



Project progress – D2.4. Advanced electrodes and electrolytes for DESA. Preparation procedures and characterization results
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The ALCHEMHY project addresses the development of advanced materials and technologies for sustainable hydrogen-based processes. Deliverable D2.4, entitled “Advanced electrodes and electrolytes for DESA. Preparation procedures and characterization results”, reports the progress achieved in the development of functional materials for DESA, targeting the direct electrochemical synthesis of ammonia in protonic ceramic cells.

The work covers the synthesis, processing and characterisation of electrode and electrolyte materials under conditions relevant for DESA operation, typically in the 300-550 °C range and under reducing atmospheres. The focus has been on identifying material systems that combine adequate electrical transport properties with chemical and thermomechanical stability, which remains one of the main constraints for this technology.

Cathode development has been centred on oxide materials with perovskite and perovskite-related structures, considered as potential candidates for operation in NH_3/H_2 -containing environments. The results confirm that composition and defect chemistry largely determine the behaviour of these materials under reduction. In several cases, Co- and Fe-rich oxides showed clear limitations, including phase instability, significant chemical expansion or low electrical conductivity. By contrast, chromite- and titanate-based compositions exhibited more stable behaviour, with electrical conductivities in the order of $1\text{-}10 \text{ S}\cdot\text{cm}^{-1}$ at intermediate temperatures, making them more suitable for further optimisation.

For the electrolyte, the work has focused on proton-conducting ceramics with chemical compatibility with the electrode components. Ionic conductivities in the range of $10^{-3}\text{-}10^{-2} \text{ S}\cdot\text{cm}^{-1}$ were obtained under relevant conditions, together with thermal expansion values compatible with typical electrode materials.

The results provide a basis for the selection of material combinations suitable for DESA and for their integration in proton-conducting ceramic-based electrochemical devices. In this respect, the outcomes of D2.4 are directly connected to the next stage of the work, addressed in Deliverable D2.5 (Details on DESA configuration and design), where the integration of these materials into a functional prototype will be further realized.

The outcomes of this deliverable contribute to advancing DESA technology towards more efficient and stable systems for ammonia synthesis.



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