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Probing Localized Nanomechanical Properties of Energy-Harvesting Polymers

Abstract.
The purpose of this project is to investigate the localized nanomechanical properties of energy-harvesting polymers, such as polyvinylidene fluoride (P(VDF-TrFE)), which is widely used in electromechanical sensing and actuation because of its low stiffness, low cost, and ability to be formed in a wide variety of configurations. Little is known, however, about the influence of nanoscale morphology on electromechanical response. This is because crystallite sizes range from 50 nm to 100 nm, a scale that has not been probed mechanically. The project will focus on the nanoscale properties of P(VDF-TrFE) using an innovative adaptation of and atomic force microscope (AFM) instrument in the Nano-Engineering Research Core Facility (NERCF) at UNL. This instrument will afford nanoscale-resolution imaging of dynamical mechanical properties of novel engineered nanostructures made with P(VDF-TrFE) copolymers. By this approach, we will be able to eluci- date the relationships between nanostructure and materials properties. Devices based on these enhanced nanomaterials would be able to efficiently extract ambient energy from mechanical mo- tion and vibrations, such as those generated by machinery, animals, humans, wind, or water. Such devices could, for example, be embedded in small and flexible systems to power sensors and communications for wearable and portable electronics. This would obviate the need for re- plenishing batteries or fuels to power the equipment. In addition, the electromechanical devices can simultaneous serve as vibration and motion sensors, or even as actuators alternating with energy harvesting functions. The funding provided by the Energy Research Grant would further laboratory research, analysis, and reporting that will put our team in a strong position from which to seek funding from major federal funding sources, such as the Department of Energy, the National Science Foundation, and the Army Research Office.