Studies on tunability of polarization components and electric field induced crystallization in polyvinylidenefluoride (PVDF); a piezo polymer for flexural sensing and energy harvesting

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Polyvinylidenefluoride (PVDF) a semi-crystalline polymer is known for its piezoelectric properties and has been studied extensively for flexible piezoelectric devices and applications. PVDF is known to stabilize in various crystalline phases, however, the β –phase is known to exhibit piezoelectric properties due to the non-centrosymmetric feature of the crystallization. PVDF thin films fabricated using tape casting technique with precursor solutions of varying viscosities reveal that the polarization components transform from a dominant planar component to an out-of-plane polarization components with increase in viscosity. Interestingly the planar components possessed a head to head or tail to tail kind of paired domains separated by a distance of ~ 380-400nm. The electrostatic energies computed by numerically solving the electrostatic equilibrium equation for the electrically inhomogeneous system are in good correlation with the experiments. On increment of electric field, the domains were observed to grow in size and shape which indicates amorphous to crystalline transformation in the case of PVDF. The increment of polar-regions in these semi-crystalline polymers must be associated with an amorphous to crystalline transformation which was also verified with a structural study performed under applied electric fields. The studies evidently prove that the polarization components of PVDF are sensitive to initial processing conditions and they also undergo an amorphous to crystalline transformation under applied electric fields.