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Project Report

On

Fabrication of Polymeric Nanocomposites Reinforced with Rutile Micro- and Nanoparticles, and Their Properties

For stage 2

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By

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Abstract

Microwave substrates are solid dielectric media having stable relative permittivity and low loss tangent at microwave frequencies. Dielectric substrates for microwave applications differ in many ways from the conventional printed circuit boards (PCBs) used at low frequencies. Materials used for the same should have low dielectric constant and low loss tangent. Poly(aryl)etherketone (PEK) is a high temperature semi-crystalline thermoplastic polymer which has low dielectric constant and low loss tangent both of which are basic requirements for a material to be used as substrate for microelectronic applications. In view of this, present work deals with PEK based micro- and nanocomposites containing TiO_2 (rutile) micro- and nanoparticles, respectively. These composites were prepared by solution method followed by hot compaction method. XRD and SEM analysis of TiO_2 confirms the presence of Rutile phase. By addition of TiO_2 (Rutile) to the polymer matrix coefficient of thermal expansion reduces by 18.2% and 23.46% for 30 wt% micro- and nanocomposites respectively, as compared to pure polymer and makes the composite more suitable for microelectronic applications. The dielectric constant measured at 1 MHz for the 30 wt% nanocomposite increases from 4 to 7.27. At the same frequency the loss tangent value reduces from 7.07×10^{-3} for pure PEK polymer to 5.82×10^{-3} for 30 %wt. nanocomposite. The microhardness values improve by 32% for the nanocomposites as compared to pure polymer. The moisture absorption test shows that the percentage weight gain even after addition of ceramic filler (rutile) is a minimum value of 0.67% for 30 wt.% nanocomposite. Differential scanning calorimetry showed shows decrease in crystallization temperature with negligible change in melting and glass transition temperature for both micro- and nanocomposites. Thermogravimetric analysis showed increase in decomposition temperature which means improvement in thermal stability. Temperature effect on dielectric properties were studied to determine the effect of changing temperatures on dielectric properties of the prepared composites. Dielectric properties are affected at higher temperatures with no change in properties for temperatures below 100°C.