Final Report

Project acronym: *MOCO3*
Project number*: 4241*
M-ERA.NET Call 20*16*

Period covered: 01/08/2017 to 31/12/2020

Refer to beneficiaries when filling out this report.
To be completed by the project coordinator only.
Minimum font size is 11 pt.

2. Publishable project summary

Focus on methodology, results, and conclusions (max. 1 page).
Please note: The publishable summary will be used for dissemination by M-ERA.NET and the EC.

The MOCO3 project focuses on the development of multifunctional molten carbonate based composite materials, which have potential application as membranes for CO_2 separation, as well as electrodes and electrolytes in molten carbonate fuel cells for operation at intermediate temperatures (450°C-700°C). These technologies revolve around the use of molten carbonate-based material systems, and the principles and know-how resulting from MOCO3 will bring significant impacts to improve the performance and stability of these devices.

The consortium of the project includes three universities, one research institute and one SME (Small and medium-sized enterprises). University of Oslo (UiO), Warsaw University of Technology (WUT) and University of Aveiro (UA) are the three universities. SINTEF led the project and CIM-mes Project (CMP) joined the project as SME.

Method of experimental verification and numerical modeling was implemented in MOCO3 for finding the high-performance electrode and electrode architectures. The best candidate electrode materials were selected though material screening (including stability, wettability, and transport properties) and electrodes (cathodes) were fabricated based on that. The fuel cells were assembled using conventional electrode matrix and anode materials with the newly developed cathodes and tested at temperatures between 550 and 650 °C. At 650 °C, the highest power density achieved using the newly developed electrodes was repeatedly measured showing approximately 0.3 W/cm^2 which is beyond the state-of-the-art. However, larger cells with size of 10 cm x 10 cm shows significant less power density. Fundamental electrode kinetics were studied by using impedance spectroscopies for finding the limiting steps and the influence of oxide ion transport to the carbonates.

Asymmetric CO_2 separation membranes by using a non-wetting solid support were fabricated with high oxide ion conducting oxides for holding the molten carbonates in the membrane layer. This architecture allows thin membrane layer resulting significant improvement of CO_2 flux. However, the long-term stability of the asymmetric membrane needs to be improved due to the molten carbonates' migration.

3D structure of the electrodes was reconstructed with input from microstructure analysis data (e.g., Micro-CT) and the fuel cell performance was modelled focusing on the influence of the electrode microstructure to the power output.