Spin-polarized Catalysts for Energy-Efficient AEM Water Electrolysis

Rapports

Informations projet

SpinCat

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Site Web du projet

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Periodic Reporting for period 2 - SpinCat (Spin-polarized Catalysts for Energy-Efficient AEM Water Electrolysis)

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Résumé du contexte et des objectifs généraux du projet

Hydrogen tops the EU's list as a promising, clean, cost-effective, and low-carbon fuel, and water electrolysis based on renewable energy represents a potential technology for its production. However, wide implementation is prevented by the requirement of rare and expensive platinum group metals (PGMs) to catalyze the cathodic hydrogen evolution reaction (HER) and the anodic oxygen evolution

reaction (OER). Therefore, the development of efficient PGM-free catalysts is instrumental for realizing the EU's decarbonization objectives. The EU-funded SpinCat project will create a new class of magnetic earth-abundant catalysts that, through spin polarisation, can promote catalytic activity towards OER by a factor of three as compared to state-of-the-art PGM-based catalysts, establishing cost-effective hydrogen production without the use of PGMs.
The overall objectives of SpinCat are:
- To realize magnetic catalysts with dominant ferromagnetic ordering.
- To develop a fundamental understanding of parameters affecting the oxygen evolution reaction over magnetic catalysts.
- To rationally improve magnetic catalytic materials by cutting-edge predictive modeling.
- To demonstrate a magnetically-enhanced anion-exchange membrane electrolyzer prototype.
The long-term vision of SpinCat is to establish cost-effective H2 production by reducing the cost of membrane-based electrolyzer technology by omitting the need for PGMs. This will be achieved by focusing, for the first time, on spin polarization in magnetic perovskites, thus enhancing the efficiency of this catalyst family. We foresee the knowledge and concepts developed in this project to expand beyond OER to electrochemical transformations in general, e.g. CO2 upgrade and NH3 synthesis, allowing an activity boost therein. Hence, leveraging spin polarization for catalysis boost can create far-reaching benefits in industries, providing the desired energy efficiency.

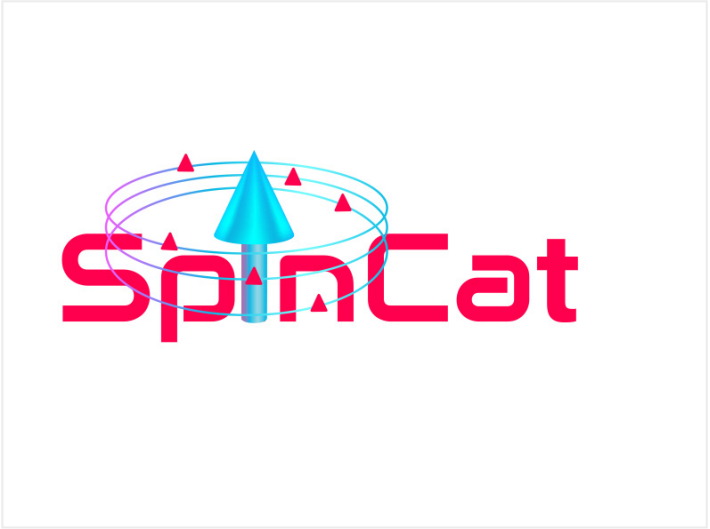
Travail effectué depuis le début du projet jusqu'à la fin de la période considérée dans le rapport et principaux résultats atteints jusqu'à présent

The SpinCat project has fully achieved its objectives for the second reporting period (01/06/2022 30/11/2023). The project has delivered exceptional results with significant immediate or potential impact, and all objectives mentioned in the Annex 1 of the Grant Agreement for the 18 months period were achieved. In addition, the SpinCat has produced four peer-reviewed papers, all available in open access and a patent.
Notably, WP3 (Predictive modelling) managed to accomplish vigorous computational screening of the potential magnetic catalysts (Deliverable 3.2 and 3.3) and enabled WP1 (Catalyst development) to produce a good selection of magnetic catalytic samples (Deliverable 1.1 and 1.2) thus allowing for WP2 (Electrochemical studies) to deliver good electrochemical characterisation thereof (Deliverable 2.2). While coherently working with WP2, WP4 (AEM electrolysis) accomplished to fabricate and test proprietary alkaline exchange membrane materials (Deliverable 4.2 and 4.3) to serve as a core component in the upcoming magnetically enhanced anion exchange membrane electrolysis (AEMEL) prototype. In addition to research efforts, the SpinCat has put effort into the project management (Deliverables 6.4) as well as exploitation and dissemination activities (Deliverables D5.4) and more results can be expected to emerge before the project's end date.
The SpinCat sets out to exploit its results, and three Key Exploitable Results, based on the current project procedures, are identified: (1) Magnetically enhanced AEM electrolysis test cell (Fraunhofer ISE); (2) AEM electrolysis test stand (Fraunhofer ISE); (3) Patent application "Magnetically enhanced

electrolysis stack” (Magnetocat). When fully developed, these innovations could be introduced as the new products into an emerging market (i.e. commercial exploitation)

Progrès au-delà de l’état des connaissances et impact potentiel prévu (y compris l’impact socio-économique et les conséquences sociétales plus larges du projet jusqu’à présent)

SpinCat has deployed state-of-the-art synthesis and characterization techniques, which will speed up the process to get magnetic catalytic materials with high activity and durability ready to be employed in the targeted magnetically-enhanced anion exchange membrane electrolyzer.
SpinCat has developed a reliable electrochemical method for testing of the catalysts for alkaline OER. This was achieved through establishing the best protocol for catalyst ink formulation, understanding of the electrochemical aging process, as well as optimization of the electrochemical testing conditions.
SpinCat has demonstrated that its infrastructure with respect to theoretical screening is in place, and experimental results were emerging that agreed with the theoretical search criteria. SpinCat is working on novel computational methods for understanding the connections between magnetism and heterogeneous catalysis that will make future screening processes much more reliable and faster. An initial set of descriptors with physical meaning based on bulk properties is ready to be checked experimentally.
SpinCat has constructed one conventional anion exchange membrane electrolysis test bench, as well as designed one anion exchange membrane electrolysis test bench affording the application of the magnetic field, and the latter unit is currently underway. The gas-diffusion-electrode approach to the fabrication of membrane electrode assembly and the selection of diffusion media were affirmed. Experimentally, SpinCat has selected a proprietary anion exchange membrane for electrolysis to be used in our current and future anion exchange membrane electrolysis efforts.
The SpinCat looks into earth-abundant nanomaterial-based catalysts for innovative magnetically-enhanced AEMEL to produce low-cost green hydrogen, which is needed for the decarbonization of the energy and chemical sectors. Accordingly, SpinCat contributes to EU Green Deal, EU Action Plan on Critical Raw Materials, and EU Industrial Strategy.



The SpinCat logo features spin polarization

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