ISIS@MACH ITALIA

Science and Technology Facilities Council
ISIS Neutron and Muon Source

Experiment Proposal

Experiment number GP2023027

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Experiment title	Modulation of the filtering capacity of an electrospun polymeric membrane	
MRF Instrument	**SEM ZEISS SIGMA**	**Days requested:** 2
Access Route	Direct Access	**Previous GP Number:** No
Science Areas	Environment	**DOI:** -
Sponsored Grant	None	**Sponsor:** -
Grant Title	-	**Grant Number:** -
Start Date	-	**Finish Date:** -
Similar Submission?	-	
Industrial Links	-	

Non-Technical Abstract Electrospun membranes are characterized by high porosity which makes them suitable to be used as a filter for water and air. Electrospinning is a manufacturing process that produces small fibers from a polymer solution. When a specific polymeric solution is pumped from the needle and an electric field is applied between the needle and the collector, there is the formation of fibers with small dimensions (micrometric or nanometric). Goal of this study is to modulate the porosity of electrospun membranes by co-electrospinning of two polymers. Samples obtained by varying polymeric concentrations, electrospinning sequence and times will be analysed by an electron microscopy scan to evaluate the morphology of the structures and by Bacterial Filtration Efficiency to evaluate the filtering capacity of pathogens.

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:**
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Sample record sheet

Principal contact Dr Tamer Al Kayal, National Research Council of Italy, ITALY
MRF Instrument **SEM ZEISS SIGMA** **Days Requested:** 2
Special requirements:

SAMPLE

Material	Polyurethane, Copper Nanoparticles, Pullulan	-	-
Formula	CHNOCu	-	-
Forms	Solid		
Volume	1 cc		
Weight	1000 mg		
Container or substrate	No	-	-
Storage Requirements	-	-	-

SAMPLE ENVIROMENT

Temperature Range	Room Temperature - K	-	-
Pressure Range	Room Pressure - mbar	-	-
Magnetic field range	None - T	-	-
Standard equipment	None	-	-
Special equipment	-	-	-

SAFETY

Prep lab needed	No	-	-
Sample Prep Hazards	No	-	-
Special equip. reqs	None	-	-
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

Modulation of the filtering capacity of an electrospun polymeric membrane

1. Background and Context

The increase in air pollution and the emergence of new diseases in recent years has led to the search for innovative solutions for optimizing the purification of the environments in which we live. Filtering is an efficient strategy towards air purification and, in particular, electrospinning is an economic and simple process that allows the production of membranes with excellent filtering properties. A project financed by the Tuscan Region has made it possible to develop electrospun membranes coated with copper nanoparticles which have demonstrated excellent antiviral and antimicrobial properties. The proposal we present aims at improving the filtering properties of the membrane which allow to retain particles (pollutants, bacteria, viruses, etc.) present in the air and make them inoffensive towards humans.

2. Proposed experiment

The aim of this study is to modulate the porosity of the electrospun membranes to modify their filtering characteristics. When the concept behind this study proves to be effective, it will allow a significant improvement in the knowledge about electrospinning-based production of filtration devices. Both surface and cross-section analysis would provide very important information on the surface morphology and the spatial distribution of particles. The porosity will be tuned by modifying the composition of the starting solution in terms of both compositions and concentrations. Metal nanostructures will be also included in the membranes to introduce anti-bacterial properties.
In this framework, the use of a 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 cross-correlated in terms of morphology (resulting from secondary electrons) and composition (resulting from the analysis of X-ray photons).

3. Summary of previous experimental proposals or characterisation

Electrospun membranes have already been investigated by conventional Scanning Electron Microscope (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 two days of measurements to analyse 16 samples, acquiring morphologies at different accelerating

voltages and with different electron detectors (conventional and In-Lens SE), as well as EDX spectra in those samples where metal nanostructures are included.