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Electromechanical numerical and experimental characterization of polymeric nanowires

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A recent branch of nanotechnology is represented by nanopiezotronics: a new research field that focuses on the development of nanogenerators able to convert nanoscale mechanical energy into electric energy [1]. New devices can be developed based on these technologies in the near future, such as: nanoactuators, nanomotors and nanomachines. Moreover to achieve a robust performance in industrial applications, these nanostructures should operate in their elastic limit under static and cyclic loadings to avoid failures and guarantee mechanical integrity. In this framework characterization of their mechanical properties is very important. However, due to the small scale and the particular geometrical configuration of these nanostructures the experiments are very complex. Even the multiphysics nature of the problem plays an important role. In this work a coupled numerical-experimental nanoscale characterization of one, two and three dimensional polymeric piezoelectric nanostructures is performed with a focus on their micro/macro mechanical and electromechanical properties. First the electromechanical response of PVDF nanowires is characterized in different test configurations: single nanostructures and array of nanostructures. Second some piezoelectric coefficients are determined through advanced multiscale-multiphysics numerical simulations. In general, piezoelectricity constants could be characterized in direct and converse manner, however for soft piezoelectric materials such as polymer nanofibers could not be easily obtained in the direct way and the converse piezoelectric measurement is more suitable [2]. To this aim piezoresponse force microscopy (PFM) is used to allow the measurement of the induced deformations after application of a local electric field applied through an atomic force microscopy (AFM) tip.

Keywords: multiscale and multiphysics modeling, nanopiezotronics, electrospinning, polymer nanowires, energy harvesting

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