ABSTRACT

The thesis encompasses the development of dielectric and piezoelectric materials derived from polymer-ceramic composites/nanocomposites. These composites have been made through addition of electro-ceramic fillers like TiO_2, $BaTiO_3$, and PZT etc in insulating polymer matrices like polydimethylsiloxane (PDMS) and polyurethane (PU) elastomers using both melt mixing technique and room temperature mixing. The different electro-ceramic fillers (TiO_2, $BaTiO_3$, and PZT etc) have been prepared through high temperature solid state reaction and sol-gel method. The filler particles have been characterized by different techniques *viz* X-ray diffraction (XRD) analysis, fourier transform infrared (FTIR) spectroscopy, X-ray photoelectron spectroscopy (XPS), and UV-visible spectroscopy etc. The different mechanical and electrical properties of the polymer-ceramic composites have been investigated in detail. Both DC resistivity and dielectric properties like permittivity, dielectric loss, and AC resistivity/conductivity have been reported in the frequency range 10-10^6 Hz for all composites under investigation. All these composites show composition dependent dielectric properties, and composites with tunable dielectric properties can be obtained through judicial adjustment of composition. Temperature dependent dielectric properties of neat polymer, neat ceramic fillers as well as different polymer-ceramic composites have been studied. The effect of stress on different electrical properties like DC resistivity/conductivity, dielectric constant (ε'), and DC current (I_{dc}) of these composites has also been investigated. These composites show excellent piezoelectric behavior, where the DC resistivity and dielectric constant of these flexible composites are found to change appreciably with the change in applied stress. The breakdown strength of these composites has been studied and found to be composition dependent. The effect of poling has also been studied with respect to dielectric constant and DC resistivity. Thermal stability of these composites was also investigated. It is found that composition play a significant role in the thermal stability of these composites. The morphological study through FESEM, HRTEM, and AFM/SPM reveals distribution of particulate filler in matrix polymer which in turn affects different properties. Some modelings of dielectric constant against composition have also been done.

Keywords: Polymer Composite, Ceramic, Mechanical Property, Electrical Property, Dielectric, Piezoelectric, Modeling