DIELECTRIC INTEGRITY OF HIGH TEMPERATURE NANOCOMPOSITES

by

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ABSTRACT

It has been shown that in many cases the addition of nanoparticles to polymers leads to an improvement in dielectric breakdown strength at room temperature. Polymer composites have been studied extensively for use as electrical insulation. In some applications electrical insulation may be exposed to elevated temperatures and a thermally stable polymer material such as polyamideimide (PAI) is required. In this study, PAI-silica and PAI-alumina composites were examined for use as high temperature electrical insulation.

Thermal analysis was completed on unfilled polymer and composites in order to quantify the effect of nanoparticles on the glass transition and decomposition temperatures of PAI polymer. These properties were important to characterize in order to understand the thermal stability with increased temperature. It was found that nanoparticles had no measureable effect on glass transition temperature, but they do increase the decomposition temperature of the polymer by 20-50^{o}C.

Dispersion of the composites was also studied. The relationship between dispersion quality and breakdown strength was evaluated. It was found that poor dispersion (the presence of agglomerates) decreased the breakdown strength of nanocomposites.

Electrical testing, such as breakdown strength and voltage endurance, are critical tests when evaluating material for use as electrical insulation. The goal of this study was to develop and characterize thermally stable dielectric composites, so these properties were measured as a function of temperature. Degradation in these properties was expected with increasing temperature. However, since the addition of nanoparticles has been shown to increase PAI decomposition temperature, the effect of increased temperature on dielectric properties was also expected to be mitigated.

Dielectric properties of silica composites were focused on in this study due to processing concerns with alumina composites. AC and DC breakdown strength of PAI and nanosilica filled PAI were measured at room temperature and elevated temperatures. Test temperatures were well below the decomposition range of polyamideimide as measured by the thermogravimetric analysis (TGA). Silica composites at all loadings (whether treated or untreated) were shown to have higher AC and DC breakdown strengths at elevated temperatures than unfilled material. Dielectric spectroscopy was

also completed on silica composites, and showed that 10 weight percent loaded composites have higher permittivities at all temperatures.