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ELECTROACTIVE POLYMER FILM

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Summary: Pure Polyurethane (PU) elastomers are one of the most important class of polymers due to some remarkable electromechanical characteristics such as large electric field induced strain, high specific energy and fast speed of response. This makes the material very attractive for many electromechanical applications. Many electroactive strain properties of the PU were investigated but the fundamental mechanisms which are responsible for the electrostriction have not been yet well understood. We found that the thermal absorption on melting of Differential scanning calorimetry (DSC: 131Evo, SETARAM, France) thermal analysis often corresponds to data of electrostriction. Crystalline volume fraction may contribute to the electrostriction. If the volume fraction of surface crystallization on solidification is controlled by solidification condition, the experimental error can be explained to obtain the reproducible data.
PU was chosen with conductive particles of carbon black (CB). The electric field induced into the composite was assumed not to pass through the CB nanoparticles. The purpose is to report the influence of solidification condition related to as cast thickness on electrostriction of the polyurethane composite films.
Pure PU films as well as composite films comprising a CB were prepared by a simple solution cast method. The diameters of the CB obtained directly from nanoink (SAILOR Ltd., Japan) particles in the composite films. The field-induced thickness strain (S) was measured by a laser interferometer with a precision on the order of 5 nm.
The electrostriction of thin composite film was generally higher than that of pure PU at each as cast thickness. Therefore, micelle form of CB effect was confirmed. Thinning composite film remarkably enhanced the strain at 20 MV/m. Thick composite film apparently exhibited the higher electrostriction at low electric field of less than 5 MV/m. X-ray diffraction (XRD: D8 ADVANCE, BRUKER) was used to confirm the internal structures of periodicity of composite films with different thicknesses. The peak width corresponds to the periodicity perfection of hard and soft segments. DSC analysis was used to confirm the volume fraction of crystalline of composite films with different thicknesses. The endothermic heat is usually generated by transformation from crystal to liquid on melting. It corresponds thus to volume fraction of crystalline form in material. The fusion enthalpy values were obtained by area of endothermic peak. Considering with crystalline volume fraction and crystalline periodicity, the as cast thickness dependent electrostriction was explained. Effects of making composites on strain were probably contributed by the polarization enhancement induced by increasing the capacitance.