Report on the outcomes of a Short-Term Scientific Mission[1]

Action number: CA20126

Grantee name: Fernando Luís de Góis Rodrigues de Sá

Details of the STSM

Title: Porous bacterial nanocellulose as a platform for functional piezoelectric films

Start and end date: 17/04/2023 to 17/05/2023

Description of the work carried out during the STSM

The initial proposed planned revolved around the development of nanocomposites through the in-situ growth of piezoelectric nanoparticles within bacterial nanocellulose (BC) films. The idea was to mass produce such films, since their characterization was to be performed mainly at the University of Aveiro, Portugal, upon my return.

My arrival at the Institut de Ciència de Materials de Barcelona (ICMAB), 17th of April, was met with a set-back. The microwave I was supposed to use to develop the in-situ syntheses was not operational until the first week of May. In the meantime, I worked with the barium titanate (BT) nanoparticles I brough with me from Portugal. I realized that Dra. Anna Laromaine's lab was able to develop a variety of different BC films so my initial tests were to determine the type of films that would be better suited for our nanodevice approach.

24wp

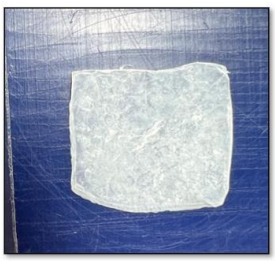
Diameter: ~1,5 cm
Thickness: ~15 µm

12wp

Diameter: ~2 cm
Thickness: 30-90 µm

Nata de Coco

Size: 1,2*1,2 cm
Thickness: ~100 µm



Square

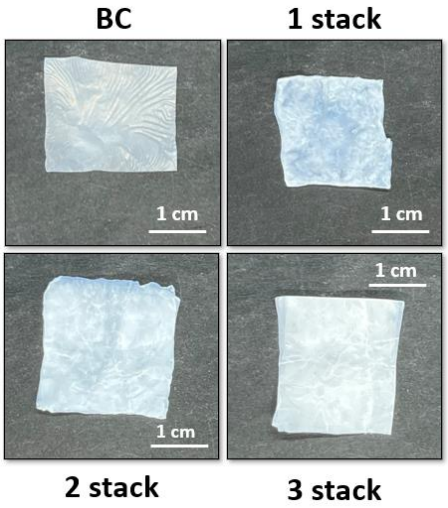
Size: I cut my own 2x2 pieces
Thickness: ~30 µm

[1] This report is submitted by the grantee to the Action MC for approval and for claiming payment of the awarded grant. The Grant Awarding Coordinator coordinates the evaluation of this report on behalf of the Action MC and instructs the GH for payment of the Grant.

As verified through the image, I initially worked with 4 typed of BC films. 24wp and 12wp are produced in similar well plates, with the same format but different size. Nata de Coco initially starts as a 3D cube but collapses upon itself after drying. Squares are cut from an initial bigger quare of about 12x12 cm. It has the advantage of being possible to tailor the films to fit my size criteria. Currently I am mainly working with 24wp and square films.

The infiltration and deposition of BT nanoparticles was achieved through two ways: vacuum filtration, by forcing the BT aqueous solution through the porous of the film, and immersion, my submerging the films in the BT solution for some time with light agitation. Filtration seemed to be the best approach, so I developed films with different BT nanoparticles concentration, 1 mM, 10 mM and 100 mM, with the BT presence being confirmed through UV spectroscopy. I also attempted to stack films on top of each other, and was successful in doing so, creating a single multi-layered composite with great adhesion between the stacked films.

My second task was the main task, the in-situ growth of zinc oxide (ZnO) nanoparticles within the BC films. This was done using both an CEM microwave, and a MILESTONE microwave, that allowed me to scale up my procedure and produce more than 1 film per synthesis. I developed several films using this methodology, even stacking them upon themselves. Below you can see stacked films and also a nata de coco nanocomposite where we can actually see that it was possible to do the in-situ growth of the ZnO inside the cellulose fibers.



Nata de Coco + ZnO

Besides the piezoelectric films, the plan also included the in-situ growth of metallic conductive nanoparticles within the BC films, such as silver and gold, to test as electrodes in the nanodevice assembly. Silver and gold films have been developed, as well as BC coupled with poly-pyrrole since we expect these combinations to lead to higher conductivity values.

My Grant was initially from the 17th of April to the 17th of May but the setbacks that I encountered forced me to further increase my stay at the ICMAB for another month, so my stay started at 17th of April but only ended at the 17th of June.

Description of the STSM main achievements and planned follow-up activities

Up until now I was able to develop several films that seem promising for piezoelectric testing. The effect of particle concentration and film porosity in the electrical performance is expected to be carefully accessed. After a deep characterization in the University of Aveiro, a publication is expected to be produced.

Also worth highlighting that I already performed my first dissemination of the developed knowledge through a conference participation, NanoSpain 2023 in Tarragona, Spain. I am also expected to

participate and share a more complete work at the Research Summit 2023 conference to be held at the University of Aveiro, in July.