ISIS@MACH ITALIA

Science and Technology Facilities Council
ISIS Neutron and Muon Source

Experiment Proposal

Experiment number GP2023033

Principal investigator (*)	Dr Claudio Resta, Enapter SRL, ITALY
Co-investigator	Dr Antonio Filpi, Enapter srl, ITALY
Co-investigator	Dr Gabriele Agonigi, enapter s.r.l., ITALY
Co-investigator	Miss Federica Trivarelli, Enapter, ITALY
Co-investigator	
Co-investigator	
Co-investigator	
Co-investigator	
Co-investigator	
Experiment title	SAXS on Membrane-electrode assembly components
MRF Instrument	**SAXS Xenocs Xeuss**
Access Route	Direct Access
Science Areas	Chemistry, Energy, Environment, Materials
Sponsored Grant	None
Grant Title	-
Start Date	-
Similar Submission?	-
Industrial Links	-

Days requested: 2
Previous GP Number: No
DOI: -
Sponsor: -
Grant Number: -
Finish Date: -

Non-Technical Abstract

Enapter produces scalable and modular AEM electrolysers, a relatively relatively new techno--logy, 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:**
Access Route	**Previous RB Number:**
Science Areas	**DOI:**
Sponsored Grant	**Sponsor:**
Grant Title	**Grant Number:**
Start Date	**Finish Date:**
Similar Submission?	
Industrial Links	

Sample record sheet

Principal contact Dr Claudio Resta, Enapter SRL, ITALY
MRF Instrument **SAXS Xenocs Xeuss** **Days Requested:** 2
Special requirements:

SAMPLE

Material	Polymeric films and metal-carbon electrodes	-	-
Formula	CHNOCu	-	-
Forms	Solid		
Volume	1 cc		
Weight	100 mg		
Container or substrate	Sample holder for membranes and GISAXS geometry	-	-
Storage Requirements	-	-	-

SAMPLE ENVIROMENT

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

SAXS 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

In order to work properly and efficiently, a very delicate equilibrium between the physical and chemical properties of MEA components and their relationship is required. In this regard, a deeper understanding of morphological and structural features of each MEA component is crucial for their optimization and improvement. Specifically, SAXS and reflectometry/GISAXS experiments could provide us with information on the nanoscale morphology of each MEA components (e.g. the presence and organisation at the nanoscale of different inorganic phases in the electrodes surface, as well as the structure and organisation of hydrophilic/hydrophobic moieties within the membrane) that can be extremely helpful for their engineering and optimization. In the case of thin membranes, the use of SAXS on different regions of the membranes allows for the investigation at the nanoscale of different polymeric structures. Data will be analysed with the help of ISIS@MACH Italia staff, taking advantage of free softwares such as SASView and the included routines accounting for the most common mathematical models for polymeric assemblies. In the case of electrodes, the surface will be investigated in the reflectometry/ GISAXS geometry, aiming at the understanding of the surface structure, its morphological and compositional modification during the operation and the adsorption of molecular layers on the surface.

3. Summary of previous experimental proposals or characterisation

Membranes and electrodes have been extensively analysed by Enapter in terms of their functional performances. The SAXS characterisation would allow for the cross-analysis of the functional vs morphological relationship at the nanoscale.

4. Justification of experimental proposals request

The Xenocs SAXS available at ISIS@MACH ITALIA is a unique instrument in Italy, in terms of its flexibility to perform SAXS/USAXS/GISAXS analysis on solid samples/surfaces, without the need to apply vacuum at the sample stage, when this is undesirable in terms of sample stability or evaporation. After discussing with ISIS@MACH ItTALIA staff, we are requesting 2 days of beam time: one day dedicated to the SAXS investigation of thin membranes and another day to be dedicated to the GISAXS/reflectometry analysis of the electrodes.