ISIS@MACH ITALIA

Science and Technology Facilities Council
ISIS Neutron and Muon Source

Experiment Proposal

Experiment number GP2023092

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Co-investigator	Professor Massimo Bonini, CSGI - University of Florence, ITALY
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Co-investigator	Professor Roberto Senesi, University of Rome Tor Vergata, ITALY
Co-investigator (*)	
Co-investigator (*)	
Experiment title	Electrostrictive properties of Alginate-based composites including reduced graphene oxide and metal-based nanostructures

MRF Instrument		**Days requested:** 2	
Access Route	Direct Access	**Previous GP Number:** NO	
Science Areas	Chemistry, Materials, Physics	**DOI:** -	
Sponsored Grant	None	**Sponsor:** -	
Grant Title	-	**Grant Number:** -	
Start Date	-	**Finish Date:** -	
Similar Submission?	-		
Industrial Links	-		

Non-Technical Abstract

Hydrogels are the subject of an increasing number of scientific studies where biomimetic approaches towards the preparation of mechanical/pressure sensors and actuators are investigated. In particular, thanks to their high deformability, self-healing and biocompatibility, hydrogels are especially interesting in biomedical applications, such as in the development of blood pressure sensors and artificial muscles. Alginate is a biocompatible and biodegradable anionic polysaccharide with high application potential due to its ability to form 2D (films) and 1D (fibers) structures thanks to its reactivity and selectivity towards metal cations and to its ability to act as a dispersant for carbon based materials. Here we propose the morphological and functional characterization of composite fibres prepared by wet spinning of alginate solutions in Cu2+ or Ag+ crosslinking baths, as well as films obtained through spray coating of alginate-reduced graphene oxide (rGO) dispersions.

Publications -

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E-platform: No

Instruments	
Access Route	
Science Areas	
Sponsored Grant	
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Grant Number:	
Finish Date:	

Sample record sheet

Principal contact
MRF Instrument **Days Requested:** 2
Special requirements:

SAMPLE

Material	Allginate, Copper, Silver, Graphite, Graphene, Graphene oxide	-	-
Formula	C, Cu, Ag, O, H	-	-
Forms	Solid		
Volume	0,1 cc		
Weight	100 mg		
Container or substrate	not needed	-	-
Storage Requirements	-	-	-

SAMPLE ENVIROMENT

Temperature Range	Room T - K	-	-
Pressure Range	up to 5 - mbar	-	-
Magnetic field range	- T	-	-
Standard equipment	None	-	-
Special equipment	-	-	-

SAFETY

Prep lab needed	No	-	-
Sample Prep Hazards	No	-	-
Special equip. reqs	Non	-	-
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 by IS	-	-

Experiment description of proposal "Electrostrictive properties of Alginate-based composites including reduced graphene oxide and metal-based nanostructures"

1. Background and Context

Hydrogels are the subject of an increasing number of scientific studies where biomimetic approaches towards the preparation of mechanical/pressure sensors and actuators are investigated. In particular, thanks to their high deformability, self-healing and biocompatibility, hydrogels are especially interesting in biomedical applications, such as in the development of blood pressure sensors and artificial muscles.(Jia et al., 2022) Some of the applicants have recently demonstrated the possibility to develop molecule-graphene hybrid materials with tunable mechano-response to be used as highly sensitive pressure sensors for health monitoring.(Huang et al., 2019) In this context, alginate is a biocompatible and biodegradable anionic polysaccharide with high application potential due to its ability to form 2D (films) and 1D (fibers) structures thanks to its reactivity and selectivity towards metal cations and to its ability to act as a dispersant for carbon based materials.(Srivastava and Choudhury, 2023; Tordi et al., 2023) Composites including graphite, graphene and graphene oxide are now being studied by the applicants: in fact, this study is part of Pietro Tordi's research activity as a PhD student in co-tutorship between the University of Florence (Italy) and the University of Strasbourg (France), funded by the Italian Ministry of University and Research (MUR) for three years. The aim of the project is the realization of Alg-based composites for pressure-based sensors and actuators. Currently part of the studies are carried out at the Institut de Science et d'Ingeniérie Supramoléculaires (ISIS, University of Strasbourg), in the Nanochemistry Lab of Prof. Paolo Samorì. The characterisation of the electro-striction properties of alginate-based composites would pave the way towards novel perspectives for the application of these materials.

2. Proposed experiment

Some of the applicants have recently reported very interesting results when characterizing the electromechanical behaviour of conductive carbon nanotubes/polymer composites intended to be used as stretchable sensors and transducers.(Fazi et al., 2023) In this proposal we aim at establishing a scientific collaboration between Italian and French research groups, from the Universities of Strasbourg, Florence and Rome, where the combination of the respective chemical and physical backgrounds would allow to characterize the electrostrictive properties of alginate-based composites. In particular, composite films and fibres will be characterized, focussing on resistivity, I/V curves, and the strain dependence of stress and current. Fibers are prepared by wet spinning of alginate solutions in Cu^{2+} or Ag^{+} crosslinking baths, while films are obtained through spray coating of alginate-reduced graphene oxide (rGO) dispersions. A green reducing agent such as ascorbic acid is used for the reduction of Cu^{2+}, Ag^{+} and GO (to obtain CuNPs, AgNPs and rGO respectively), to impart electrical conductivity to the composite.

3. Summary of previous experimental proposals or characterisation

The samples have been already characterized in terms of the alginate interaction with copper(Tordi et al., 2023), silver and graphene oxide (articles in preparation).TGA, DSC, SEM-EDX, XPS, Raman, FT-IR, tensile tests and I/V analysis were used to investigate the obtained composites, proving that

their chemical composition, thermal stability, morphology, mechanical and electrical properties can be tuned as a function of the preparation. In this proposal we aim at the extension of the investigation towards the electrostrictive properties. The expertise and instrumentation available at the UTOV unit in the characterization of such properties would allow

4. Justification of experimental time requested

We are requesting the instrument “SEM with correlative AFM” as the microscope operation is available either in high or low vacuum (with a partial pressure from 7 up to 500 Pa in nitrogen and water vapour). The possibility to use low vacuum is especially important for our research as our samples consist of hydrogel films, where a small amount of water vapour is needed to keep their deformability. We request 2 days for the experiments: in fact, we expect that the first day would be needed to optimize measurement conditions and perform a screening of the most interesting samples (in terms of their electrostrictive properties), while the second day will be used to perform actual measurements on the selected samples. These are the expected figures: 12 samples will be pre-screened during the first day (30 minutes per sample, i.e. a total time of 6 hours plus the time needed to change the samples and evacuate the chamber); 6 samples in the second day, where more refined analysis will be performed, such as the cross-section analysis and the EDX compositional investigation.

References

Fazi, L., Andreani, C., D’Ottavi, C., Duranti, L., Morales, P., Preziosi, E., Prioriello, A., Romanelli, G., Scacco, V., Senesi, R., Licoccia, S., 2023. Characterization of Conductive Carbon Nanotubes/Polymer Composites for Stretchable Sensors and Transducers. Molecules 28, 1764. https://doi.org/10.3390/molecules28041764

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