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For immediate release

InComEss

Advanced lead-free piezoelectric composite fibres for mechanical harvesting

The InComEss project proposes a new green-and-cost-effective strategy for highly efficient energy harvesting systems, combining new smart advanced polymer-based composite materials and structures into a single/multi-source concept. These systems will include several components, ranging from the generator to the energy storage components. For the generator component, lead-free polymer-based PiezoElectric (PE) composite fibres and thermoplastic-based melt-mixed ThermoElectric (TE) composites will be developed.

Current energy harvesting systems employed to convert mechanical energy and waste heat into electricity are based on piezoelectric and thermoelectric materials, respectively. ThermoElectric (TE) materials make use of temperature gradients to generate voltage, while PiezoElectric (PE) materials can transform mechanical vibrations into electrical energy. Although PE and TE materials are already used in various applications (transducer devices, electrical generators, fuel lighters, gas stoves, etc.), their widespread implementation remains a challenge. Among the factors limiting their exploitation are the lack of efficient PE/TE materials that are light-weight and the inherent brittleness of PE ceramic and semiconductor TE materials. These restrictions are strongly pushing the development of novel cost-efficient and eco-friendly PE- and TE-based materials solutions that could be used in a wider range of commercial applications, including powering of IoT-based wireless sensors devices.

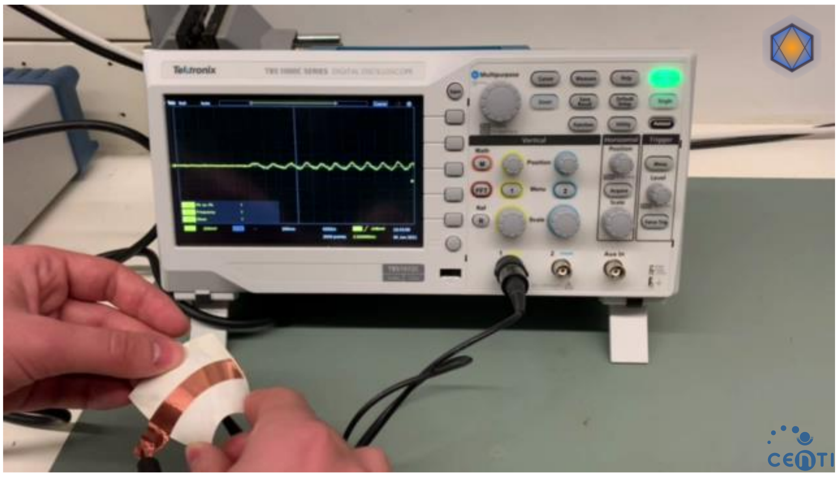

Figure 1:Testing composite electric response under mechanical stress

Compared to their inorganic counterparts, PE polymers have several advantages, namely being lightweight, low cost, highly flexible and thin, making them suitable for large-area applications. However, most of the PE polymers, mainly polyvinylidene fluoride (PVDF) and its copolymers, have shown a relatively weak PE charge coefficient. **As an alternative, flexible polymer composites incorporating ferroelectric (FE) and piezoelectric (PE) ceramic particles randomly distributed within a non-active polymer matrix are being produced within InComEss**.

The main goal of this research line is the development of advanced mono/bi-component **lead-free PE composite fibres with improved piezoelectric characteristics and good mechanical properties** for enhanced power and voltage output of PiezoElectric Generators (PEG) and hybrid ThermoPiezoelectric Generators (TPEG) devices.

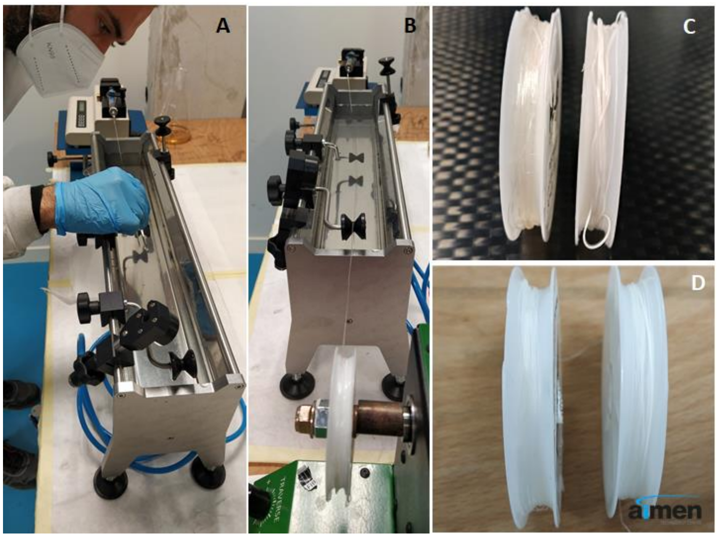

Figure 2:Lab-scale development of piezoelectric composite fibres by wet-spinning method (A, B). Coils of PVDF, BTO/PVDF composite fibres (C) and PVDF-TrFE, BTO/PVDF-TrFE fibres (D).

The specific objectives are:

- Development of flexible and efficient mono/bi-component lead-free PE composite fibres by wet-/melt-spinning techniques allowing an optimum integration of the ceramic particle fillers within the selected polymer hosts to maximize both PE voltage and charge coefficients
- Application of advanced processing methods for improved PE features and avoiding dielectric losses and maximizing the energy conversion (electromechanical coupling).
- Identify the processing-composition-properties relationship that control the alignment of the added ceramic particles for improved energy conversion efficiency of PE composite fibres.

Details

Project title: INnovative polymer based COmposite systeMs for high efficient Energy Scavenging and Storage

Project ID: 862597

Start Date: 01/03/2020

Project Duration: 42 months

Project Consortium:

aimen, ipf Leibniz-Institut für Polymerforschung Dresden, CENTI, nanocyl, SMART MATERIAL, Tampere University, FORTH, SKELETON TECHNOLOGIES, Università di Padova, Brunel University London, CORE INNOVATION, MARELLI, sonaca, ICCS, circe, UNE, ARCHITECTURAL BUILDING ENVELOPES FOCCHI

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