

NOVEL ELECTRODE COATINGS AND INTERCONNECT FOR SUSTAINABLE AND REUSABLE SOEC

UPDATES ON ACTIVITIES at M36

The NOUVEAU consortium has now reached the end of its 36-month journey! In this sixth newsletter, as we come to the conclusion of this remarkable project, we would like to extend our heartfelt thanks to each of you for your continued support.

From day one, NOUVEAU has focused on making Solid Oxide Electrolysis Cell (SOEC) technology more sustainable and reusable through the development of NOVEL ELECTRODE COATINGS AND INTERCONNECTS. To reduce reliance on Rare Earth Elements (REEs) and Platinum Group Metals (PGMs), the project has explored alternative materials and innovative approaches for REE recycling for SOECs.

True sustainability requires not only innovation, but also reduced consumption—and together we have reached important milestones toward this goal.

We hope you enjoy reading about our latest achievements!

Joint Webinar "Advances in Materials Modeling: From Atoms to Industrial application"

Together with NOUVEAU, the sister projects NICKEFFECT, MOZART, and FreeMe have founded the 4SEE CLUSTER. The 4SEE Cluster is a collaborative initiative focusing on safe and sustainable-by-design metallic coatings and engineered surfaces.

As a cluster activity, a joint webinar was co-organised by the NOUVEAU project and EMMC on 18 June 2025.

You can watch inspiring and stimulating talk here:

<https://emmc.eu/events/joint-webinar-of-nouveau-project-and-sister-projects/>

This dynamic online event brought together leading experts from across Europe, including representatives from TU/e, Matgenix, Exelisis, Elsyca, and VUB. We would like to express our sincere appreciation to all presenters and to the Executive Team of EMMC for their valuable contributions.

Presentations included:

- Sher Ahmad (TU/e) on multiscale modeling for solid oxide electrolyzers
- Guillaume Brunin (Matgenix) on DFT & machine-learned potentials with active-learning for process optimization
- Kostas Pyrgakis (Exelisis) showcasing a decision-support tool for plating-on-plastics
- Bart Van den Bossche & Paula Vieira (Elsyca/MOZART) on macro-scale nickel dispersion plating
- Mesfin Haile Mamme & Parisa Molaeipourashka (VUB/NICKEFFECT) diving into micro-scale, multi-ion plating modeling

This event successfully brought together atomic-scale modeling, machine-learning, DFT, and electrochemistry, enabling real-world experts to address modelling bottlenecks and promote interoperable workflows across EU research teams. In addition, the discussions advanced the shared vision of safe- and sustainable-by-design metallic coatings and engineered surfaces.

Participants enjoyed insightful presentations, engaging discussions, and valuable networking opportunities—laying the foundation for future collaboration across the 4SEE Cluster.

PhD Achievements within NOUVEAU



- Valentin Brard successfully completed his PhD as part of NOUVEAU project after three years of thesis work on the subject of “*Seperation and Recycling of Materials form Solid Oxide Cells*” at the **Institut des Matériaux de Nantes Jean Rouxel**.

We warmly thank his thesis supervisors, **Olivier Joubert** and **Dr. Annie Le Gal La Salle**, whose guidance, trust and advice supported him throughout this journey.



- **Julien Rivière** successfully defended his PhD on **10 July**, as part of the European NOUVEAU project. His research, entitled “*New lanthanum-free air electrode materials For high-temperature electrolysis*”, was conducted at the **UCCS Laboratory**. This outstanding work earned Julien the title of Doctor from the **École Centrale de Lille**.

Heartfelt congratulations to Julien, and sincere thanks to his jury:

Prof. Lionel Montagne (University of Lille & UCCS),

Prof. Fabrice Mauvy (University of Bordeaux & ICMCB),

Dr Pierre-Marie Geffroy (CNRS & IRCER, Limoges),

Dr Armelle Ringuedé (CNRS & IRCP, Paris),

Dr Annie Le Gal La Salle (CNRS & IMN),

Dr Vesna Middelkoop (VITO, Belgium),

and the supervisory team: **Dr Victor Duffort (CNRS)** and **Prof. Rose-Noëlle Vannier (Centrale Lille)**

The contributions of Valentin and Julien mark key milestones in advancing sustainable energy technologies, and we look forward to seeing where their scientific journeys lead next.

UPDATES ON ACTIVITIES

Research on Coating Methodologies: VITO

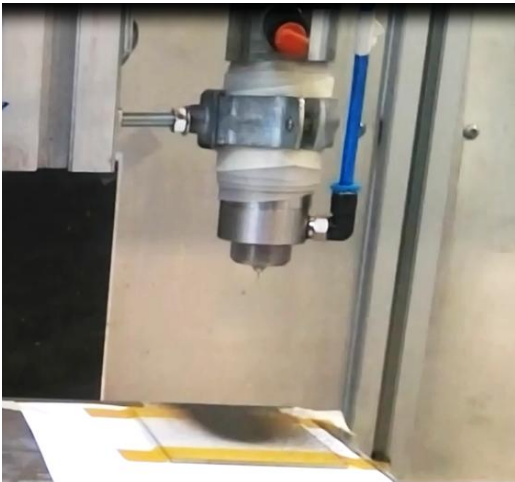


Fig 1: Spray coating experiment

Activities at VITO focus on the development of lanthanum-free oxygen Electrode coatings for SOECs using spray-coating techniques. Spray coating enables fine-tuning of electrode microstructure, leading to improved SOEC performance compared to state-of-the-art screen-printing technologies.

During the first phase of NOUVEAU, a dedicated spray-coating system was constructed, allowing systematic variation of composition and porosity. Initial experiments successfully produced porous lanthanum-free electrode coatings on different substrates, with thicknesses ranging from a few micrometers up to 20 μm . SEM analyses supported further optimisation of coating quality.

In addition to coating parameters, suspension stability plays a critical role in achieving Reproducible coatings and preventing nozzle clogging.

Stability is being improved by optimizing suspension composition, including binder and dispersant content. Figure 1 shows one of the initial spray-coating experiments.

Research on Recyclability and re-use: IMN

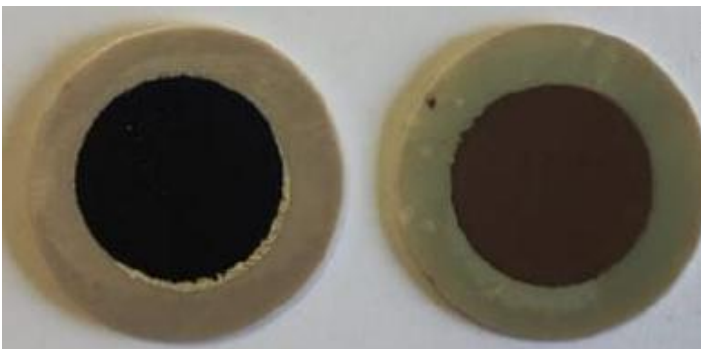


Fig. 2. Photographs of complete cells made from recycled materials sourced from industrial waste and end-of-life cells. Left: air side; right: fuel side

IMN's tasks in the NOUVEAU project consist in elaborating recycling strategy for the One of the major achievements of Valentin BRARD's PhD was to successfully recover the various materials that make up SOC cells from industrial waste. NOUVEAU's cell components. After characterization, Ana Sucgang, a master's student at IMN, reused these different materials, to build the first SOC cell made from 100% recycled materials (Fig. 2).

Supported by an electrolyte, it currently has low power output, but its open-circuit potential of over 1.0 V is very promising.

Green inks development: Fiaxell



Fig. 3. Green inks developed by Fiaxell

Activities at Fiaxell are focused on the development of water-based suspensions, so-called 'green inks'. These green inks could have a multi-impact, such as reducing the industrial step the manufacturing, improving health environment for the workers in the lab/manufactory, and reducing global cost of solid oxide cells.

In this project, starting from the already existing green inks at Fiaxell, green inks of GDC10 and CSCO from Marion Technologies were developed. The inks

Solid Oxide Cells fabrication: Fiaxell

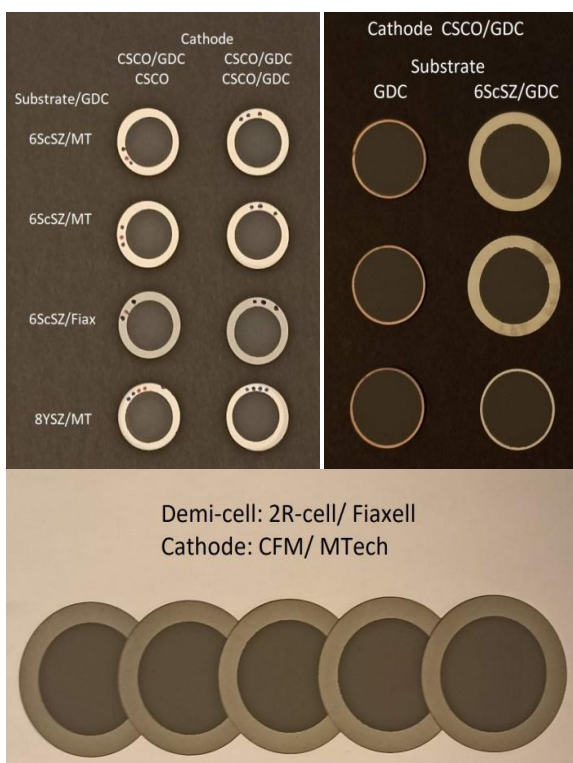


Fig 4 Cells developed by Fiaxell

The green inks were used to prepare symmetrical and anode supported cells using screen printing as a deposition technique available at Fiaxell.

The first set of symmetrical cells with CSCO MTEc on 6ScSZ and 8YSZ electrolyte substrates was send to CNRS partner to study the impact of the electrode thickness and composition on the performances. The cells with pure and composite electrodes were successfully fabricated.

The second set of symmetrical cells with CSCO MTEc on GDC electrolyte substrates was send to VITO partner to compare two different electrode coating techniques, such as screen printing and spray coating. The cells with the 6ScSZ electrolyte substrate were also fabricated for comparison reason.

The third set of cells with CFM MTEc electrode material on demi cells 2R-cell developed by Fiaxell was send to IMN for recyclability and re-use research.

Interconnect coatings with Cr reduction and system integration: modelling effect of component geometry on substrate steel oxidation behaviour

Under accelerated oxidation conditions, the investigated ferritic stainless steels exhibit a tendency for breakaway oxidation (formation of fast-growing iron-rich oxides) at the sample edges (Fig 5). According to our suggestion, this effect corresponds to a higher surface-to volume ratio at the sample edges, limiting the chromium flux to the surface.

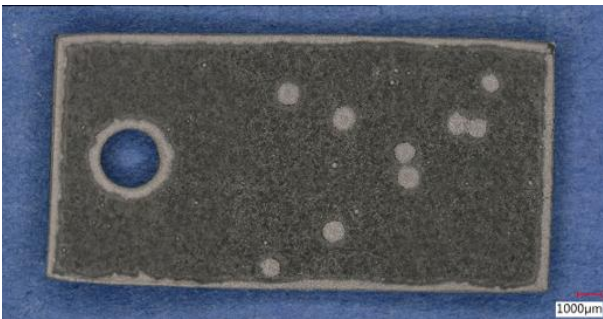
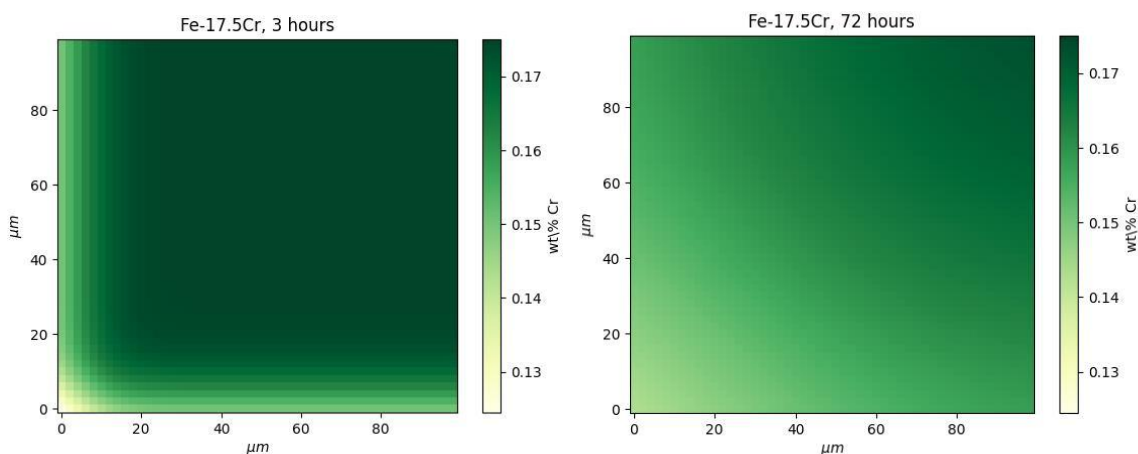


Fig 5. Photo of AISI430 steel specimen after exposure in air for 3000 hours at 900°C

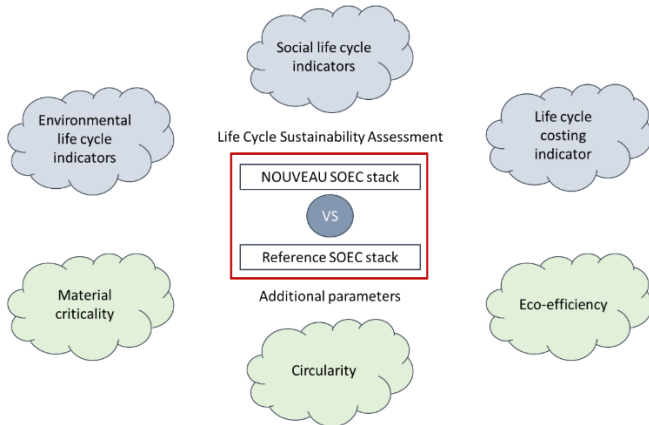
To investigate chromium reduction and system integration effects, Forschungszentrum Jülich (FZJ) developed a 2D kinetic-thermodynamic model that accounts for chromium diffusion and geometrical factors influencing breakaway oxidation in steel components.

Application of the model to an Fe-17.5Cr alloy revealed significantly deeper chromium depletion at component edges. Chromium levels dropped below 13% after just 3 hours of exposure, compared to 15–16% on flat surfaces.



These modelling results demonstrate that edges of steel components—such as SOEC interconnects with gas channels—are particularly vulnerable to breakaway oxidation. Consequently, component geometry must be carefully considered in material selection and lifetime assessment.

Assessing NOUVEAU progress through sustainability benchmarking



The Systems Analysis Unit at IMDEA Energy continues to lead the sustainability assessment and benchmarking of the novel technologies developed in the NOUVEAU project. IMDEA Energy benchmarked the NOUVEAU stack against a conventionally manufactured solid oxide electrolysis cell (SOEC) stack. The study focused on replacing the LSCF anode with a less critical calcium-based

anode (CSCO), adopting a new interconnect manufacturing route using atomized stainless-steel powders and integrating an end-of-life strategy.

In addition to life cycle sustainability indicators, eco-efficiency, material criticality and circularity parameters were evaluated. The NOUVEAU stack without recycling showed the best environmental profile across five out of six indicators. Stainless steel and electricity were identified as environmental hotspots, while nitric acid additionally became an environmental hotspot in the scenario with end-of-life strategy integration. Economically and socially, further process optimisation is needed to increase manufacturing efficiency.

Integrating NOUVEAU concepts (calcium-based anode, new interconnect manufacturing, and end-of-life strategy) enable to reduce material criticality by over 69% compared to the reference stack. Although the NOUVEAU concept shows an unfavourable eco-efficiency relative score (factor-X), it provides a solid basis for continued optimisation. Overall, the NOUVEAU system shows potential advances in material and environmental sustainability, with room for improvements in terms of market competitiveness.

Season's greetings



Thank you for a great year. Wishing you a wonderful Christmas and happy new year.

May this season bring you joy, inspiration, and confidence.

CONSORTIUM



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