Influence of Crystal Orientation on Electromechanical Behaviors of Relaxor Ferroelectric P(VDF-TRFE-CTFE) Terpolymer

Authors: Qing Liu, Jean-fabien Capsal, Claude Richard

Abstract: In this current contribution, authors are dedicated to investigate influence of the crystal lamellae orientation on electromechanical behaviors of relaxor ferroelectric Poly (vinylidene fluoride –trifluoroethylene -chlorotrifluoroethylene) (P(VDF-TrFE-CTFE)) films by control of polymer microstructure, aiming to picture the full map of structure-property relationship. In order to define their crystal orientation films, terpolymer films were fabricated by solution-casting, stretching and hot-pressing process. Differential scanning calorimetry, impedance analyzer, and tensile strength techniques were employed to characterize crystallographic parameters, dielectric permittivity, and elastic Young’s modulus respectively. In addition, large electrical induced out-of-plane electrostrictive strain was obtained by cantilever beam mode. Consequently, as-casted pristine films exhibited surprisingly high electrostrictive strain 0.1774% due to considerably small value of elastic Young’s modulus although relatively low dielectric permittivity. Such reasons contributed to large mechanical elastic energy density. Instead, due to 2 folds increase of elastic Young’s modulus and less than 50% augmentation of dielectric constant, fully-crystallized film showed weak electrostrictive behavior and mechanical energy density as well. And subjected to mechanical stretching process, Film C exhibited stronger dielectric constant and out-performed electrostrictive strain over Film B because edge-on crystal lamellae orientation induced by uniaxially mechanical stretch. Hot-press films were compared in term of cooling rate. Rather large electrostrictive strain of 0.2788% for hot-pressed Film D in quenching process was observed although its dielectric permittivity equivalent to that of pristine as-casted Film A, showing highest mechanical elastic energy density value of 359.5 J/m^3. In hot-press cooling process, dielectric permittivity of Film E saw values at 48.8 concomitant with ca.100% increase of Young’s modulus. Films with intermediate mechanical energy density were obtained.

Keywords: crystal orientation, electrostrictive strain, mechanical energy density, permittivity, relaxor ferroelectric

Conference Title: ICFMM 2015 : International Conference on Functional Materials and Microsystems

Conference Location: Paris, France

Conference Dates: December 30-31, 2015