ISIS@MACH ITALIA

Science and Technology Facilities Council
ISIS Neutron and Muon Source

Experiment Proposal

Experiment number GP2024027

Principal investigator	Professor Martina Aulitto, University of Naples, ITALY
Co-investigator	Dr Gennaro Gentile, IPCB CNR, ITALY
Co-investigator (*)	Dr Marino Lavorgna, CNR, ITALY
Co-investigator	
Co-investigator	
Co-investigator	
Co-investigator	
Co-investigator	
Co-investigator	
Experiment title	Bacterial cellulose/graphene oxide hybrids: structural characterization by XRD tomography
MRF Instrument	**XRD TOMOGRAPHY**
Access Route	Direct Access
Science Areas	Biology and Bio-materials
Sponsored Grant	None
Grant Title	-
Start Date	-
Similar Submission?	-
Industrial Links	-

Days requested: 4
Previous GP Number: -
DOI: -
Sponsor: -
Grant Number: -
Finish Date: -

Non-Technical Abstract

In this activity, we have realized hybrid bacterial/cellulose graphene aerogels, by production of bacterial cellulose in presence of graphene oxide.
After reduction of the graphene oxide phase to reduced graphene oxide (rGO), the realized materials present very interesting properties in terms of electrical conductivity. Moreover, aerogels also present piezoresistive properties under compression, thus being interesting bioderived systems for possible use as sensors.
Nevertheless, to optimize the performance of the materials, a careful morphological characterization is needed, to evaluate the effective distribution of the rGO phase in the bacterial cellulose based aerogel. Owing that, the aim of the proposal is to study, by using the instrument suite of IM@IT, the morphology of bacterial cellulose/graphene derivative hybrids. In particular, XRD tomography will provide info about the spatial distribution of graphene derivatives and bacterial cellulose nanofibers in the aerogels.

Publications -

ISIS neutron and muon source

E-platform: No

Instruments	
Access Route	
Science Areas	
Sponsored Grant	
Grant Title	
Start Date	
Similar Submission?	
Industrial Links	

Days Requested:
Previous RB Number:
DOI:
Sponsor:
Grant Number:
Finish Date:

Sample record sheet

Principal contact Dr Marino Lavorgna, CNR, ITALY
MRF Instrument **XRD TOMOGRAPHY** **Days Requested:** 4
Special requirements:

SAMPLE

Material	4 bacterial cellulose aerogels	bacterial cellulose/GO aerogels	-
Formula	cellulose	cellulose/graphene oxide	-
Forms	Solid	Liquid	
Volume	1 cc	1 cc	
Weight	0.1 g	0.1 g	
Container or substrate	-	-	-
Storage Requirements	-	-	-

SAMPLE ENVIROMENT

Temperature Range	- K	- K	-
Pressure Range	- mbar	- mbar	-
Magnetic field range	- T	- T	-
Standard equipment	None	None	-
Special equipment	N/A	N/A	-

SAFETY

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

Bacterial cellulose/graphene oxide hybrids: structural characterization by XRD tomography

1. Background and Context

Cellulose is one of the most abundant polymers on Earth and represents an intriguing building block for the production of functional materials from renewable non-fossil carbon sources [1].

Amongst different types of cellulose, bacterial cellulose (BC), also known as microbial cellulose, is a biodegradable, natural cellulose that is synthesized by bacteria. The diameter of BC fibers is 20–100 nm. Bacterial cellulose has high water retention due to being very hydrophilic and having a high surface area to mass ratio. It also has great mechanical strength, exhibits high crystallinity, and is relatively inexpensive to produce [2].

Nanocellulose/graphene derivative hybrids are gaining an even growing attention due to its unique physiochemical properties and giant potentials as renewable smart nanomaterials, opening up to the realization of novel advanced functional materials for multi-sensing applications [3]. However, integrating inorganic functional two-dimensional carbon materials in nanocellulose is not a simple step, when a precise control of the dispersion of the graphene phase in the nanocellulose structure is desired.

In this activity, we have realized hybrid bacterial/cellulose graphene aerogels, by production of bacterial cellulose in presence of graphene oxide.

After reduction of the graphene oxide phase to reduced graphene oxide (rGO), the realized materials present very interesting properties in terms of electrical conductivity. Moreover, aerogels also present piezoresistive properties under compression, thus being interesting bioderived systems for possible use as sensors.

Nevertheless, to optimize the performance of the materials, a careful morphological and structural characterization is needed, to evaluate the effective distribution of the rGO phase in the bacterial cellulose based aerogel as well as the effect of GO reduction on the porosity of the developed aerogel. Owing that, the aim of the proposal is to study, by using the instrument suite of IM@IT, the morphology of bacterial cellulose/graphene derivative hybrids. In particular, XRD tomography will provide info about the hierarchical structure of the aerogels, revealing porosity and distribution of graphene derivatives and bacterial cellulose nanofibers in the aerogels. In distinct proposals we asked to characterize the same samples by SAXS/WAXD and by SEM FEI.

2. Proposed experiment

The bacterial cellulose/graphene derivative hybrids will be prepared by University of Naples. The following characterization will be performed:

XRD tomography (Unit CNR-IPCB): to obtain more insights into the hierarchical structure of the aerogels, the porosity and the spatial distribution of graphene derivatives and bacterial cellulose nanofibrils and how the reduction of GO affects the aerogel structure.

In distinct proposals we asked to characterize the same samples by SAXS/WAXD and by SEM FEI.

-

3. Summary of previous experimental proposals or characterisation

No previous experiments have been carried out on these samples

4. Justification of experimental time requested

We have requested the XRD tomography available at IPCB CNR to evaluate the three dimensional structure of bacterial cellulose/graphene derivative hybrid aerogels.

It is proposed to measure n. 8 samples (4 pristine bacterial cellulose aerogels and 4 hybrids containing graphene derivatives.

The use of the XRD tomography technique will allow to obtain a three-dimensional map of the cellulose and graphene derivatives distribution in the aerogels as well as porosity distribution: we aim to measure n. 8 samples using a field of view of 0.5 mm x 0.5 mm, fixing the pixel size to the lowest available value. Hence, we request 4 days of beamtime which accounts also for setup time.

References

[1] D Wang (2019) A critical review of cellulose-based nanomaterials for water purification in industrial processes. Cellulose 26:687–701. https://doi.org/10.1007/s10570-018-2143-2

[2] V Raghavendran, E Asare, and I Roy, Bacterial cellulose: Biosynthesis, production, and applications. Advances in Microbial Physiology, Volume 77, 2020 Elsevier Ltd. ISSN 0065-2911. https://doi.org/10.1016/bs.ampbs.2020.07.002

[3] A Brakat, H Zhu (2021). Nanocellulose-Graphene Hybrids: Advanced Functional Materials as Multifunctional Sensing Platform. Nano-Micro Letters, 13, 94.