The effect of magnesium oxide (mgo) on the thermal conductivity

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The effect of magnesium oxide (MgO) on the thermal conductivity reinforcement of silicone elastomers has not been extensively studied. Most of the previous works about thermal conductivity of MgO/polymer composites have focused on matrices with less viscosities like epoxy [1, 2] and Poly methyl methacrylate (3). As a filler, MgO has an attractive combination of characteristics. It has a bulk thermal conductivity greater than some inorganic fillers. It is also known to be inexpensive and nontoxic. MgO is also commonly used as a dielectric powder filler for polymer molding applications. One Another unique attractive characteristic of MgO is its low hardness as compared to the other listed ceramics (4). MgO is a soft ceramic that actually exhibits deformation-like characteristics like those of many metals (5). In the context of increasing thermal conductivity and reducing wear during the molding of polymer matrices (1), high filler loadings are usually needed.

However, high filler loading is likely to cause deterioration of the thermal conductivity properties. Nano-scale inorganic particles can exhibit fascinating size-controlled thermal conductivity property-enhancement effects in polymer matrix. However, a uniform dispersion of nano fillers in polymer matrix, essential for controllable and reliable thermal conductivity properties, is difficult to achieve at high loading levels. This is because of the propensity of nanoparticles to agglomerate, resulting in as much as 99% of the interfaces being separated by air gaps (6). Interstitial air gaps trapped due to improper mating of the surfaces significantly reduces the capability to dissipate heat, resulting in deterioration of the thermal conductivity of the material. It is for this reason that thermal conductive films are often fabricated containing relatively low filler loading. However, without good thermal contacts, the performance of a high thermal conductivity heat sink to dissipate heat is limited. This is caused by interfacial thermal resistance arising from lack contact of filler particles in the matrix. One method that is commonly used to reduce the thermal contact resistance between the particles in the matrix is to include an additional material to provide an effective heat path between the filler particles in the polymer matrix (7, 8). These additional materials are preferred to be of extensively high aspect ratio and thermal conductivity e. g carbon nanofibers (CNFS) or carbon nanotubes (CNTs).

Thermal conductivity's relationship to heat dissipation bears importance for this application as the thermal conductive nature of the material is the main mechanism for a cooling device. High electrical resistivity is required in order to prevent current leakage thus making the use of MgO in this work ideal.

The presence of oxygen-containing groups facilitates the functionalization of MWCNT bundles, and increases the solubility in polar media (9). This, in turn, affects the processing of CNTs and increases the possibility of further modification/functionalization depending on application (10). Concerning the use of CNTs as reinforcements in composite materials, the incorporation of oxygen-containing functionalities onto the graphitic surface is a very crucial step for the enhancement of interfacial adhesion. As a result, the unique mechanical, electrical and thermal conductivity properties of CNTs can be transferred to the properties of CNT-based composites (11).

MWCNTs are added in the MgO/silicone resins mixture in order to create interconnection between filler particles in the matrix. Also, surface functionalization of the MWCNTs was undertaken, in which activate organic groups were doped onto the surface of the MWCNTs. The use of hydrogen peroxide (H2O2) activates hydroxyl (-OH) functional groups to be formed on the surface of MWCNTs. These groups promote the dispersion of MWCNTs in polymer matrix, and the groups also improve the compatibility between MWCNTs, MgO and silicone elastomer matrix, resulting in the formation of conductive pathways between MgO, MWCNTs and silicone elastomer matrix. This results in improved thermal conductivity of the fabricated polymer composites. The aim of this study is to use multiwall carbon nanotubes (MWCNTs) as additional materials and inorganic nano fillers with high thermal conductivity (MgO) incorporated in silicone rubber (KE-12) to fabricate improved thermal composites.