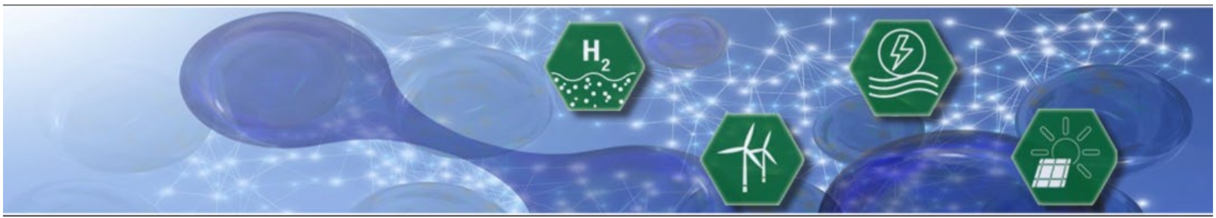
NOUVEAU



NOVEL ELECTRODE COATINGS AND INTERCONNECT FOR SUSTAINABLE AND REUSABLE SOEC

UPDATES ON THE FIRST YEAR OF ACTIVITIES

The consortium of NOUVEAU is running for 20 months! In this third Newsletter, we will guide you through our **clustering** activities with other European projects working on similar topics, with the aim to connect with similar initiatives to boost visibility: **FreeMe, MOZART, NICKEFFECT**. The objective is to conduct networking activities to establish links with the key actors of other EU funded projects to further increase the impacts of the project.
We also present the project progress of **Forschungszentrum Jülich**, **IMDEA Energy, VITO, QSARLAB**, as well as a new researcher joining the NOUVEAU project, **Dr. Sher Ahmad**.
Enjoy the reading!

4SEE CLUSTER: MEET THE NOUVEAU SISTER PROJECTS

A collaboration agreement has been signed between **NOUVEAU** and the following "sister" projects funded under the HORIZON-CL4-2021-RESILIENCE-01-12 topic:

- **FreeMe**, "Toxic Free metallization process for plastic surfaces", EU-funded project under Grant Agreement 101058699;

- **MOZART**, "METAL MATRIX NANO-COMPOSITE COATINGS UTILIZATION AS ALTERNATIVE TO HARD CHROMIUM", EU-funded project under Grant Agreement 101058450;

- **NICKEFFECT,** "Ni-based ferromagnetic coatings with enhanced efficiency to replace Pt in energy & digital storage applications", EU-funded project under Grant Agreement 101058076.

Together with NOUVEAU, the projects have founded the **4SEE CLUSTER.** The 4SEE Cluster is a collaborative initiative focusing on safe and sustainable-by-design metallic coatings and engineered surfaces. By combining resources, expertise, and knowledge, the cluster aims to address shared challenges, enhance collaboration, and accelerate progress towards safer and more sustainable solutions. The aim of this collaboration is to establish a strong liaison between the four initiatives - aiming to revolutionise metallic coatings and engineered surfaces for the European economy - in terms of multilaterally implementing different actions

FREEME: SAFE AND SUSTAINABLE-BY-DESIGN METALLIC COATINGS AND ENGINEERED SURFACES

FreeMe project aims to **eliminate the use of hexavalent chromium (Cr^{6+}) and palladium (Pd)** from the **Plating on Plastics** (PoP) process, based on REACH compliant chemicals, avoiding toxic compounds and ensuring long-term sustainability. For this purpose, FreeMe proposes two **safe and sustainable by design approaches** for the metallization of polymeric surfaces:

1. Utilization of **sprayable resins** with the addition of suitable nickel-based precursors, that will be deposited on the plastic surface leading to the creation of the necessary nuclei for the next step of electroless deposition and the formation of the conductive layer.
2. A **Cr^{6+} & Pd free pre-treatment** of the surface followed by incorporation of nickel active sites via reduction of nickel salts in the plastic surface. The electroless plating of the surface will follow leading to the formation of the conductive layer.

The proposed technologies will be applied in three different **applications** in the:

- automotive,
- aerospace and
- home appliances industries

Contacts:
Project website: Homepage - FreeMe Project (freeme-project.eu)
Dissemination management: melina.p@exelisis.gr

NICKEFFECT: BOOSTING THE RESEARCH AND DEVELOPMENT OF NEW SOLUTIONS FOR MATERIALS REPLACING THE PLATINUM GROUP METALS (PGM)

NICKEFFECT, a new project co-funded by the European Commission's Horizon Europe programme, aims to develop novel ferromagnetic Ni-based coating materials to replace the scarce and costly Platinum and ensure high efficiency in key applications.

Running from June 2022 until June 2026, the NICKEFFECT project is led by a consortium that is a multidisciplinary team comprised of 12 partners from 7 different EU and HEU-associated countries (Belgium, France, Germany, Greece, Ireland, Spain, and the United Kingdom). It covers stakeholders of the whole project value chain: scientific and technology developers, technology providers, end-users, as well as transversal partners.

Contacts:

Project website: Main Home — NICKEFFECT

Dissemination management: danijel@f6s.com; laura@f6s.com

MOZART: LEVERING NEW COATING SOLUTIONS TO REPLACE HARD CHROMIUM AND REVOLUZIONISE THE SURFACE FINISHING INDUSTRY

MOZART project has the ambitious purpose of assisting the fulfillment of REACH requirements to eliminate Hard Chromium (HC), a toxic and carcinogenic substance, offering an environmentally less harm and less toxic alternative to the painting and coating industry, following the Safe and Sustainable by Design (SSbD) principles.

Contacts:

Project website: Home - Mozart-Project

Dissemination management: myrto.pelopida@axia-innovation.com

UPDATES ON ACTIVITIES

RESEARCH ON MATERIALS

Forschungszentrum Jülich (FZJ) analyzed oxide scales formed on bare and MCF-coated steel during air oxidation (Fig.1). The analysis revealed substantially thinner Cr-rich scales on the coated steel compared to the bare steel. Apparently the presence of the coating slows the oxidation rate and thus might extend lifetime of the steel components limited by consumption of their Cr-reservoir.

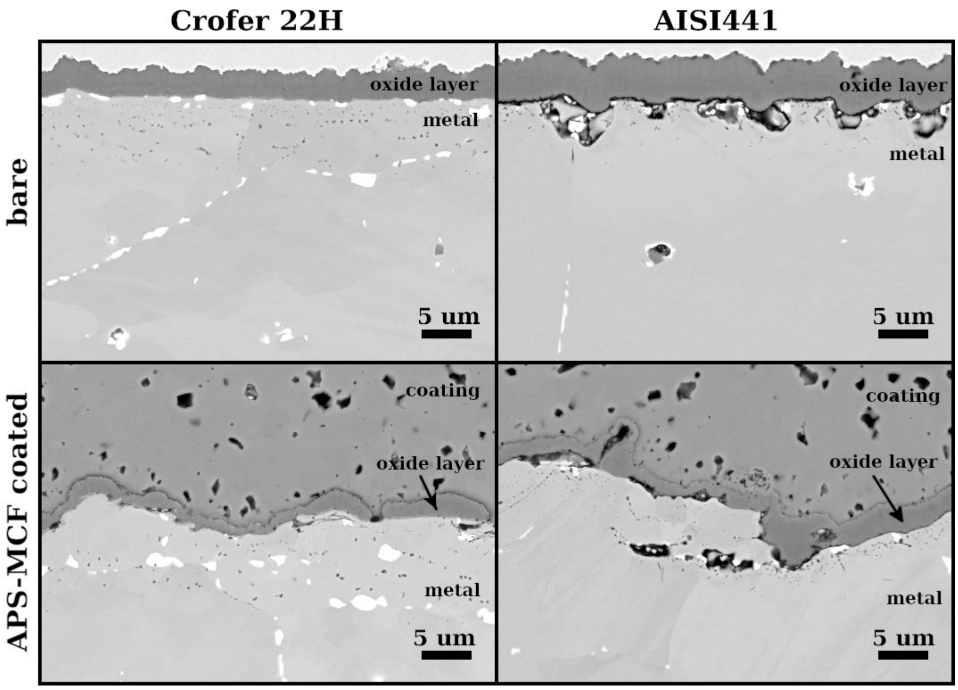


Figure 1: SEM images of bare and coated steels exposed to air for 1000 hours at 800°C.

FZJ continues the evaluation of behavior of APS-MCF coated steels in cyclic oxidation experiments with heating and cooling rates similar to those experienced in real stacks to determine if the temperature changes occurring in stack can lead to faster coating degradation.

FZJ is also examining the response of bare ferritic stainless steels to simulated anode gas with varying concentrations of water to understand how industrial stainless steels would perform on the anode side of the interconnect. Initial findings indicate a distinction in the oxidation behavior between general-purpose ferritic stainless steels, which exhibit visible silica subscale formation, and the specially designed steel, Crofer 22H (Fig. 2). Further investigations are ongoing.

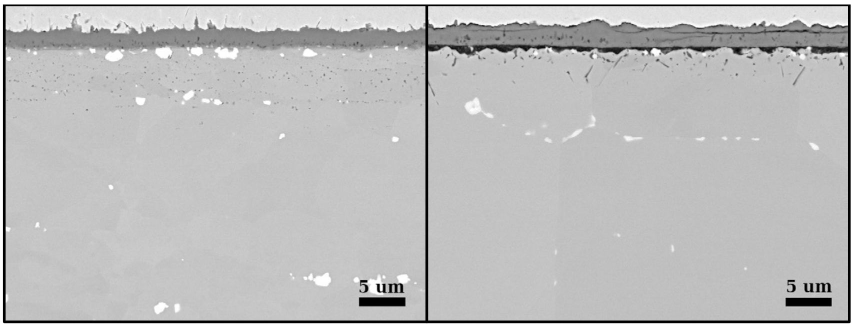


Figure 2: SEM images of Crofer 22H (left) and AISI441 (right) after 1000h exposure to Ar-4%H_2-4%H_2O

Furthermore, investigations into different coating materials on non-specialty stainless steel alloys are continuing. The deposition of state-of-the-art and novel materials by electrophoretic deposition (EPD) is being optimized with regards to layer thickness and homogeneity, followed by oxidation testing of the new materials.

RESEARCH ON COATING METHODOLOGIES: VITO

Activities at **VITO** are focused on the development of La-free oxygen electrode coatings for SOEC by spray coating. Spray coating allows to fine-tune the microstructure of the electrode layer to improve the performance of the SOEC compared to the sate-of-the art screen printing technology.

During the first period of **NOUVEAU**, a dedicated spray-coater was built for the project so that different types of microstructure can be sprayed, varied in composition and in porosity. Initial experiments have been done to prepare varied porous La-free electrode coatings on different substrates with a thickness between a few µm up to 20 µm. SEM analyses assisted in further improvements of the coatings. Besides the coating parameters, the stability of the suspension is an important factor in achieving reproducible coatings and having no clogging of the spray nozzle.

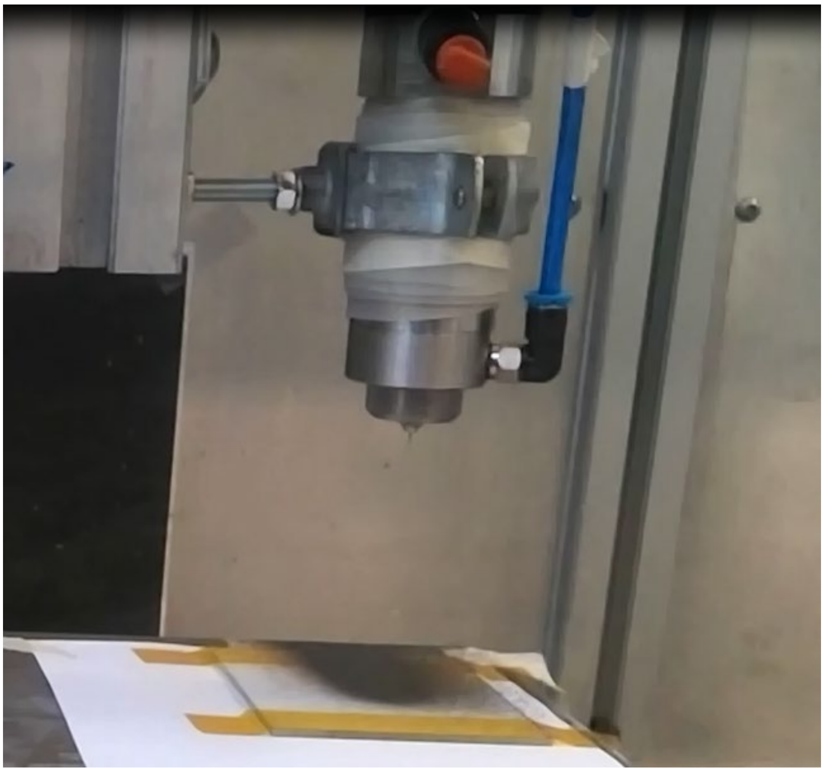


***Figure 3** Spray coating experiments at VITO*

The stability of the suspension is being enhanced by optimizing its composition, e.g. the amount of binder and dispersant. Figure 3 shows one of the initial spray coating experiments.

RESEARCH ON MODELLING: QSAR Lab

Within the **NOUVEAU** project, the **QSAR Lab** team is responsible for the modeling aspect. Over the past few months, we have built 165 molecular models of possible structures for SOEC anodes based on the brownmillerite structure. We investigated both modified and non-modified compounds, exploring two types of modifications: replacing La with Ca and Bi atoms, and substituting Fe with Co and Mn atoms. We examined fully doped as well as partially doped versions of these compounds. Depending on the extent of modification, we constructed three representative models capable of containing the desired modifications.
For these systems under investigation, we conducted quantum-mechanical calculations to obtain molecular descriptors. Using these results, we will conduct virtual screening and QSAR modeling to select the most promising compound for the anode.
In collaboration with the experimental partners of the **NOUVEAU project**, we would like to experimentally validate the results of our computational research.

$Ca_2Fe_2O_{12}$ (**XXS**)

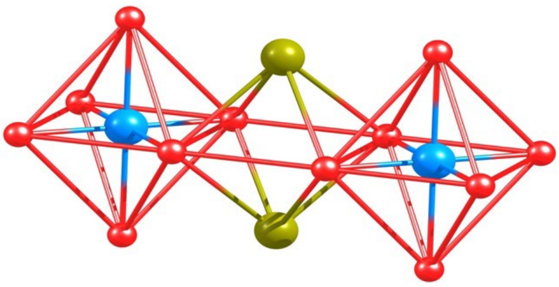


Figure 4. *– XXS Brownmillerite structure*

$Ca_5Fe_4O_{20}$ (**XS**)

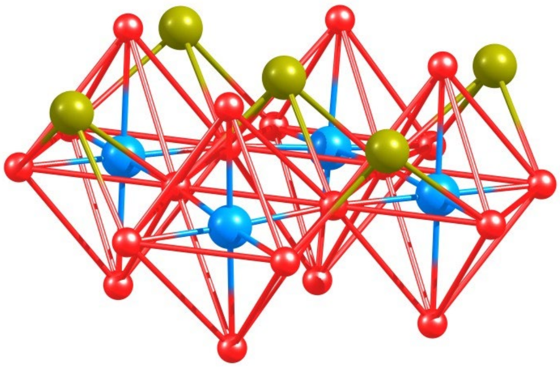


Figure 5. *– XS Brownmillerite structure*

$Ca_9Fe_8O_{29}$ (**S**)

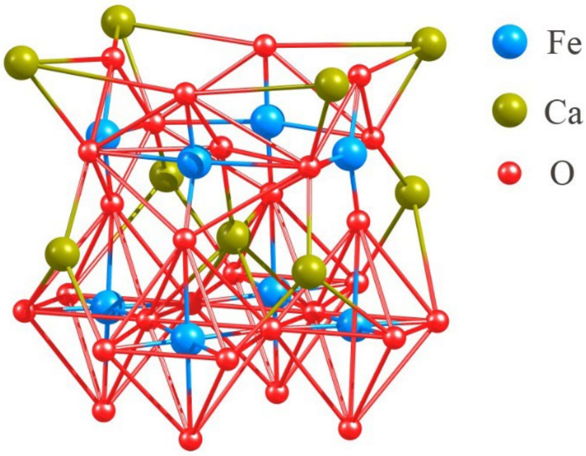


Figure 6. *– S Brownmillerite structure*

NOUVEAU on the right path towards sustainability: IMDEA Energy

Within **NOUVEAU**, the Systems Analysis Unit of **IMDEA Energy** is leading the sustainability assessment of the novel solutions proposed in the project, including the evaluation of material criticality and circularity aspects. The study takes into consideration the ultimate coating technology options and manufacturing processes relevant to the project –such as the synthesis of a lanthanum-free anode and the manufacturing of novel interconnects–, which should result in a reduced use of rare earth elements and an increased interconnect durability.

In particular, IMDEA Energy has built NOUVEAU-relevant life cycle inventories for computational implementation and subsequent sustainability, criticality and circularity assessment according to the latest methodological recommendations in the field of hydrogen-related systems. For instance, as shown in the figure, a reduction in the material criticality score above 80% was found for the NOUVEAU anode (CSCO) relative to a reference one (conventional LSCF). Moreover, a criticality score reduction around 15% was estimated at the full stack level.

Also at the solid oxide electrolysis cell stack level, preliminary results suggest a reduction above 20% in energy consumption for the full manufacturing process, remarkably affecting the life-cycle profile of the product. This decrease is mainly due to the use of powder metallurgy for the manufacturing of interconnects, in addition to irradiation drying after coating.

All in all, the preliminary results from the assessment of NOUVEAU-based solutions suggest promising improvements in a wide range of sustainability aspects, showing that the NOUVEAU approach is on the right path.

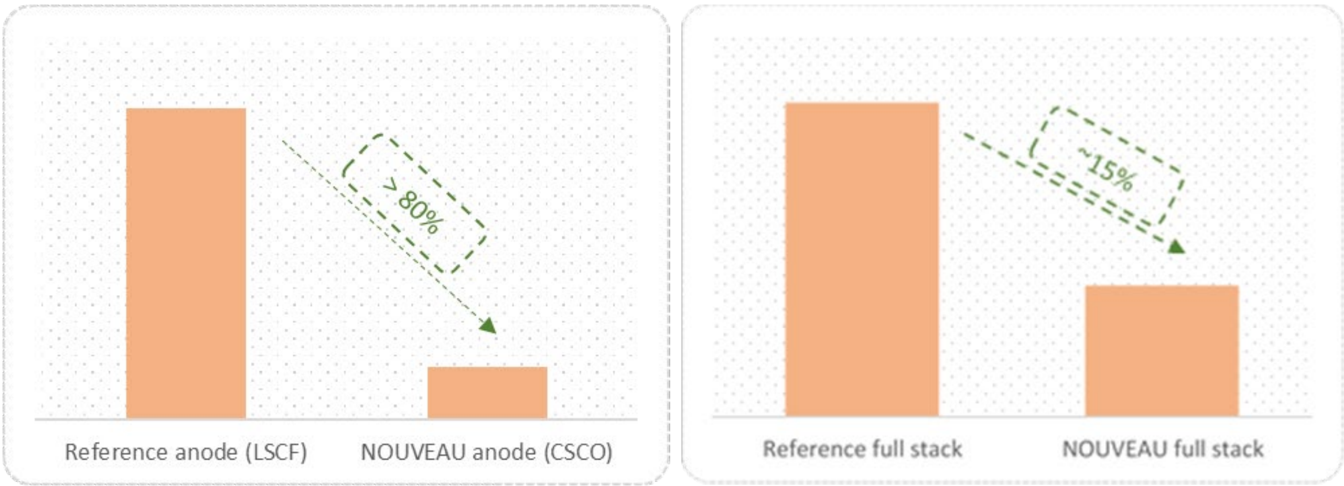


Figure 7. *Decrease in material criticality (SH2E score) at the NOUVEAU anode and stack levels.*

Meet NOUVEAU researchers: Dr. Sher Ahmad

Dr. Sher Ahmad is post-doctoral researcher at **Eindhoven University of Technology**. He is a distinguished chemical engineer with research areas focused on modelling and simulation of flow through porous catalysts and their application in wastewater and fine chemical synthesis.

Dr. Ahmad completed his PhD in Chemical Engineering from the prestigious University of Montpellier, France. His doctoral research focused on the modeling and simulations of enzyme based porous catalytic supports, a crucial aspect in advancing wastewater treatment technologies. This rigorous program provided him with a deep understanding of both theoretical and practical applications in chemical engineering, laying a solid foundation for his subsequent research endeavors.

Following his PhD, Dr. Ahmad extended his research expertise with a postdoctoral fellowship at the University of Liège, Belgium. Here, he made substantial strides in continuous flow catalysis, working closely with research and development partners. His key project involved developing a comprehensive Computational Fluid Dynamics (CFD) model, coupled with a population balance model for the continuous flow synthesis of zeolite nano particles.

Presently, Dr. Sher Ahmad is deeply involved in the NOUVEAU project, where his role is pivotal in enhancing the efficiency of solid oxide electrolysis cells (SOECs). His research focuses on the development of novel materials, employing advanced multiscale modeling and simulations. By integrating AI and ML tools, Dr. Ahmad aims to significantly improve the physio-chemical properties of electrode materials. His work is not just a testament to his expertise in chemical engineering but also showcases his commitment to pioneering sustainable energy solutions.

CONSORTIUM

VLAAMSE INSTELLING VOOR TECHNOLOGISCH ONDERZOEK NV (VITO)
BELGIUM
https://vito.be/en

Forschungszentrum Jülich GmbH (JÜLICH)
GERMANY
https://www.fz-juelich.de/en

MARION TECHNOLOGIES (MTEC)
FRANCE
https://www.mariontechnologies.com/en/home/

Coatema Coating Machinery GmbH
GERMANY
https://www.coatema.de

Eindhoven University of Technology (TU/e)
NETHERLANDS
https://www.tue.nl/en/

QSAR Lab Ltd
POLAND
https://www.qsarlab.com/en/

IMDEA Energy
SPAIN
https://energia.imdea.org/en/

CNRS – IMN
FRANCE
https://www.cnrs-imn.fr/

CNRS – UCCS
FRANCE
https://uccs.univ-lille.fr/index.php/fr/

FIAXELL SOFC TECHNOLOGIES
SWITZERLAND
https://fiaxell.com/

CONTACT US

PROJECT COORDINATOR
Marijke Jacobs
- Researcher
- VLAAMSE INSTELLING VOOR TECHNOLOGISCH ONDERZOEK NV (VITO)

marijke.jacobs@vito.be

https://www.linkedin.com/company/nouveau-project/

Or visit our sister project NICKEFFECT

https://www.linkedin.com/company/nickeffect-eu/

Funded by the European Union

"Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or HaDEA. Neither the European Union nor HaDEA can be held responsible for them.".