ABSTRACT

Functionalized Nanofibers by Electrospinning for Energy Applications

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Hybrid composite bionanomaterials produced by electrospinning present the possibility of functionalizing polymeric nanofibres with active organic molecules, such as chiral dipeptides [1]. Peptides consist of sequences of amino acids that can self-assemble into various supramolecular structures, such as nanospheres, nanotubes, and nanowires, exhibiting quantum confinement and photoluminescence [1-5]. These materials have many advantages, such as excellent thermal and mechanical stability, high piezoelectricity, and excellent optical properties. Thus, here we report the fabrication and characterization of hybrid systems based on the chiral cyclo-dipeptides (L-Tryptophan-L-Tryptophan and cyclo-L-Tryptophan-L-Tyrosine), and linear dipeptide (Boc-L-phenylalanyl-L-Leucine and Boc-L-phenylalanyl-L-Isoleucine). The structural, morphological, mechanical and optical properties of the hybrid composites were measured showing an enhancement as compared to the bulk counterparts. Remarkably, these fibers exhibited efficient pyroelectric and piezoelectric responses for energy harvesting and a piezoelectric nanogenerator capable of producing a power density of 0.18 μWcm-2 was demonstrated for Cyclo (L-Trp-L-Trp)@PLLA [1].
Beyond purely organic composites, these hybrid structures can be further combined with magnetic inclusions giving additional degrees in device design. In this respect, magnetoelectric responses are achieved and flexible magnetocaloric fibers can be built for magnetic refrigeration [2]. Thus, the results highlight the impact of dipeptide nanostructures and magnetic inclusions on magnetolectric, pyroelectric and piezoelectric properties, indicating that these hybrid systems are very promising for applications in the field of environmentally friendly and biocompatible nanoenergy harvesting, magnetic refrigeration and piezoelectric generators for portable and wearable devices.

[1] D. Santos et al, Materials, 16, 2477 (2023); D. Santos et al, Materials, 16, 4993 (2023)
[2] V. Isfahani, ACS Appl. Mater. Interfaces, 16, 8655–8667 (2024).