Understanding the Origin of Electrostriction Property in Electroactive Polymers

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Electrostrictive polymers with large deformation and low hysteresis are attractive for sensing, actuation, and energy-harvesting. To understand the origin for large electrostriction observed in electroactive polymers, we chose to study a variety of semicrystalline polymers, including poly(vinylidene-*co*-fluoride) [P(VDF-TrFE)] random copolymer, poly(VDF-*co*-TrFE-*co*-chlorotrifluoroethylene) [P(VDF-TrFE-CTFE)] random terpolymer, even-numbered nylons (e.g., nylon-12 and nylon-6), poly(ether-amide) multiblock copolymers (PEBAX), and thermoplastic polyurethanes (TPUs). It is observed that uniaxiallyl stretched P(VDF-TrFE)-based polymers exhibit positive longitudinal strain upon electroactuation, whereas uniaxiallyl stretched polyamide-based polymers exhibit negative longitudinal strain. From these observations, the large electrostriction in electroactive polymers can be attributed to nanoactuation of the crystalline phases. In P(VDF-TrFE)-based polymers, nanoactuation is realized by the twisted-to-all trans conformation transformation. In polyamide-based polymers, nanoactuation is realized by the trans-to-twisted conformation transformation. This understanding will help us design new electroactive polymers for large electrostriction in practical applications.

Biographic Sketch

Professor Lei Zhu received his B.S. degree in Materials Chemistry in 1993 and M.S. degree in Polymer Chemistry and Physics in 1996 from Fudan University. He received his Ph.D. degree in Polymer Science from University of Akron in 2000. After two-year post-doctoral experience at the Maurice Morton Institute, University of Akron, he joint Institute of Materials Science and Department of Chemical, Materials and Biomolecular Engineering at University of Connecticut, as an assistant professor. In 2007, he was promoted to associate professor with tenure. In 2009, he moved to Department of Macromolecular Science and Engineering at Case Western Reserve University as an Associate Professor. In 2013, he was promoted to full Professor. His research interests include high κ polymer and organic-inorganic hybrid nanomaterials for high energy density capacitor applications, development of artificial antibody as nanomedicines, and supramolecular self-assembly of discotic liquid crystals. He is recipient of NSF Career Award, 3M Non-tenured Faculty Award, DuPont Young Professor Award, and Rogers Teaching Excellence Award. He is author and co-author of 182 refereed journal publications and 7 book chapters. He delivered over 160 invited talks and 45 contributed presentations, and his total citation is ~9000 times with an *h*-index of 53 (Google Scholar).