistance at interface. In addition to the soil, surface state and CP conditions, the localization of the elements under CP (anode, cathode) and foreign structure is crucial. Indeed, depending on the relative position of each element, the influence can be i) anodic, ii) cathodic, iii) combined and iv) induced.

Project aims:

- Perform a critical literature review on the CP influence phenomena and modelling in soil
- Study representative cases by finite element modelling.

## ENERGY

Project Title: <b>Investigation of coating disbondment rate in soils</b>		Acronym: <b>CD Rate</b>
Research area: <b>Energy, Cathodic protection in soils</b>	Project period: <b>01/01/2023 – 31/12/2026</b>	
Research leader: <b>Erwan Diler</b> erwan.diler@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>MRC Soil</b>	
	Keywords: Fusion Bonded Epoxy, Three-layer Polyethylene, Soils, cathodic protection, cathodic disbondment	

To ensure the integrity of offshore and onshore structures against corrosion, a complementary approach combining cathodic protection (CP) and organic coatings is usually used. The efficiency of the CP is ensured by maintaining the potential of the structures in a protective range, following the standard recommendations, such as ISO 15589-1.

The influence of cathodic protection on the coating is rather complex since it depends on many factors such as the nature of the coating, the soil (type, pH buffer capacity, moisture level...), the temperature, the electrochemical processes and the kinetic involved. In the literature, many standard tests are proposed to assess the cathodic disbondment. However, the objective of these short-term methods is more to rank the different coatings than to determine a representative disbondment kinetic. These tests are usually limited to chloride containing electrolyte and thus possibly not representative of the underground environment.

A recent study, performed at IC, highlighted that higher cathodic disbondment was observed in seawater in contrast to soils. This can be explained by the high content of Na<sup>+</sup> in seawater, known to sustain a high alkalinity below the disbonded coating, and promote the interface and/or coating degradation. In soils, under unsaturated conditions (40-65% water saturation), the cathodic disbondment of the tested FBE and 3LPEs remain limited for current density lower than 2 A/m<sup>2</sup>.

Project aims:

Determine the coating disbondment rate for a commercial Fusion Bonded Epoxy (FBE) and a Liquid Epoxy (LE) at the vicinity of 2 A/m<sup>2</sup> to be compared with previous data.

## ENERGY

Project Title: <b>Polarization database of cathodic protection in soils</b>		Acronym: <b>CPSoilDatabase</b>
Research area: <b>Energy, Cathodic protection in soils</b>	Project period: <b>01/01/2023 – 31/12/2026</b>	
Research leader: <b>Erwan Diler</b> erwan.diler@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>MRC Soil</b>	
	Keywords: Keywords: Polarization, cathodic protection, soil, moisture level, texture, carbon steel	

Soil can be defined as a mixture of rock particles, organic matter, air and water. The main physical properties of soils are texture, structure, porosity, and resistivity. Soil texture is determined by the relative proportion of the three kinds of soil mineral particles, called soil separates: sand, silt and clay.

Water that enters a field is removed from a field by runoff, drainage, evaporation or transpiration. Water in soils mainly affect the gaseous and species diffusion and the soil resistivity. The oxygen effective diffusivity strongly depends on the moisture level. This can be explained by the tortuosity, the air and water ratio, i.e. the oxygen diffusivity in air being much more higher than in water. The moisture level also affects the active surface, i.e. the polarizable surface of the metal. The active surface increases with the moisture content. In terms of oxygen reduction, the competition between the active surface and the oxygen diffusivity is expected to lead to high CP current demand at moisture level in the range of about 60% wat. sat. In contrast, at 100% wat. sat. the current demand is expected to be very low (low oxygen diffusivity). The moisture level also affects the soil resistivity, i.e. the lower the water content, the higher the resistivity, as well as the Open Circuit Potential. Under resistive media, ohmic drop (IR) in soil can affect the current distribution, affecting thus de current demand and polarization curves. The coupons (defect) geometry can also have an influence. Thus, the current demand in soil is difficult to predict.

Polarization curves for different soil textures and moisture levels are crucial for modelling of cathodic protection. It allows better understand the seasonal fluctuation in terms of current demand and distribution along a structure to be protected. It allows also to model complex structures and interference phenomena.

Project aims:

Develop and define a method to obtain reproducible, comparable, and stabilized polarization curves in different soils at various moisture level.

## ENERGY

Project Title: <b>Effect of the presence of CO contamination in CO<sub>2</sub> on the risk of SCC in CCUS application</b>		Acronym: <b>COScc</b>
Research area: <b>Energy, CCUS</b>	Project period: <b>01/01/2022 – 01/12/2026</b>	
Research leader: <b>Christophe Mendibide</b> christophe.mendibide@institut-corrosion.fr Tel: +33 4 77 40 00 45	Source of funding: <b>MRC CCUS &amp; H<sub>2</sub>S</b>	
	Keywords: Carbon capture, Stress corrosion cracking, CO <sub>2</sub> , CO	

In Carbon Capture, Utilization and Storage (CCUS) applications, the industrial process is generally divided into 3 different stages:

- Carbon capture generally through a so-called "amine unit"
- Transportation of the captured CO<sub>2</sub> in pipeline, generally in dense phase or supercritical state
- Storage or utilization of the gas.

After the capture stage, CO<sub>2</sub> is produced with a non-negligible level of impurities like, NO<sub>x</sub>, SO<sub>x</sub>, CO, O<sub>2</sub>, H<sub>2</sub>S...

From the literature and experience, particularly in heat-exchanger applications, it is well-known that the presence of CO in pure CO<sub>2</sub> can generate a pseudo-passive state of the carbon- and low alloy steels generally active in pure CO<sub>2</sub> environments. This pseudo-passivity can therefore promote a stress corrosion cracking phenomena at room temperature (SCC).

The project focuses on the evaluation of the risk of SCC in CO<sub>2</sub> saturated solution when the gas is contaminated with CO. Electrochemical and SCC experiments are conducted in solution saturated with CO<sub>2</sub>-CO that mimic the in-service exposure during the transport of CO<sub>2</sub> in pipelines.

Project aims:

- Estimate if the presence of CO contamination in CCUS process can promote SCC
- Estimate what are the critical level of CO that triggers the SCC cracking
- Evaluate the effect of other contaminants like O<sub>2</sub>
- Evaluate the behavior of standard pipeline steel in CO<sub>2</sub>-CO-O<sub>2</sub> atmospheres.

## ENERGY

Project Title: <b>Assessment of the corrosion resistance of CRAs in environments simulating the shutdown at the CCUS injection sites</b>		Acronym: <b>CRAInject</b>
Research area: <b>Energy, CCUS</b>	Project period: <b>01/01/2022 – 01/12/2026</b>	
Research leader: <b>Christophe Mendibide</b> christophe.mendibide@institut-corrosion.fr Tel: +33 4 77 40 00 45	Source of funding: <b>MRC CCUS &amp; H2S</b>	
	Keywords: Carbon capture, Stress corrosion cracking, localized corrosion, crevice corrosion, corrosion resistant alloys	

In Carbon Capture, Utilization and Storage (CCUS) applications, the industrial process is generally divided into 3 different stages:

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- Transportation of the captured CO<sub>2</sub> in pipeline, generally in dense phase or supercritical state
- Storage or utilization of the gas.

The storage can be made in depleted oilfield that are build with many different carbon steels and corrosion resistant alloys.

In standard operation, a literature review conducted before starting this project highlight that there is no significant risk of corrosion in the injection area. However, during shutdown operations, the formation or aquifer waters can flowback and contact the metallic components used for the injection process. A brine containing a high level of chloride, saturated with CO<sub>2</sub>, generally in a supercritical state, can therefore contact the metals, leading to possible corrosion of carbon steels or of the CRA grades used in the infrastructures.

The objective of the project is to estimate if the CRAs typically in place storage site can suffer from corrosion and stress corrosion cracking due to this phenomenon.

Project aims:

- Evaluate the corrosion resistance of CRA in conditions simulating the water flowback at CCUS storage sites.
- Qualify the resistance of a couple of CRA grades regarding the risk of localized & crevice corrosion as well as SCC.

## ENERGY

Project Title: <b>Impurities Impacts and Management for CO<sub>2</sub> storage</b>		Acronym: <b>SPECS</b>
Research area: <b>Energy, CCUS</b>	Project period: <b>01/06/2026 – 31/12/2029</b>	
Research leader: <b>Christophe Mendibide</b> christophe.mendibide@institut-corrosion.fr Tel: +33 4 77 40 00 45	Source of funding: <b>European funding (Horizon)</b>	
	Keywords: Carbon capture, impurities	

To achieve the EU's challenging objectives of carbon emission reduction, CCS is a key part of the solution to decarbonize industry. So, the deployment of CCS is set to reach industrial levels in the coming years. With the impending increase of capture capacity, storage operators will have to combine CO<sub>2</sub> streams coming from different sources. Mixing these CO<sub>2</sub> streams, with different impurity compositions, can induce specific challenges for the design and safe operation of CO<sub>2</sub> transport and storage networks. Furthermore, Directive 2009/31/EC mandates that the CO<sub>2</sub> stream impurities should be below levels that pose a significant risk to the transport and storage integrity, the environment, or human health. However, while considerable research has addressed the impact of impurities on CO<sub>2</sub>-transport, focusing on both corrosion and flow assurance challenges, the impact of impurities on the integrity of the storage complex itself (comprising well(s), reservoir rock, and caprock) has received little attention. Even so for each component of the storage complex that can be specifically impacted by CO<sub>2</sub> mixed with impurities. The SPECS project aims at unravelling the impacts of impurities system-wide, from the injection well to the caprock. Besides increasing the understanding of the effects of impure CO<sub>2</sub> flows and derisk impurities presence in the storage complex, SPECS ambition is to provide protective/mitigation/monitoring solutions, as well as guidance and recommendations for technology providers and regulatory authorities, in order to be able to contribute to standardization work in collaboration with certification and standardisation bodies. The overall ambition of the project is to facilitate access to storage for more CO<sub>2</sub> stream mixes and enhance the CCS chain economics. SPECS project concept is based on an integrative approach of the impact of impurities on the storage complex from the wells to the caprock.

This project is funded under the call HORIZON-CL5-2025-02-D3-25 and coordinated by IFE (Norway)  
Project ID : 101269692

**Project aims:**

- Identify and evaluate physico-chemical impacts of impurities on the CO<sub>2</sub> storage complex
- Derisk or mitigate adverse effects caused by the presence of impurities in the CO<sub>2</sub> storage complex
- Provide knowledge needed for guidelines and specifications for CO<sub>2</sub> compositions for storage.

## ENERGY

Project Title: <b>Impurity impact on CO<sub>2</sub> transport : closing knowledge gaps for a robust European CO<sub>2</sub> transport infrastructure</b>		Acronym: <b>IMPACTEU-CO<sub>2</sub></b>
Research area: <b>Energy, CCUS</b>	Project period: <b>01/06/2026 – 31/12/2029</b>	
Research leader: <b>Christophe Mendibide</b> christophe.mendibide@institut-corrosion.fr Tel: +33 4 77 40 00 45	Source of funding: <b>European funding (Horizon)</b>	
	Keywords: Carbon capture, impurities	

CCUS remains a key element in the European strategy for carbon neutrality in 2050, however only pilot projects have been deployed to date. To enable a sustainable CCUS industry at scale, it is vital to ensure a resilient, interoperable, and safe CO<sub>2</sub> transport infrastructure capable of handling CO<sub>2</sub> streams at different flow rates, pressures and states and with different compositions and impurities. The presence of impurities in CO<sub>2</sub> streams may impact severely thermophysical properties and consequently flow characteristics. Reactive impurities can form strong acids originating unacceptable corrosion of pipelines and ships. These effects combined, may result in unacceptable risks for the infrastructure, the environment, and populations. IMPACT-EUCO<sub>2</sub> will tackle these challenges and bridge the knowledge gaps that hinder the development of an European CO<sub>2</sub> transport network. The project will also work closely with regulators, standardization and certification bodies, technology developers and the industry, and associations to enable the development and rapid market uptake of knowledge based technology, under a common regulatory and standards framework, that ensures interoperability and sustainability, thus contributing for the deployment of CCUS at scale.

This project is funded under the call HORIZON-CL5-2025-02-D3-25 and coordinated by IFE (Norway)  
Project ID : 101269030

### Project aims:

- Build-up fundamental knowledge about effects and acceptable levels of impurities on CO<sub>2</sub> streams and enhance the European technological capabilities for safe CO<sub>2</sub> transport, with focus on more detailed knowledge on the limits for different combinations of impurities for formation of separate corrosive phases in CO<sub>2</sub> streams.
- Map and characterize European CO<sub>2</sub> sources to facilitate the upscaling of CCUS projects.
- Assess risks associated with the presence of impurities in CO<sub>2</sub> streams for the transport infrastructure, safety, and environment, and propose mitigation measures.
- Effectively communicate and disseminate the knowledge gained to regulators, standardisation bodies, industry, and citizens, enabling the development of an interoperable CO<sub>2</sub> transport network.
- Set a forum for knowledge sharing and support the wider community, bringing key operators/actors of CCUS infrastructures, RTOs, academia, industrial manufactures, associations, and promoting a close collaboration with the ECCSEL network and transatlantic knowledge exchange.
- Develop an open-access digital platform based on high-quality data and knowledge, contributing to establishing the foundation for developing innovative companies related to CCUS applications.
- Contribute to the development of a knowledge-based, cutting-edge, and world-leading European industry, and supporting the training of personnel and creation of highly qualified, high-value jobs.

## ENERGY

Project Title: <b>Catalytically active and corrosion resistant thin films</b>		Acronym: <b>Fun Mat II</b>
Research area: <b>Energy, Fuel cells and electrolysers</b>	Project period: <b>01/01/2019 – 31/12/2027</b>	
Research leader: <b>Smita G. Rao</b> smita.gangaprasad.rao@ri.se Tel: +46 10 228 47 87	Source of funding: <b>Public funding</b>	
	Keywords: Catalysis, oxygen reduction reaction, corrosion, thin film	

Water recombination-based devices are one of the alternatives for the production of green electricity. These devices however rely heavily on electrocatalysts to increase their efficiency. In today's industrial devices precious and costly metals such as platinum (Pt) are used as catalysts. Other more abundant and cheaper alternatives, for example, cobalt and manganese oxides, are therefore being investigated.

In this project, pure cobalt (Co) thin films were synthesised to investigate if thin films can be used for the catalysis of ORR. This was successfully carried out by electrochemically modifying the magnetron sputtered thin films and growing catalytically active hexagonal cobalt oxide nanoparticles.

Multicomponent system CoCrFeNi is an emerging alloy system with high research interest for its high corrosion resistance suitable for harsh environments in which the applications for water recombination are found. In this project, CoCrFeNi and CoCrFeMoNi were synthesised as thin films. The corrosion resistance of the films was investigated in addition to their catalytic activity. The effect of Fe and Mo content on these properties was also studied. The presence of Fe was crucial for the electrochemical activation of films and catalytic activity towards ORR. The addition of Mo improved the corrosion resistance in simulated PEM fuel cell environment.

In the continuation of the project, the thin film structure will be tailored to further improve the catalytic and corrosion resistance. Mn will be investigated as an alternative to Co. The synthesised materials will also be tested in small-scale alkaline batteries and fuel cells.

This project is a PhD project and a collaboration between RISE and Linköping University. Details of the project results can be found in Clara Linder's Ph.D. thesis (2024).

**Project aims:**

- Investigate corrosion properties of thin film in alkaline and acidic environments.
- Investigate catalytic activity towards water recombination of corrosion resistant thin films.
- Combine catalytic activity and corrosion resistance in one material system synthesised as a thin film.

## ENERGY

Project Title: <b>Thin protective titanium suboxide coatings for next-generation porous transport layers of PEM water electrolyzers</b>		Acronym: <b>PROTIS</b>
Research area: <b>Energy, fuel cells and electrolyzers</b>	Project period: <b>01/03/2023 – 31/08/2026</b>	
Research leader: <b>Michel Prestat</b> michel.prestat@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>Public funding (ANR)</b>	
	Keywords: Proton exchange membrane water electrolysis, thin films, porous transport layers	

Proton exchange membrane water electrolysis (PEMWE) is one of the low temperature processes for producing hydrogen by electrochemically splitting the water molecule. However, the high capital expenditures (capex) due to the use of expensive corrosion-resistant materials limit the economic competitiveness of this technology compared to the well-established fossil fuel-based hydrogen production, like steam reforming, that generates intensive CO<sub>2</sub> emissions. In particular, on the anode side, the state-of-the-art porous transports layers (PTL), that are metallic elements distributing water, gas and electrons, are made of titanium protected by precious metal coatings (Pt, Au) in order to withstand the acidic conditions and the high electrochemical potential.

Two main corrosion-related strategies can therefore be considered in order to significantly decrease the PEMWE capex: replacing titanium by other alloys, such as stainless steels, and developing novel cost-effective coatings. The PROTIS project combines these two approaches by investigating the protection of 316L stainless steels by thin layers of titanium suboxides (as first priority) and other oxide coatings (as alternative solutions).

This project, coordinated by IC, is carried out in collaboration with the LEMTA (Laboratoire d'Energétique et de Mécanique Théorique et Appliquée, Université de Lorraine, France) and the Laboratory of Materials for Energy Conversion of Empa (Swiss Federal Laboratories for Materials Science and Technology, Switzerland).

Project aims:

- Synthesizing thin titanium suboxide films by physical vapor deposition and atomic layer deposition on porous stainless steel PTL and carrying out
- Depositing alternative coatings (mostly oxides) using non-vacuum techniques, such as electrodeposition.
- Carrying out ex situ corrosion testing (with emphasis on long-term experiments) to assess their anti-corrosion behavior and their durability under PTL-like conditions.
- Implementing the novel coated PTL in PEMWE cells and assessing their effect on the electrolysis performance and durability.

## ENERGY

Project Title: <b>Aluminum in Lightweight PEMFCs with High-temperature</b>		Acronym: <b>ALPH</b>
Research area: <b>Energy, Fuel Cells and Electrolysers</b>	Project period: <b>01/08/2025 – 01/08/2027</b>	
Research leader: <b>Karin Törne</b> Karin.torne@ri.se Tel: +46 10 228 48 81	Source of funding: <b>Public funding</b>	
	Keywords: Aluminum alloys, PVD coating, HT-PEMFC (High Temperature Proton Exchange Membrane Fuel Cell), Bipolar plates	

A significant part of the total CO<sub>2</sub> emissions within the EU are from transport in heavy-duty trucks, and these emissions could be drastically reduced by electrifying the transport. However, heavy-duty trucks have strict demands on both energy and power density; a battery may be insufficient to power an electric driveline for a heavy-duty truck. Here fuel cells are a promising alternative to allow for electrified cargo transportation with drastically reduced CO<sub>2</sub> emissions.

However, conventional low temperature proton exchange membrane fuel cell (LT-PEMFC) systems may provide insufficient power to a heavy-duty truck driveline. By operating at higher temperatures, such as those in a high temperature PEM fuel cell (HT-PEMFC), at e.g. 160 °C, the need for temperature and water management may be simplified, thereby reducing the weight and increasing the power density of the fuel cell.

Further weight decreases may be possible by replacing graphite based bipolar plates with aluminum plates. However, as the environment in an HT-PEMFC is highly corrosive, stable coatings need to be developed to enable the use of aluminum bipolar plates. The ALPH-project will develop coatings for aluminum bipolar plates for use in HT-PEMFC. The project also intends to further develop methodology to characterize these plates *ex-situ* and perform *in situ* HT-PEMFC cell tests using the coated plates. Furthermore, aluminum plates will be formed with suitable flow fields and the welding of bipolar plates to form a stack will be investigated. The produced and coated aluminum plates will be evaluated regarding their potential use in a HT-PEMFC powered drivelines for heavy-duty trucks.

**Project aims:**

- Improving the corrosion properties of coated Al-BPPs for HT-PEMFC and developing ex-situ corrosion characterization methodology for BPPs in HT-PEMFC.
- Demonstrating manufacturing steps of Al-BPP by designing and manufacturing single cell flow fields as well as laser welding aluminum sheets.
- Demonstrating the feasibility of Al-BPP in HT-PEMFC and obtain more than 1000 h runtime with acceptable degradation (5 % decrease in cell voltage / 1000 h).
- Evaluating Al-BPP for HT-PEMFC and comparing the design and potential power density of an air cooled and a liquid cooled HT-PEMFC for heavy duty trucks.

## ENERGY

Project Title: <b>Unlocking the Full Potential of Electrolysis with Next-Generation Proton Exchange Membrane Stacks</b>		Acronym: <b>UNICORN</b>
Research area: <b>Energy, fuel cells and electrolysers</b>	Project period: <b>01/11/2023 – 31/10/2026</b>	
Research leader: <b>Michel Prestat</b> michel.prestat@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>European funding (Swedish Energy Agency)</b>	
	Keywords: Proton exchange membrane water electrolysis , coating, bipolar plates	

Proton exchange membrane water electrolysis (PEMWE) is currently the most promising route towards green hydrogen production due to the "zero-gap" cell configuration, leading to higher operational current densities, and nearly instantaneous response to fluctuating power output, making it ideal for coupling with renewable energy sources. The major shortcoming of PEMWE, however, is that it requires the use of expensive components, made from critical raw materials, to overcome the harsh acidic operating environment, highly oxidative potentials at the anode, and stringent gas-crossover requirements. Today's commercial PEMWE systems all rely on noble metal catalysts and protective coatings, titanium-based bipolar plates, and perfluorinated sulfonic acid (PFSA)-based membranes. These materials lead to increased capital expenditure (CAPEX) costs and have been identified as either critical raw materials (e.g. platinum group metals and titanium) or materials with sustainability/environmental concerns (e.g. PFSA). The overall goal of the project is to develop low cost, non-toxic, safe-by-design, sustainable electrolyzer stacks for next-generation PEMWE based on the patented Hystar's technology that is operated with thin electrolyte membrane and dry anode feed.

**Project aims:**

- Carrying out ex situ corrosion testing of coated and uncoated bipolar plates (BPP) under atmospheric and immersed conditions (with emphasis on long-term experiments) to assess their stability and durability.
- Depositing novel cost-effective coatings (mostly oxides) on BPP using non-vacuum techniques, such as electrodeposition.
- Implementing the novel coated BPP in PEMWE cells and assessing their effect on the electrolysis performance and durability.

## ENERGY

Project Title: <b>Direct seawater electrolysis technology for distributed hydrogen production</b>		Acronym: <b>SWEETHY</b>
Research area: <b>Energy, fuel cells and electrolyzers</b>	Project period: <b>01/03/2025 – 28/02/2029</b>	
Research leader: <b>Michel Prestat</b> michel.prestat@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>European funding (Horizon)</b>	
	Keywords: Seawater electrolysis, anion exchange membrane, coatings.	

SWEETHY is a nine-partner European project that aims at developing an advanced technology for direct seawater electrolysis for the production of H<sub>2</sub> and O<sub>2</sub> under intermittent conditions accounting and the coupling to renewable power sources (especially wind, PV). The electrolyzer is based on an anion exchange membrane (AEM) operating in natural or alkaline seawater and be operated in Messina, Italy, to withstand more than 2000 h of operation and to produce 20 gH<sub>2</sub>/h with a degradation rate lower than 1%/100h. The SWEETHY technology is being developed along three axes:

- a) Materials optimization to meet the specific requirements of seawater environment: A particular emphasis is made on selective PGM-free electrocatalysts for hydrogen and oxygen evolution reactions, on AEM with high selectivity for transporting hydroxide anions and anti-fouling properties as well as on novel anti-corrosion coatings for bipolar plates and porous transport layers.
- b) Novel electrolyzer stack architecture applying hydraulic cell compression: This innovative approach (compared to state-of-the-art AEM-based stacks) enables to produce H<sub>2</sub> at high pressure in a durable and scalable way.
- c) Sustainability and integration into renewable-power systems: A focus is laid on efficient by-product utilization in industrial symbioses, feeding back to materials optimization and stack development early on.

The French Corrosion Institute leads the work package on corrosion and corrosion protection.

**Project aims:**

- Investigating the corrosion behavior of bare metallic substrates (for bipolar plates and porous transport layers) in near-neutral and highly alkaline seawater.
- Developing protective coatings by electrodeposition and other cost-effective, atmospheric-pressure techniques for the anodic and cathodic sides of the electrolyzer.
- Selecting appropriate pipe materials withstanding the operative conditions of a direct seawater electrolyzer (upstream and downstream).

## ENERGY

Project Title: <b>Hydrogen applicability of steels in gas storage facilities</b>		Acronym: <b>Store H2</b>
Research area: <b>Energy, Hydrogen</b>	Project period: <b>01/01/2023 – 01/12/2026</b>	
Research leader: <b>Laura Moli-Sanchez</b> laura.moli.sanchez@institut-corrosion.fr Tel: +33 4 77 40 00 45	Source of funding: <b>Industrial funding</b>	
	Keywords: Hydrogen, Fatigue, Toughness	

In order to achieve the climate targets, there is political consensus on the central role of hydrogen use in all sectors. The storage of hydrogen is the basic requirement for sector coupling because centralized energy storage in underground storage facilities (UGS) enables a secure and long-term supply of hydrogen. Due to the highly fluctuating production of hydrogen from various sources and the equally expected highly fluctuating demand, UGS will play a central role in the future energy system. The required conversion of existing underground gas storage facilities to hydrogen or the storage of natural gas-hydrogen mixtures makes special demands on the technical equipment (well completion), several aspects of which have not yet been sufficiently investigated. An essential aspect in this context is the suitability of underground pipe sections (typically API steels) and their corrosion and mechanical properties when exposed to hydrogen. The suitability of the material itself, as well as the suitability of the welded joints (and welding procedures and heat input by welding) must be investigated. The study described here is intended to provide answers to these questions.

The work is divided in 2 main tasks.

1. An exhaustive literature review including analysis of the existing standard for material qualification under H2 pressure and their limitation.
2. A qualification program on alloys that could find a possible application in underground storage but whose properties under H2 atmosphere are poorly documented.

This work is a collaboration between the French Corrosion Institute (France), The University of Leoben (Austria) and the Fraunhofer (Germany)

Project aims:

- Literature review and standard analyses to determine the materials that are already used for H2 service and the gap in data needed to allow the use of candidate materials with limited documentation of their properties in H2 environment.
- Qualify for service a couple of materials selected from the literature review and not documented in the literature. Different test methods are considered in the program: toughness, fatigue, constant and ripple load, permeation.

## ENERGY

Project Title: <b>Hydrogen embrittlement of pipe, casing and tubing materials used in underground storage of gaseous hydrogen</b>		Acronym: <b>HyMF</b>
Research area: <b>Energy, Hydrogen</b>	Project period: <b>01/01/2024 – 01/09/2026</b>	
Research leader: <b>Christophe Mendibide</b> christophe.mendibide@institut-corrosion.fr Tel: +33 4 77 40 00 45	Source of funding: <b>Industrial Funding</b>	
	Keywords: Hydrogen, storage, H <sub>2</sub> S	

In the perspective of hydrogen underground storage, the behavior of the metallic materials used in the infrastructures (pipe, casing, tubing) shall be evaluated under hydrogen pressure to ensure the safety of the facilities. In a design perspective, at least two properties need to be investigated: the toughness and the resistance to the crack propagation under fatigue loading.

Moreover, considering the presence of liquid phases and the possible bacterial activities developing underground, the hydrogen possibly stored can be exposed to water vapor and contaminated with H<sub>2</sub>S gas. The objective of this project is to evaluate if H<sub>2</sub>S and water vapor can modify the behavior of metallic materials under hydrogen pressure.

Project aims:

- Screen the mechanical behaviour of metallic materials used in underground hydrogen storage assets.
- Evaluate the possible effect of H<sub>2</sub>S contamination and water vapor in hydrogen on steels.

## ENERGY

Project Title: <b>Mn austenitic stainless and non-stainless steels for hydrogen applications: production, transport and storage</b>		Acronym: <b>Hystory</b>
Research area: <b>Energy, Hydrogen</b>	Project period: <b>01/06/2024 – 31/12/2028</b>	
Research leader: <b>Laura Moli-Sanchez</b> laura.moli.sanchez@institut-corrosion.fr Tel: +33 4 77 40 00 45	Source of funding: <b>Public funding (RFCS)</b>	
	Keywords: Hydrogen, pipeline, transportation and storage	

The goal of the HYSTORY project is to develop Mn austenitic stainless and non stainless steels via high throughput metallurgy screening. The project targets the development of innovative grades for hydrogen production (PEM electrolyzers), cryo-compressed hydrogen storage and compressed hydrogen transport. Therefore, the susceptibility to hydrogen embrittlement and the interaction between hydrogen and the microstructures will be deeply studied. The positioning of the novel developed grades versus current steel solutions (austenitic stainless 316L and ferritic line pipe grade) will be assessed in terms of hydrogen embrittlement susceptibility and steel manufacturing competitiveness. In addition, key performance indicators defined for each studied property and weight algorithm will assist the optimization of the metallurgies and the alloys comparison.

The project aims at progressing a development between TRL2 to TRL4 over the project duration.

**Project aims:**

- Define an optimized composition of Mn austenitic non-stainless steel for hydrogen applications.
- Produce a selection of experimental heat at an industrial scale.
- Screen the properties under hydrogen of the novel developed grade (toughness, FCGR, permeation, SSRT).

## ENERGY

Project Title: <b>Clad pipes for safe and effective hydrogen storage and transport</b>		Acronym: <b>CladPipe4H2</b>
Research area: <b>Energy, Hydrogen</b>	Project period: <b>01/01/2025 – 01/01/2028</b>	
Research leader: <b>Laura Moli-Sanchez</b> laura.moli.sanchez@institut-corrosion.fr Tel: +33 4 77 40 00 45	Source of funding: <b>Public Funding</b>	
	Keywords: Hydrogen, storage, Transport, Cladding	

The overall aim of the project CladPipe4H2 is the development, manufacturing and testing of new metallic structural material combinations for safe and effective hydrogen storage, transportation and distribution. In the project, material combinations will be developed and manufactured consisting of a base material to meet the strength requirements and a clad material to fulfil the hydrogen barrier and embrittlement resistance requirements. The main goal of the project is to provide durable structural materials and components for stationary (e.g. power production, machinery, residential and industrial use) and mobile (e.g. road, off-road, rail, ship, and aviation) high-pressure gaseous hydrogen applications ( $\geq 300$  bar). Focus use cases are vessels as well as pipelines and piping for gaseous hydrogen storage and transport being exposed to these high pressures and many load cycles. Due to combination of two metallic materials, costs will be saved by reducing wall thickness compared to monolithic metallic components and by substituting expensive fiber-reinforced polymers. The microstructure and their interaction with hydrogen as well as the influence on the mechanical properties will be investigated. Energy- and cost-effective process routes for small batch size and high-volume production will be realized and the manufactured components will be validated with developed testing methods.

Project aims:

- Develop cladmed material for hydrogen transport and storage.
- Develop processing routes for cladmed material applications for hydrogen.
- Develop test methodologies for testing cladmed materials under hydrogen.

## ENERGY

Project Title: <b>Evaluation of the effect of impurities in hydrogen on the fracture toughness of modern and vintage steels</b>		Acronym: <b>ToughHy-II</b>
Research area: <b>Energy, Hydrogen</b>	Project period: <b>01/01/2026 – 01/01/2029</b>	
Research leader: <b>Laura Moli-Sanchez</b> Laura.moli.sanchez@institut-corrosion.fr Tel: +33 4 77 40 00 45	Source of funding: <b>MRC Hydrogen</b>	
	Keywords: Hydrogen, Pressure, Crack Propagation, toughness	

Hydrogen is a potential alternative to fossil fuels that must be transported and stored safely. It is therefore essential to accurately assess fracture toughness under gaseous hydrogen conditions in order to enable the reliable design of industrial infrastructure. For example, hydrogen can be stored in salt caverns or aquifers.

In the case of aquifer storage, moisture may be present, along with bacteria capable of producing H<sub>2</sub>S, which alters the gas composition. Consequently, it is crucial to consider the impact of these impurities (H<sub>2</sub>S, H<sub>2</sub>O, O<sub>2</sub>) when evaluating the risks that hydrogen storage may pose to the integrity of infrastructure.

In the initial project, “ToughHy”, several testing methods for assessing fracture toughness were compared, and the effect of impurities in hydrogen was investigated using ASTM E1820 on carbon steel. Fracture toughness tests conducted according to ASTM E1820 demonstrated a pronounced sensitivity to both gas composition and moisture. The introduction of 100 ppm H<sub>2</sub>S into moist hydrogen led to a significant reduction in toughness, comparable to the effect of increasing the pressure from 100 to 500 bar in dry, pure hydrogen. Moisture alone was already found to be highly detrimental.

In this second phase of the project, “ToughHy-II”, the research continues. New impurities (CO, H<sub>2</sub>, CO<sub>2</sub>) and Welds are now being investigated, as well as the comparison between vintage and modern materials. One approach for transporting hydrogen is to utilize existing pipeline infrastructure (vintage materials), which can be retrofitted for hydrogen service or new materials. Therefore, it is important to evaluate the effects of previous operations on the integrity of these materials.

**Project aims:**

- Comparison between vintage and modern material for hydrogen transport and storage
- Evaluation of the effect of impurities on the fracture toughness under hydrogen pressure
- Effect of impurities on the fracture toughness under hydrogen pressure of welded carbon steel
- Effect of impurities on the fracture toughness under hydrogen on a series of different alloys.

## ENERGY

Project Title: <b>Characterization of the cracking susceptibility of different alloys under H<sub>2</sub> pressure at cryogenic temperature</b>		Acronym: <b>CryoH<sub>2</sub>-II</b>
Research area: <b>Energy, Hydrogen</b>	Project period: <b>01/01/2026 – 01/01/2029</b>	
Research leader: <b>Laura Moli-Sanchez</b> Laura.moli.sanchez@institut-corrosion.fr Tel: +33 4 77 40 00 45	Source of funding: <b>MRC Hydrogen</b>	
	Keywords: drogen Pressure, Corrosion Resistant alloys, cryogenic SSRT and Fatigue	

In a previous project entitled “CryoH<sub>2</sub>”, a test methodology utilising the hollow specimen technique, compliant with ISO 7039, was developed to enable SSRT tests to be conducted at cryogenic temperatures and under hydrogen pressure. 316L stainless steel, manufactured by various conventional methods as well as by additive manufacturing, was evaluated. The primary focus was on assessing the influence of hydrogen partial pressure, temperature, and certain contaminants and the link with microstructure and industrial processing.

In this continuation of the project, new alloys will be introduced, including welds, non-ferrous grades, quenched and tempered carbon steels, and a selection of corrosion-resistant alloys (CRAs). Additionally, the project will concentrate on advancing the hollow specimen technique for evaluating low-cycle fatigue.

Project aims:  
Characterization of the properties of a selection of materials at cryogenic temperatures and under hydrogen pressure.

## ENERGY

Project Title: <b>Characterization of the properties of non-standard products under hydrogen pressure</b>		Acronym: <b>ExoticH2</b>
Research area: <b>Energy, Hydrogen</b>	Project period: <b>01/01/2026 – 01/01/2029</b>	
Research leader: <b>Laura Moli-Sanchez</b> Laura.moli.sanchez@institut-corrosion.fr Tel: +33 4 77 40 00 45	Source of funding: <b>MRC Hydrogen</b>	Keywords: Hydrogen Pressure, Non standard products

Hydrogen is regarded as a promising alternative to fossil fuels, but it must be transported and stored in a safe manner. Consequently, it is crucial to accurately evaluate material's properties in gaseous hydrogen environments to ensure the dependable design of industrial infrastructure.

While assessments of this kind are now routinely carried out on standard thick products such as plates or pipelines, supported by well-established test methods (e.g. ASTM E1820, ASTM E647), the situation is quite different when it comes to more specialised materials, such as wires, flat products, coatings or cladding. For these, robust methodologies are less readily available.

The aim of this project is to investigate methods for qualifying non-standard materials for use under hydrogen pressure.

Project aims:

Propose test methodologies to qualify non-standard materials under hydrogen pressure.

## ENERGY

Project Title: <b>Additive Manufacturing of Stainless steel for Hydrogen Service</b>		Acronym: <b>Transfer</b>
Research area: <b>Energy, Hydrogen</b>	Project period: <b>01/06/2026 – 31/01/2029</b>	
Research leader: <b>Laura Moli-Sanchez</b> Laura.moli.sanchez@institut-corrosion.fr Tel: +33 4 77 40 00 45	Source of funding: <b>RFCS (research fund for coal and steel)</b>	
	Keywords:	

TRANSFER aims to develop hydrogen-compatible stainless steels for additive manufacturing (AM), enabling the production of complex components for hydrogen infrastructure and energy conversion systems. The focus is on austenitic and martensitic grades, optimised through alloy design and advanced post-processing (HIP, hirtisation and heat treatments) to enhance resistance to hydrogen embrittlement and fatigue. By benchmarking AM routes such as Powder Bed Fusion (PBF-LB) and Wire Arc Additive Manufacturing (WAAM) against conventional steels, TRANSFER will establish their competitiveness in demanding hydrogen environments. Two industrial demonstrators will validate this approach: a gas turbine fuel nozzle and a compressor centrifugal impeller, both representing critical hydrogen service conditions where AM's ability to produce complex geometries and near-net-shape parts offers decisive advantages. Over 550 specimens will be produced and tested to generate a comprehensive database on hydrogen transport, fracture, and fatigue performance, providing critical inputs to pre-normative standards and certification pathways. Sustainability is embedded in TRANSFER through the use of scrap-based AM powders, life-cycle assessment, and techno-economic analysis, demonstrating reduced CO<sub>2</sub> emissions, material savings, and shorter lead times of AM compared to conventionally manufactured steels. The consortium unites research institutes, steelmakers, powder manufacturers, AM technology providers, and end-users, ensuring both scientific excellence and industrial relevance. This strong value-chain coverage guarantees that the project contributes directly to RFCS objectives in clean steel technologies, sustainable and resource-efficient manufacturing, circularity, and global competitiveness. By systematically addressing alloy design, printing conditions, and post-treatment strategies, TRANSFER will generate durable, sustainable steel components solutions for the hydrogen economy. Project RFCS ID: 101294629

**Project aims:**

- Gas Turbine Fuel Nozzles: operating in high/low temperature cycles, low mechanical load environments where austenitic stainless steels are most suitable. TRANSFER aims to maintain formability of 316L while improving strength and H-resistance through optimized microstructures enabled by AM.
- Compressor centrifugal impeller: Subjected to cyclic mechanical loading - dependent on the hydrogen source and scheduled machine stops - as well as high centrifugal stress, where martensitic stainless steels are required. The goal is to, by AM, achieve an improvement in resistance to hydrogen-assisted fatigue crack growth compared to 316L, while preserving good formability and processability.

## ENERGY

Project Title: <b>Assessment test methods conservatism to evaluate the toughness of steels under hydrogen pressure</b>		Acronym: <b>SentHy</b>
Research area: <b>Energy, Hydrogen</b>	Project period: <b>01/10/2025 – 31/12/2028</b>	
Research leader: <b>Laura Moli-Sanchez</b> Laura.moli.sanchez@institut-corrosion.fr Tel: +33 4 77 40 00 45	Source of funding: <b>Industrial</b>	
	Keywords: Hydrogen, SENT, CT, fracture mechanics	

The qualification of metallic material for operation under hydrogen pressure generally requires laboratory testing to estimate the toughness and the fatigue crack growth rate. Regarding the toughness evaluation, considering the very high ductility of the materials to be tested, one appropriate test method is described in ASTM E1820. The tests are generally conducted on compact tension specimens but due to standards validity requirements and material wall thickness limitations, it is often impossible to sample the specimens in an orientation that can mimic the service conditions

Other specimens (SENT, SENB) are better suited to allow for selecting the orientation of the crack propagation that is tested and define laboratory conditions that fit the service ones. However, data from the literature underline that these specimens are less conservative than the CT and that the actual toughness obtained with one specimen or another can be largely different.

The objective of the project is therefore to clearly establish the impact of the specimen geometry, sampling orientation and test conditions on the actual toughness estimated after standard testing under hydrogen pressure. The main expected outcome is a clarification of the best laboratory practices to study material under hydrogen pressure and a comparison of the conservatism in the test results depending on the type of specimen selected for testing.

Project aims:

- Compare the conservatism of the different specimen geometries for the evaluation of the fracture toughness under hydrogen pressure
- Evaluate the effect of microstructure heterogeneities in on the fracture toughness under hydrogen of a selection some steels
- Evaluate the effect of impurities in the H<sub>2</sub> gas when tested with different specimen geometries.

## ENERGY

Project Title: <b>Optimized pressure vessel steels for new low carbon fuel tanks</b>		Acronym: <b>Trust</b>
Research area: <b>Energy, Hydrogen</b>	Project period: <b>01/06/2026 – 31/01/2029</b>	
Research leader: <b>Laura Moli-Sanchez</b> Laura.moli.sanchez@institut-corrosion.fr Tel: +33 4 77 40 00 45	Source of funding: <b>RFCS (research fund for coal and steel)</b>	
	Keywords: CO <sub>2</sub> , NH <sub>3</sub> , H <sub>2</sub> , steel	

The integrity management of infrastructure assets for the energy transition raises several critical questions. Will existing welding procedures remain applicable to future pressure vessel tanks? Can these tanks serve dual purposes in export terminals—storing incoming ammonia from other continents while also captured CO<sub>2</sub> from local industry for sequestration offshore? Additionally, do transient conditions (such as full-to-empty cycles) pose a risk for environmental cracking? The TRUST project aims to address these inquiries by evaluating welding procedures for Pressure Vessel steels across three strength levels: the current 355 MPa, as well as higher 500 MPa and 700 MPa. These multipurpose tanks will play a crucial role in export-import terminals, accommodating the new fuels of the energy transition: ammonia, CO<sub>2</sub>, and H<sub>2</sub>. TRUST will assess weld performance, heataffected zones (HAZ), and base metal behavior in cryogenic environments. Furthermore, TRUST will document and disseminate findings within relevant standardization committees. Ultimately, based on gap analysis, and propose material design guidelines. Project ID : 101295673

**Project aims:**

- Delivery of samples welded with industrially relevant welding procedures for comprehensive testing (mechanical, corrosion).
- Proposition of a combination of steel and welding procedure(s) with and/or without PWHT ensuring a minimum CTOD value in the HAZ of 0.3 mm at -40°C.
- Provide a combination of steel and welding procedure with and without PWHT resistant to hydrogen embrittlement (HE)
- Provide a combination of steel and welding procedure with and without PWHT, free of environmental assisted cracking in an captured CO<sub>2</sub> environment.
- Provide a combination of steel and welding procedure without PWHT, free of stress corrosion cracking (SCC) in an NH<sub>3</sub> environment.
- Prototype demonstration.

## ENERGY

Project Title: <b>Fuel production and advanced materials for Swedish energy production</b>		Acronym: <b>BAMSE</b>
Research area: <b>Energy, Nuclear</b>	Project period: <b>18/03/2025 – 30/10/2026</b>	
Research leader: <b>Rikard Norling</b> rikard.norling@ri.se Tel: +46 10 228 48	Source of funding: <b>Public funding (Swedish Energy Agency)</b>	
	Keywords: Corrosion in lead, FeCrAl, Nuclear, SMR	

The project will qualify, validate and demonstrate advanced corrosion-resistant materials for lead-cooled small modular reactors (SMRs). The project includes characterization of new alumina-forming steels, including proprietary alloys as well as commercial FeCrAl variants. Manufacturing methods for additive manufacturing, powder metallurgy, HIP, HVAF and plasma spraying will be evaluated to optimize microstructure, mechanical properties and corrosion resistance in high-temperature liquid lead environments. The project also includes the development of protective coatings and test methods that support standardization and industrialization. This enables flexible energy use and contributes to a sustainable energy transition.

**Project aims:**

- To characterize and industrialize new materials with high corrosion resistance, especially in liquid lead.
- To verify the material properties in various product forms, including solid structures and corrosion protection applications.
- In the long run, the project aims to enable a faster commercialization of SMRs.

## ENERGY

Project Title: <b>Qualification of newly developed corrosion monitoring systems under ionizing radiation for the radioactive waste French underground laboratory</b>		Acronym: <b>SensIRAD 2</b>
Research area: <b>Energy, nuclear waste disposal</b>	Project period: <b>01/03/2025 – 01/09/2026</b>	
Research leader: <b>Johan Becker &amp; Erwan Diler</b> johan.becker@institut-corrosion.fr erwan.diler@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>Public fundings (ANDRA)</b>	
	Keywords: Corrosion monitoring, electrical resistance sensors, carbon steel, storage and disposal of radioactive waste	

The French deep geological repository solutions for the disposal of high and intermediate-level long-lived radioactive waste is studied since decades at the underground pilot laboratory (URL) managed by the French National Agency for Radioactive Waste Management (Andra). The URL is located in the East of France, 500 meters deep, in a stable Callovo-Oxfordian claystone layer, selected for its containment properties. The concept relies on a multibarrier approach including the use of a carbon steel (CS) casing inserted in microtunnels and in which sealed radioactive waste container will be then introduced. After insertion of the CS casing, a remaining technological gap between the Cox and the extrados of the casing is filled with a specific cement grout. This cement grout aims to buffer the acidic transient resulting from the release of acidity in the pore water due to the oxidation of sulfur-based minerals.

The Andra is therefore conducting studies focusing on the corrosion and mechanical behavior of the CS casing, with particular interest for real-time corrosion monitoring solutions as an alternative to the common gravimetric method using reference coupons. Several techniques are investigated, including the electrical resistance (ER) raising several challenges to satisfy the requirements implied by the specific conditions of the disposal or radioactive waste in deep geological repository.

In this context, a new ER sensor corrosion monitoring solution has been developed and qualified in the framework of previous projects, *i.e.* SensAndra and SensIrad. This ER sensor design was proved to enable real-time monitoring of the corrosion under strong ionizing conditions. Besides, results from this first irradiation campaign suggest an influence of the  $\gamma$ -rays on the corrosion dynamic of the low carbon steel ER sensors. To better understand this effect, further investigations will be conducted in this project including irradiation of sensors i) under controlled atmospheric conditions and ii) in cement grout that mimics the environment at the extrados of the URL microtunnels casing.

Project aims:

- Develop a test cell that enables to control and monitor environmental conditions (relative humidity, temperature ...) under irradiation conditions.
- Assess the effect of the irradiation on the corrosion of a low carbon steel under controlled atmospheric conditions and in cement grout.

## ENERGY

Project Title: <b>Development, supply and support of corrosion monitoring systems for the radioactive waste French underground laboratory</b>		Acronym: <b>SensAndra 2</b>
Research area: <b>Energy, nuclear waste disposal</b>	Project period: <b>01/10/2025 – 01/10/2029</b>	
Research leader: <b>Johan Becker &amp; Erwan Diler</b> johan.becker@institut-corrosion.fr erwan.diler@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>Public funding (Andra)</b>	
	Keywords: Corrosion monitoring, electrical resistance sensors, carbon steel, Storage and Disposal of Radioactive Waste	

In the context of the high-level radioactive waste disposal, the in-situ corrosion rate of the infrastructure must be evaluated and monitored. In France, it is expected to dispose of high and intermediate level long-lived radioactive waste at about 500 m depth in a deep geological disposal, drilled in a very stiff clay Callovo-Oxfordian claystone (Cox) is expected. To do so, 100 m length carbon steel casing will be inserted inside disposal cells which are horizontal tunnels drilled in the Cox. In the current concept, a specific cement grout will be injected between the carbon steel casing and the claystone. This cement grout aims to pass through the acidic transient - due to the release of acidity into the pore water by destabilising the sulphur-bearing minerals (pyrite) which were oxidized during the excavation phase of the cells - without high corrosion process on casing.

All the experiments and prototypes aiming to validate and improve this concept are currently performed in the French Underground Research Laboratory (URL) (Bure, France). The corrosion rate of the carbon steel casing will be assessed and monitored using a set of electrical resistance sensors, compatible with high temperature and alkali environment. The specifications also require a long distance between the sensors and the acquisition, as well as a long-life span, a high accuracy and an integration to global URL monitoring system.

The SensAndra 2 project aims to continue the development of the newly developed ER sensors and transmitters used for the real-time corrosivity monitoring in deep geological conditions for high-level radioactive waste disposal. Additional ER sensors will be therefore provided for further investigations related to i) the assessment of the measurement uncertainties of the ER sensors and transmitters, ii) the instrumentation of new microtunnels at the URL and iii) laboratory experiments on a microtunnel demonstrator. Besides, developments of new ER sensors geometries compatible with industrial alloys and intended to detect the initiation/propagation of localized corrosion will be conducted.

**Project aims:**

- Deploy additional ER corrosion monitoring solution at the URL and assess the measurement uncertainties of the sensors and transmitters.
- Perform experiments in controlled conditions on a laboratory microtunnel demonstrator using ER corrosion sensors.
- Investigate new ER sensors geometries compatible with industrial alloys and the detection of localized corrosion.

## ENERGY

Project Title: <b>Potential influence of microorganisms on the corrosion of carbon steel in the French radioactive waste disposal context</b>		Acronym: <b>HAnubiss 3</b>
Research area: <b>Energy, nuclear waste disposal</b>	Project period: <b>01/06/2023 – 01/06/2027</b>	
Research leader: <b>Erwan Diler</b> erwan.diler@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>Public funding</b>	
	Keywords: Corrosion, Microbially Influenced Corrosion, carbon steel, cement grout, pore water, microbiology	

In the context of the high-level radioactive waste disposal CIGEO, the corrosion rate due to microbially influenced corrosion (MIC) has to be evaluated. In France, it is envisaged to dispose of high- and intermediate-level long-lived radioactive waste at a depth of 500 m in a deep geological disposal, drilled in the Callovo-Oxfordian claystone (Cox) formation. To do so, according to the current concept, a carbon steel casing will be inserted inside disposal cells, which are horizontal tunnels drilled in the Cox. A specific cement grout will be injected between the carbon steel casing and the claystone. The main objective of this filling grout is to balance the transitory acidic conditions in the medium induced by the Cox oxidation. In addition, the alkalinity provided by the cement is expected to favor the steel passivity and act as strong environmental constraint for microorganisms. However, throughout its life, the disposal cell will be subject to various hydraulic, thermal, physical-chemical, and mechanical transients. This study is conducted to evaluate the possibility of MIC in such environments for various cement grout formulations and temperatures.

The corrosiveness will be investigated with or without microorganisms enriched from samples of Andra's underground research laboratory and complemented by adapted collection strains. Two cement grout mixtures, three temperatures (30, 50 and 80°C), three dissolved oxygen levels, and three durations (6, 12 and 18 months) are investigated. The monitoring of corrosion during the experiments will be ensured using a gravimetric method and real-time corrosion sensors based on the measurements of the electrical resistance. The corrosion data will be completed with microbiological analyses including cultural and molecular characterizations. This work is performed in collaboration with Corrodys (France).

**Project aims:**

- Assess the potential influence of microorganisms in this specific environment.
- Compare the cement-grout formulations in terms of environment constraints and impacts on carbon steel corrosion.
- Assess the influence of low oxygen on the corrosion rate and potential MIC.

## ENERGY

Project Title: <b>Impact of H<sub>2</sub>S fugacity on hydrogen charging and SSC of carbon steels</b>		Acronym: <b>Fugacity II</b>
Research area: <b>Energy, Oil &amp; Gas</b>	Project period: <b>01/04/2022 – 01/06/2026</b>	
Research leader: <b>Christophe Mendibide</b> christophe.mendibide@institut-corrosion.fr Tel: +33 4 77 40 00 45	Source of funding: <b>Industrial funding</b>	
	Keywords: Stress corrosion cracking, H <sub>2</sub> S, Permeation	

As the total pressure of oil & gas production environments increases, thermodynamic calculations using perfect fluids simplifications are not valid anymore. For acid gases such as H<sub>2</sub>S, this involves the use of fugacity instead of partial pressure. However, most industrial standards related to H<sub>2</sub>S cracking are using partial pressure scales. It is also a common practice to perform H<sub>2</sub>S qualification tests at low total pressure, at the same H<sub>2</sub>S partial pressure as the one of the production environment, disregarding the potential effects of fugacity.

In a first JIP conducted during the period 2019-2021, the potential impact of fugacity on the risks of H<sub>2</sub>S cracking was studied. The proof of concept of the fugacity effect was assessed using hydrogen permeation techniques at high pressure (up to 300 bar). We observed 2 different effects depending on the range of pH and pH<sub>2</sub>S:

- Either the permeation flux at high pressure is lower than the one obtained at atmospheric pressure under the same pH/pH<sub>2</sub>S node
- Or, due to variation in scale protectiveness, a so-called "inversed fugacity effect" was observed leading to a higher hydrogen charging flux at high pressure rendering the standard qualification test possibly not enough conservative.

This new project aims at complementing the results obtained in the first program, mainly through the use of cracking tests (HIC/4PB and DCB) together with permeation.

**Project aims:**

- Evaluation of the possibility to qualify material using the fugacity concept through testing at atmospheric pressure.
- Estimate in which pH/pH<sub>2</sub>S conditions the inverse fugacity effect can be observed.
- Estimate the possible effect of buffer system on the results.
- Proof of concept of the fugacity effect above the bubble point (work in full liquid systems).

## ENERGY

Project Title: <b>FeCl<sub>2</sub> based buffers to control the pH during SSC test</b>		Acronym: <b>Buffer SSC</b>
Research area: <b>Energy, Oil and Gas</b>	Project period: <b>01/01/2026-31/12/2028</b>	
Research leader: <b>Christophe Mendibide</b> christophe.mendibide@institut-corrosion.fr Tel: +33 4 77 40 00 45	Source of funding: <b>MRC CCUS and H2S</b>	
	Keywords: SSc, H <sub>2</sub> S, buffer, FeCl <sub>2</sub> , acetates	

Sulfide Stress Cracking (SSC) and Hydrogen-Induced Cracking (HIC) are common failure mechanisms affecting carbon and low alloy steels in the oil and gas industry. For SSC, ISO 15156-2 defines different severity regions based on pH and the partial pressure of H<sub>2</sub>S, which are considered the primary parameters influencing the risk of cracking in carbon steels and are key inputs for material selection. To control pH during testing, various buffer systems can be employed, most of which are based on the acetic acid/acetate pair. But in recent years, concerns have been raised within the industry regarding the potential impact of high-acetate buffer systems on qualification test outcomes. This impact of acetates has been evaluated in a previous project "AcetateSSC".

In this follow-up, we are investigating the use of FeCl<sub>2</sub>-based buffers to regulate pH. This approach would utilise a natural buffering system, achieved by saturating the solution with iron cations. According to some literature, FeCl<sub>2</sub> buffers may also help prevent the formation of microgrooving on SSC specimens, which can sometimes complicate the pass/fail assessment.

2 grades are investigated :

- X100 pipeline steel to evaluate the effect of the buffer on the groove formation. FeCl<sub>2</sub> is compared with other buffering systems
- C125 to complement the former study AcetateSSC and evaluate the relative severity of the different buffer system

Project aims:

- Evaluate if FeCl<sub>2</sub> buffer systems can modify the SSC test results in comparison with standard acetate based ones
- Evaluate the effect of FeCl<sub>2</sub> on grooving formation during SSC tests.

## ENERGY

Project Title: <b>Hydrogen embrittlement resistant new steel links solutions for offshore wind turbines</b>		Acronym: <b>HELIX</b>
Research area: <b>Energy, wind energy</b>	Project period: <b>01/07/2022 -31/01/2026</b>	
Research leader: <b>Nicolas Larché</b> nicolas.larche@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>Public Funding (RFCS)</b>	
	Keywords: Hydrogen embrittlement, bolting, wind energy, cathodic protection, coatings	

To increase the use of electricity produced from renewables the full potential of Europe's offshore wind energy has to be developed. To unlock Europe's offshore potential, the number of installed offshore wind turbines is expected to rise in the coming years. Cost reduction and efficiency are still imperative in this technology and the industry is thus designing larger power generators, up to 10 MW. This trend will lead to larger foundations due to higher mechanical demands. Flanged connections are still an integral part of any offshore developments with fasteners being the primary means for assembly.

Fasteners with diameters over M48 are becoming common and bolts already used can be as high as M72. Therefore, a technical and research effort is needed in the fasteners field to support the ever-increasing size of offshore wind turbines. On one hand, HELIX will develop, test and provide fasteners able to withstand high applied stresses under harsh environmental conditions typical of large offshore wind turbines. This will be achieved by developing and optimising a novel high strength steel grade in qualities 10.9 and 12.9 and new protecting zinc-flake based coatings. On the other hand, HELIX will contribute to unravel how atmospheric and immersed conditions, material composition and microstructure, surface treatment and previous corrosion affect hydrogen embrittlement of high strength steels. HELIX will use advanced characterization techniques as well as traditional techniques under both atmospheric and immersion conditions, to advance in the knowledge of hydrogen absorption in high strength steels under cathodic protection and in atmospheric conditions. This knowledge will not only allow tailoring the steel and coating microstructure to achieve both excellent corrosion protection ability and low risk of hydrogen embrittlement but also influence on policy and practice in the offshore wind sector.

**Project aims:**

- To optimize new lower cost high strength steel composition with improved hardenability, high toughness and high hydrogen embrittlement resistance
- To identify the mechanisms of hydrogen absorption/desorption of the optimized steels.
- To develop coatings based on zinc flakes and different topcoat materials to protect the steel and to reduce hydrogen production in service.
- To study the interaction of the optimized steel, the novel coatings and the environment on the hydrogen absorption mechanisms.
- To demonstrate the higher performance of the developed fasteners in real environments.

## ENERGY

Project Title: <b>Extended life DURation for steel welds and LINKs for off-shore renewable energy generation</b>		Acronym: <b>DURALINK</b>
Research area: <b>Energy, wind energy</b>	Project period: <b>01/07/2024 – 31/12/2027</b>	
Research leader: <b>Flavien Vucko</b> flavien.vucko@institut-corrosion.fr Tel: +33 2 98 05 15 52	Source of funding: <b>Public funding (RFCS)</b>	
	Keywords: High strength steel, hydrogen embrittlement, cathodic protection, fatigue	

The growth and stability of the wind industry will depend essentially on continued reductions in wind energy cost, even below that of fossil-fuel based energy sources. Consequently, the offshore wind industry is upscaling Wind Turbines from 8 MW up to more than 12 MW. This level of upscaling puts tough materials challenges because the mass of the turbine increases linearly with the cube of the rotor radius. DURALINK project is thus motivated by the challenges in structural integrity assessment of the large structures and chains that will support offshore wind generation in the future. Therefore, the main objective of DURALINK is to identify optimization design opportunities for offshore structures that lead to a reduction of the CAPEX and OPEX of offshore wind turbines. To attain this objective, DURALINK will identify optimization design opportunities for offshore structures through the evaluation of existing and improved steel grade welds, corrosion-fatigue analysis with cathodic protection at different potentials and developing predictive models of mechanical degradation. Furthermore, high strength steels composition will be optimized to lower Hydrogen Embrittlement susceptibility improving the security of chains for offshore wind turbines. Finally, DURALINK proposes a novel concept for protection of support structures. For this, it will develop novel thermal sprayed coatings for protection of substructure against marine corrosion able to be deposited by High Velocity Wire Arc Spray. The corrosion performance and enhanced behavior of the coated steels under fatigue, corrosion-fatigue and tribocorrosion conditions will be evaluated.

**Project aims:**

- To identify optimization design opportunities for offshore structures through the evaluation of existing steel-grade welds through corrosion-fatigue analysis with cathodic protection at different potentials and the development of fatigue models.
- To optimize high strength steels composition, used in chains for offshore XL-WT, to lower Hydrogen Embrittlement susceptibility.
- To improve the fatigue behaviour of welds in S420NL and S460NL steel grades thanks to the effect of High Frequency Mechanical Impact post weld treatment for R > 0.5.
- To develop novel Thermal Spray coatings for protection of substructure against marine corrosion able to be deposited by High Velocity Wire Arc Spray.
- To evaluate the corrosion performance and enhanced behaviour of the coated steels under fatigue, corrosion-fatigue and tribocorrosion conditions.

## PROCESS INDUSTRY

<b>Project Title:</b> <b>Effect of chloride on corrosion behaviour of different alloys in simulated biorefinery process</b>		<b>Acronym:</b> <b>CorrBioref</b>
<b>Research area:</b> <b>Process industry, Biorefinery and biomass</b>	<b>Project period:</b> <b>01/01/2025 / 31/12/2026</b>	
<b>Research leader:</b> <b>Abdelkader Meroufel, Matthieu Regnere</b> abdelkader.meroufel@ri.se matthieu.regnier@institut-corrosion.fr Tel: +46 10 228 49 95	<b>Source of funding:</b> <b>MRC Biorefinery</b>	
	<b>Keywords:</b> Corrosion, Biorefinery Process, Corrosion-resistant Alloy	

Biorefinery is an emerging technology and a continuously growing business sector with a continuous development of new advanced processes. Many of these processes are highly demanding regarding the corrosion resistance of the alloys used in biorefinery plants. This makes it challenging to introduce the new advanced processes on a large commercial scale and to benefit from their full potential. This requires significant extent of effort and knowledge not only related to the processes, but also to material selection to avoid corrosion of components used in such challenging environments.

Based on initial results, the project continues exploring Corrosion resistant alloys (CRAs) behaviour under unsaturated conditions at high temperature as well as the performance in hot acids in semi-immersion exposure conditions. The focus is paid to the stress corrosion cracking phenomenon where no data are available for both end-users and material producers. CRAs performance data will be the main deliverable that will help biorefinery sector in materials selection question.

**Project aims:**

- To determine the performance of different CRAs in terms of SCC resistance under unsaturated conditions and hot acid in semi-immersion.
- To understand the effect of critical parameters that determine materials behaviour.
- To establish data on materials compatibility in simulated biorefinery processes.

## PROCESS INDUSTRY

Project Title: <b>Less Corrosive Biofuel Production Process</b>		Acronym: <b>LowCoBio</b>
Research area: <b>Process industry, Biorefinery and biomass</b>	Project period: <b>14/12/2024-14/12/2027</b>	
Research leader: <b>Matthieu Regniere and Rikard Norling</b> Matthieu.regniere@institut-corrosion.fr Tel: +33 4 77 40 00 45 Rikard.norling@ri.se Tel: +46 10 228 48 89	Source of funding: <b>Public funding</b>	
	Keywords: Biofuel, Corrosion	

The overall aim of the LowCoBio project is to accelerate the commercialization of bio-oil based production routes of renewable fuels. This will be achieved by a cross-cutting project approach where the production processes are developed further, at the same time as corrosion issues of the materials and processes are investigated. This is an important research area since corrosion constitutes one of the present barriers to scale-up. The project aims to provide guidance on adjusting the process conditions throughout the whole production process, from pretreatment to liquefaction and upgrading, so that product quality and yield remain high at the same time as the need for very expensive construction materials is avoided. To achieve its ambitious overall aim, the project has defined 4 specific objectives (SO), described below.

**Project aims:**

- Improve biofuel production process with reduced product corrosivity.
- Scale-up and demonstration at TRL 5.
- Lifecycle, techno-economic and environmental impact analysis.
- Provide materials selection guidelines.

## PROCESS INDUSTRY

Project Title: <b>Sustainable production of lignin-derived end-products via depolymerisation reactions</b>		Acronym: <b>SPLENDOR</b>
Research area: <b>Process industry, Biorefinery and biomass</b>	Project period: <b>18/03/2025 – 30/10/2026</b>	
Research leader: <b>Rikard Norling</b> rikard.norling@ri.se Tel: +46 10 228 48 89	Source of funding: <b>Public funding (EU – HORIZON)</b>	
	Keywords: Black liquor, Lignin, Supercritical	

SPLENDOR aims to demonstrate a groundbreaking one-step depolymerization technology that efficiently converts lignin from black liquor, a pulping industry byproduct, into valuable aromatic chemicals, without the need for pre-treatment, additional chemicals, or catalysts. This process integrates seamlessly into pulp mills, enhancing scalability and cost-efficiency. It achieves complete conversion of lignin into bio-aromatic monomers, dimers, and oligomers, while recycling inorganic chemicals back to the mill in a zero-waste approach.

The long-term continuous operation of the hydrothermal depolymerization process will be performed to address engineering challenges. A 250 L/h prototype will operate for six months in an operational pulp mill, providing data for future scale-up to a 5000 L/h plant. The project will demonstrate continuous 24/7 operation of the 250 L/h prototype, addressing engineering challenges such as variable feedstock and reactor component corrosion and wear.

Corrosion investigation will be conducted on parts exposed to supercritical water, using metallographic analysis to examine factors such as the extent of pit formation, material loss, and the morphology of corrosion products on the surfaces.

The project will also develop four industrial applications - fine chemicals, waterproofing coatings, plasticizers for tires, and fuel components - and showcase their market potential.

SPLENDOR supports a circular economy by converting black liquor into high-value bio-based chemicals, improving resource efficiency, and boosting the European chemical industry's economic viability.

#### Project aims:

- Scale, validate and improve the performance of the depolymerisation process
- Develop methodology for integrating the depolymerisation process into operational pulp mills.
- Perform extensive testing of the 250L/h prototype under varied feedstock and operational conditions
- Observe and record wear and tear including corrosion caused by supercritical water.
- Upon commercialization SPLENDOR is expected to save over 800,000 tons of CO<sub>2</sub> annually, advancing Europe's climate goals and circular economy targets.

## PROCESS INDUSTRY

<b>Project Title:</b> <b>Industrial Online Corrosion Monitoring – Acoustic Emission and Electrochemical Probes</b>		<b>Acronym:</b> <b>CorrMon</b>
<b>Research area:</b> <b>Process industry, chemistry</b>	<b>Project period:</b> <b>01/01/2023 – 31/12/2026</b>	
<b>Research leader:</b> <b>Clément Boissy</b> (Electrochemical Probes) clement.boissy@institut-corrosion.fr Tel: +33 6 78 21 57 88  <b>Clément Lecart</b> (Acoustic emission) clement.lecart@institut-corrosion.fr	<b>Source of funding:</b> <b>Internal and Industrial funding</b>	
	<b>Keywords:</b> Chemical Process Industry, Industrial Corrosion Assessment, Online Monitoring, Acoustic Emission, Electrochemical probe	

Corrosion monitoring is a key point for process industry. It aims to be able to follow corrosion propagation or detect corrosivity deviation to anticipate maintenance operation and optimize OEE. Moreover, corrosion monitoring enables evaluation of the corrosion in operative environment as an extension of laboratory work. IC regularly proposes the use of coupons to evaluate corrosion rate, but this technique is very limited. Online corrosion monitoring by acoustic emission is also currently proposed (mature technology still under development) and use of electrochemical probes is under development.

**Acoustic Emission (AE)** defines the elastic energy which is released in material in the form of transitional ultrasonic elastic waves, resulting of internal micro displacement. Many developments occurred in recent decades alongside advances in electronics and IT, since 1950 with the works of J. KAISER. Applications of AE technique could be gathered in two families: control of structure integrity and online monitoring. It's in this second family that IC offers and develop its skills for industry. It consists in monitoring equipment during process without external intervention. AE enables to assess potential active damage (SCC, intergranular or pitting corrosion, fatigue...) evolution depending of process parameters and process management. AE is a powerful nondestructive and nonintrusive technique allowing online volume monitoring in severe conditions, for example: chloride stress corrosion cracking in DSS decanter, thermal fatigue phenomena in the bottom of polycondensation calves and mechanical fatigue on the supports of crystallizers.

**Electrochemical Probe** offer on the market tends to shrink with withdrawal of major company in Europe. It has been developed for Oil and Gas industry and have difficulties to be adapted for process industry considering the wide range of process and materials that requires adaptability and electrochemical expertise. Commercial systems are rather inexpensive but without any adaptability. For this reason, IC is collaborating with ORIGALYS to develop a system that could be used as a potentiostat but also as a datalogger for weeks of recordings. Test lab in 2023 and industrial test in O&G industry (2024) permit to validate the performances of the equipment. The first test in process industry plant is planned for 2025 with several months of monitoring. Improvement of the datalogger regarding power supply and data communication is also planned for 2025.

*This project is funding by Industrials plants (Acoustic Emission) and internally (Electrochemical Probes)*

**Project aims:**

- To develop online monitoring of active corrosion and damages
- To replace offline corrosion monitoring with coupons
- To provide data to industrial customers in order to help them in decision making for process management or maintenance operation scheduling or investment.

## PROCESS INDUSTRY

Project Title: <b>Non-destructive testing using microwaves to assess plastic corrosion</b>		Acronym: <b>NDT plastic</b>
Research area: <b>Process industry, chemistry</b>	Project period: <b>01/11/2024-30/04/2026</b>	
Research leader: <b>Katarina Bokström</b> katarina.bokstrom@ri.se Tel: +46 10 228 49 60	Source of funding: <b>Public funding (Vinnova)</b>	
	Keywords: Fiber reinforced plastic (FRP), Non-destructive testing (NDT), microwave, inspections, digitalization of industry	

The project will develop and deploy devices to measure the thickness of fiber reinforced plastic (FRP) with microwaves at four different sites, a pulp mill, two chlorine mills and a chemical plant. The microwave devices are constructed with a new and cheap type of chip, allowing for wide use of the future product. This methodology has been proven in previous projects to be very promising for the purpose. Software and hardware will be developed in collaboration between RISE and Percy Roc.

The response of the measuring instrument will be correlated to evaluations of the material in the laboratory. This knowledge will be the basis for safe and secure use of technology. In addition to knowledge of the effects of different materials on microwave propagation, knowledge of how different environments (chemical solution, liquid and gas) affect the signals will also be obtained. Lessons will also be learned on how to make the product practical for use in industry.

**Project aims:**

- To determine the thickness of FRP-constructions using a portable microwave unit
- To develop software that can help in interpretation of corrosion defects as measured with the microwave unit
- To form a microwave module at a TRL-level and user friendly that can be used within Swedish industry.

# Sweden and France publications

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