

Lead-free 1-3 Piezocomposites and Their Electrical Properties

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1-3 piezocomposites consist of individual piezoelectric ceramic rods, or fibers, aligned in a direction parallel to the poling direction, and surrounded by a polymer matrix. They are attractive for actuator and sensor applications because they provide increased anisotropy and specific strength over monolithic ceramic, as well as excellent flexibility. Piezocomposites also have the added benefits of lower acoustic impedance, lower dielectric constant, higher hydrostatic charge coefficients and in some cases increased thickness mode coupling. In this study, lead-free, 1 mole% CuO-added potassium sodium niobate ($K_{0.5}Na_{0.5}NbO_3$) - KNN ceramics were prepared using conventional ceramic processing methods of solid state calcination, dry pressing and sintering. Then piezocomposites with 1-3 connectivity were prepared by dicing the ceramics using a wire cutter and then filling the spaces with an epoxy matrix. Piezocomposites with various ceramic volume fractions (V_c) were prepared. The dielectric constant of the piezocomposites were found to increase from 75 to 165 with increasing V_c in the 1-3 piezocomposite. The piezoelectric charge coefficient (d_{33}) was found to vary from 30 to 80 pC/N and electric field induced strains of up to 0.08% were obtained from the piezocomposites with remnant polarization ($2P_r$) values reaching 17 $\mu\text{C}/\text{cm}^2$.

Key Words: 1-3 Piezocomposite, Lead-free, KNN, Dice & Fill