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Soft fibre based piezoelectric energy harvesting textiles

For energy harvesting from human movement, fibre based electrical power generators are highly desirable as they are light weight and comfortable and look no different from the con-ventional fabrics. The conjunction of piezoelectric materials in fibres and therefore fabrics offers a simple route for the building of soft piezoelectric generators. The flexible textile structures can themselves be designed so as to provide piezoelectric output on low levels of strains and loadings while providing high fatigue resistance under a large number of variable mechanical deformation and loading cycles. In this work, we demonstrate "3D spacer" technology based all-fibre piezoelectric fabrics as power generators and energy harvesters. The single step knitted structure consisting of high β-phase (~80%) piezoelectric PVDF produced using conventional melt spinning under high electric field (0.6 MV/m) are knitted together with Ag coated PA66 yarns acting as the top and bottom electrodes. The novel and unique textile structure provides an output power density in the range of 1.10-5.10 μWcm^{-2} at applied impact pressures in the range of 0.02-0.10 MPa, providing significantly higher power outputs and efficiencies over the existing 2D woven and nonwoven piezoelectric structures. The all fibre piezoelectric fabric possesses the advantage of efficient charge collection due to intimate contact of electrodes and uniform distribution of pressure on the fabric surface, leading to en-hanced performance. Furthermore, an substantial increase in piezoelectric output of the PVDF yarns has been achieved using $ZnSnO_3$ based perovskite which has doubled the piezoelectric constant from 60 pm/V to nearly 130 pm/V. Bearing all these merits in mind, we believe our method of producing large quantities of high quality piezoelectric yarn and piezoelectric fabric provides an effective option for the development of high performance energy-harvesting textile structures for electronic devices that could be charged from ambient environment or by human movement. Furthermore, via the creation of hybrid photovoltaic films and fibres, energy can be captured from solar radiation and used where the mechanical impetus is absent. The high energy efficiency, mechanical durability and comfort of the soft, flexible and all-fibre based power generator is highly attractive for a variety of potential applications such as wearable electronic systems and energy harvesters charged from ambient environment or by human movement.

Biography

E Siores is the Provost and Director of Research and Innovation, Bolton University. He was educated in UK (BSc, MSC, MBA, PhD) and pursued his academic career in Australia (Syd-ney, Brisbane and Melbourne) and Asia (Hong Kong, Dong Guan) before returning to Europe (UK) as a Marie Curie Fellow. He is also President, Board of Governors, TEI – Athens and Director of Innovation, FibrLec Ltd. His R&D work concentrated on advancing the science and technology in the field of automated Non-Destructive Testing and Evaluation including Ultrasound, Acoustic Emission and Microwave Thermography. His recent R&D work focuses on Smart/Functional Materials and Systems development. He has been a Editorial Boards Member of international journals and a Fellow of IOM, TWI, IEAust, SAE and WTIA. He has served on Board of Directors of a number of research centres worldwide including UK, Australia, Singapore and Hong Kong, all associated with the Bio-Nano-Materials field. He is a member of the Parliamentary Scientific Committee and has received 15 international awards in his career for R&D and innovation achievements.

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