16th April, 2021

PhD position Offer – Lorraine University of Excellency

Start : 1st October, 2021

Subject : Electrospun PVDF-Nanocellulose Hybrid Piezoelectric Generator

Generals

Workplace: Nancy
Type of contract: PhD contract – Lorraine University of Excellency grant
Contract duration: 36 months
Expected date of employment: 1st October 2021
Working hours: Full time
Remuneration: €1,676.55 gross per month
Level of study required: Engineering degree or Master's degree, preferably in Engineering Sciences

Projet context & Specific missions

The purpose of this project is to develop a new class of piezoelectric energy generator for mechanical energy harvesting. The research plan includes three phases: extraction from the bio wastes of the nanocellulose bio-fillers (Indian collaborator), fabrication of bio-filler incorporated polymer nanofibers by electrospinning and spin coating and development of piezoelectric energy generator. The matrix will consists of a Poly(vinylidene fluoride) (PVDF). The loading with bio-filler nanomaterials such as nanocellulose will enable to tailor the visco-elastic properties, to enhance the adhesion of films, to reduce its wear, even reduce the formation and propagation of cracks. The synergic effect of electrospinning and the use of bio-fillers will maximize the crystalline β-phase content of PVDF which will give superior energy harvesting behavior when used as the active material.The optimized PVDF-nanocellulose hybrid composites will be investigated for their piezoelectric properties and the design, fabrication and test of Nano Energy Generators (nano-EG) will be performed (Fig 1).

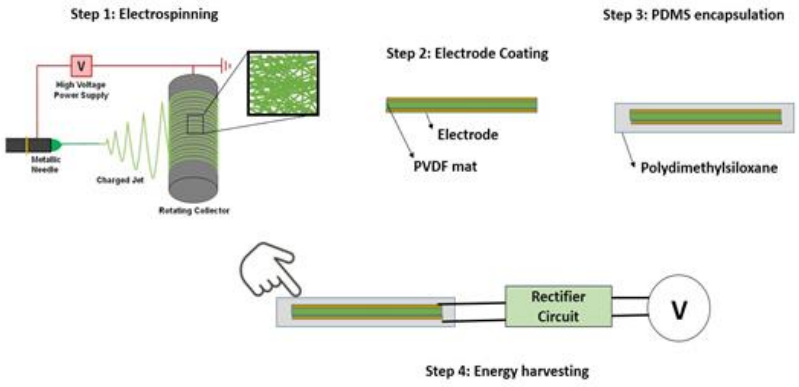

Fig. 1: Schematic of the electrospun energy harvesting device preparation

The thickness of the active layer and the proper contacts between the active layer and electrodes will be designed to generate maximum electrical output power, and the final device will be encapsulated by using polydimethylsiloxane (PDMS).
Therefore this thesis program will involve multiple domains, from the chemistry of elaboration of nanocomposite polymers to energy recovery electronics, through the characterization of physical properties (mechanical, crystalline, dielectric, ...) of materials and the development of devices.

References:
[1] Brevet FR 2981452(B1)/WO2013054062 : Dispositif de détermination du comportement mécanique local d'une éprouvette de matériau. M. Ponçot, J. Martin, P. Bourson, A. Dahoun, 14/10/2011.
[2] M. Ponçot, J. Martin, S. Chaudemanche, O. Ferry, T. Schenk, J.P. Tinnes, D. Chapron, I. Royaud, A. Dahoun, P. Bourson "Complementarities of high energy WAXS and Raman spectroscopy measurements to study the crystalline phase orientation in polypropylene blends during tensile test", Polymer, 80, 27–37, (2015)
[3] M. Donnay, M. Ponçot, J-P Tinnes, T. Schenk, O. Ferry, I. Royaud, "In situ study of the tensile deformation micro-mechanisms of semi-crystalline poly(ethylene terephthalate) films using synchrotron radiation x-ray scattering". Polymer, 117, 268–281, (2017).
[4] A. Létoffé, S. Hoppe, R. Lainé, N. Canilho, A. Pasc, D. Rouxel, R.J.J. Rioboo, S. Hupont, I. Royaud, M. Ponçot ,"Resilience improvement of an isotactic polypropylene-g-maleic anhydride by crosslinking using polyether triamine agents. " Polymer, 179, 121655, (2019).
[5] Sunija Sukumaran, Samir Chatbouri, Didier Rouxel, Etienne Tisserand, Frédéric Thiebaud, Tarak Ben Zineb, « Recent advances in flexible PVDF based piezoelectric polymer devices for energy harvesting applications », Journal of Intelligent Material Systems and Structures, (2020) 1045389X20966058
[6] Mayeen A, Kala MS, Sunija S, Rouxel D, Bhowmik RN, Thomas S, Kalarikkal N. « Flexible dopamine-functionalized BaTiO3 /BaTiZrO3/BaZrO3-PVDF ferroelectric nanofibers for electrical energy storage », Journal of Alloys and Compounds. May 8:155492, (2020)
[7] A Mayeen, MS Kala, MS Jayalakshmy, S Thomas, J Philip, D Rouxel, N. Kalarikkal, « Flexible and self-standing nickel ferrite–PVDF-TrFE cast films: promising candidates for high-end magnetoelectric applications », Dalton Transactions 48 (45),16961-16973 (2019)

Skills

The candidate has to hold an engineering degree or a Master 2 in materials science, and get fluent English (written and oral). He/she has to get minimum knowledge in polymer physics, and due to the wide opening of the thesis, skills in several of the following areas would be highly appreciated:

- Experimental electronics (measurements, implementation of test bench/electronic board)
- Material characterization: X-ray diffraction, crystallography, Raman, Brillouin and dielectric spectroscopies, DSC, DLS...
- Optics (for example: adjustment of a laser beam)
- Knowledge of programming and data processing (Matlab/Python/…).
- Lab chemistry

Laboratory Teams

The thesis will be carried out within the "Physics, Mechanics and Plasticity" and "Micro and Nanosystems" teams of the Jean Lamour Institute.

About the Jean Lamour Institute

The Jean Lamour Institute (IJL) is a joint research unit of the CNRS and the University of Lorraine. It is attached to the CNRS Institute of Chemistry. Specialised in the science and engineering of materials and processes, it covers the following fields: materials, metallurgy, plasmas, surfaces, nanomaterials, electronics. The IJL has 183 researchers and teacher-researchers, 91 engineers, technicians and administrative staff, 150 PhD students and 25 post-doctoral students. It collaborates with more than 150 industrial partners and its academic collaborations extend to some thirty countries. Its exceptional instrumental park is spread over 4 sites, the main one being a new building located on the Artem campus in Nancy.

How to apply ?

Send CV and motivation letter to :

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