

Electrospun polymer nanofiber-based electromechanically responsive materials

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Abstract: Polyvinylidene fluoride (PVDF) is a crucial piezoelectric electromechanically responsive polymer for a wide range of applications, such as flexible tactile, force and deformation sensors or mechanical energy harvesters. However, the synthesis of PVDF involves the use of per- and polyfluorinated alkyl substances (PFAS), commonly referred to as “forever chemicals”. Therefore, the development of alternative environmentally friendly flexible polymer transducer technologies has become an urgent priority [1]. Recently, an electromechanically responsive electrospun laminate approach has been demonstrated [2]. This method can involve various types of polymers, offering significant opportunities for further improvements and the integration of functionalities such as stretchability, biodegradability, or biocompatibility. For such flexible polymer systems, the literature predominantly focuses on the “direct” effect, namely the generation of electrical charge (or voltage) under applied mechanical stress, pressure, or vibration. Here, the converse phenomenon is demonstrated - mechanical deformation induced by an applied electric field. Fibrous samples with a high density of interfaces per unit volume were prepared by electrospinning from different polymers. The standard AixACCT TF2000 analyzer setup allowed characterization of sample polarization, electric-field-induced mechanical deformation, and determination of the electromechanical response nature (electrostrictive or piezoelectric). In several systems, it was also able to induce a piezoelectric-like response using special electrode configurations and high applied voltages.

Keywords: Electromechanically responsive materials, Electrospun polymer nanofibers, Energy harvesting applications

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