ISIS@MACH ITALIA

UKRI Science and Technology Facilities Council
ISIS Neutron and Muon Source

Experiment Proposal

Experiment number GP2023034

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Experiment title	FE-SEM on Membrane-electrode assembly components	
MRF Instrument	**SEM ZEISS SIGMA**	**Days requested:** 1
Access Route	Direct Access	**Previous GP Number:** No
Science Areas	Chemistry, Energy, Environment, Materials	**DOI:** -
Sponsored Grant	None	**Sponsor:** -
Grant Title	-	**Grant Number:** -
Start Date	-	**Finish Date:** -
Similar Submission?	-	
Industrial Links	Enapter srl	

Non-Technical Abstract

Enapter produces scalable and modular AEM electrolysers, a relatively relatively new tech- -nology to produce hydrogen and oxygen from water splitting electrochemical reaction. Key components are MEA (Membrane Electrode Assemblies) and PTL (Porous Transport Layer). AEM technology combines advantages of both classical alkaline and PEM water electrolysis, to produce high purity hydrogen at relatively high pressure and high current density without using expensive or scarce materials (e.g. Tit, Ir, Pl). Our research programmes would relevantly benefit by using powerful characterization techniques. Potentialities of those techniques have only been barely explored in companies' framework and may constitute a breakthrough on the analysis of the MEA components in AEM systems.

Publications -

ISIS neutron and muon source | **IM@IT E-platform:** No

Instruments	**Days Requested:**
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Sample record sheet

Principal contact Dr Claudio Resta, Enapter SRL, ITALY
MRF Instrument **SEM ZEISS SIGMA** **Days Requested:** 1
Special requirements:

SAMPLE

Material	Polymers	-	-
Formula	CHNO	-	-
Forms	Solid		
Volume	1 cc		
Weight	100 mg		
Container or substrate	No	-	-
Storage Requirements	-	-	-

SAMPLE ENVIROMENT

Temperature Range	Room temperature - K	-	-
Pressure Range	Room pressure - mbar	-	-
Magnetic field range	No MF - T	-	-
Standard equipment	None	-	-
Special equipment	-	-	-

SAFETY

Prep lab needed	No	-	-
Sample Prep Hazards	No	-	-
Special equip. reqs	No	-	-
Sensitivity to air	No	-	-
Sensitivity to vapour	No	-	-
Experiment Hazards	No	-	-
Equipment Hazards	-	-	-
Biological hazards	No	-	-
Radioactive Hazards	No	-	-
Additional Hazards	-	-	-
Additional Details	-	-	-
Sample will be	Disposed of by instrument scientist	-	-

Science Case

FE-SEM on Membrane-electrode assembly components

1. Background and Context

Enapter produces scalable and modular AEM electrolysers to produce hydrogen and oxygen from water splitting electrochemical reaction. Key components to allow efficient and durable performances are MEA (Membrane Electrode Assemblies) and PTL (Porous Transport Layer). AEM technology combines advantages of both classical alkaline and PEM water electrolysis, allowing to produce high purity hydrogen at relatively high pressure and high current density without using expensive or scarce materials (e.g. Titanium, Iridium, Platinum). Being the AEM technology relatively new, every single constituent of the final product needs to be extensively characterised to provide a deeper knowledge and speed up technological improvements.(e.g. connection between morphology and physical-chemical properties). Due to the novelty of the technology, very few advanced characterization techniques are routinely used in the field. Our research programmes would relevantly benefit by using powerful characterization techniques which Enapter doesn't own and are not readily accessible. Potentialities of those techniques have only been barely explored in companies' framework and may constitute a breakthrough on the analysis of the MEA components in AEM systems. Our main financial support comes from the holder Enapter AG, additionally Enapter earned a grant from PNRR programme from italian government and it is involved in an Horizon 2020 project ("CHANNEL").

2. Proposed experiment

Nanoscale resolution images of MEA components will be crucial to better relate their morphological features to final physical-chemical properties and their manufacturing (e.g. organisation of different phases on catalyst layer). Both surface and cross-section analysis would provide very important information on how MEA components physically interact as well as point out possible weaknesses and imperfections that may cause failures. The comparison between data acquired by backscattering and secondary electrons detectors would provide very precious morphological insights, as well as the possibility of EDX mapping would help in assessing the homogeneity and structural features of every component. In this framework, the use of oa Field Emission Scanning Electron Microscope equipped with a tiltable sample stage, such as the Zeiss Sigma available at ISIS@MACH Italia, allows for the analysis of samples surface and cross section, without the need of a metal coating. The results will be coupled in terms of morphology (resulting from secondary electrons) and composition (resulting from backscattered electrons and X-ray photons).

3. Summary of previous experimental proposals or characterisation

The membranes have already been studied by conventional Scanning Electron Microscopes (i.e., filament-based electron guns), showing features of the proper size to be investigated by SEM, but requiring the application of a metal coating.

4. Justification of experimental proposals request

The use of field emission guns in place of filament-based electron microscopes, where the limited brilliance of the source requires the metal coating of the membranes, allows for the direct imaging of polymer based samples.

Furthermore, the use of a FESEM together with In-Lens secondary electron detectors (such as the Zeiss Sigma available at ISIS@MACH Italia) allows for the use of very low accelerating voltages, avoiding the overheating of the samples and their damage. We request one day of measurements to analyse 8 sample, acquiring morphologies at different accelerating voltages and with different electron detectors (BSD, conventional and In-Lens SE), as well as EDX spectra.