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Effects of ionic irradiation on PMN-PT ferroelectric materials for space applications

Padmaja Guggilla
Alabama A&M University, USA

PMN-PT (Lead Magnesium Niobate-Lead Titanate) is an important and high performance piezoelectric and pyroelectric relaxor material having wide range of applications in infrared sensor devices. PMN-PT with 30 mole% single crystal powder was incorporated into a [P(VDF-TrFE)] (poly[(vinylidenefluoride-co-trifluoroethylene]) (70-30 mole%) copolymer matrix to form the 0-3 composites. The material was prepared and subsequently irradiated with heavy ion oxygen. The nanocomposites were analyzed and determined that the material indicated changes in its dielectric constant and pyroelectric coefficient after irradiation. PMN-PT: [P(VDF-TrFE)] nanocomposites were also characterized using Raman spectroscopy to get the finger print of these materials and their existence in the composite films. Dielectric constant and dielectric loss results were presented as a function of temperature and frequency, and pyroelectric coefficient as a function of temperature. Due to irradiation, the dielectric constant of the materials increased uniformly, while its pyroelectric coefficient showed a sharp increase to the value of 5×10-9 μC/cm2 0C with increase in temperature. Its dielectric constants showed an increase in values of 527 μC/cm^2 °C at 50°C, 635 μC/cm^2 °C at 60°C and 748 μC/cm^2 °C at 70°C. Authors also observed that both microscopic structure and environmental conditions contributed to observed properties. Dielectric loss resulted from electromagnetic energy loss as manifested through phase differences between low-frequency input signal to the films and time varying polarization. The decrease of ε' in higher frequencies region may be due to the fact that the dipoles cannot follow the fast variation of the applied field. This behavior of the increase in ε' and ε'' at lower frequencies can be due to contribution of interfacial polarization in the heterogeneous system as well as conduction from space-charges. The activation energy of the PMN-PT: [P(VDF-TrFE)] composite material was calculated and presented. Properties such as the material impedance, admittance and modulus were investigated before and after irradiation effect.

Biography

Padmaja Guggilla is an Associate Professor of Physics at Alabama A&M University with a PhD degree in Applied Physics in 2007. She has been extremely successful in writing grants. She secured over a million dollars in funding as PI and over two million dollars as Co-I. She is very well published (45+) including a book chapter and is invited to give technical talks at various international conferences. Her research interests include pyroelectric materials, infrared sensors, crystal growth, thin film and thick film technology, composite films and photovoltaic devices.

padmaja.guggilla@aamu.edu

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