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Impulse Breakdown Strength of Zinc Oxide / Epoxy Resin Nanocomposites

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Over the past two decades, polymeric nanocomposite materials have been the centre of great attention in the research community. Mixing low concentrations of metal or metal-oxide nanoparticles into polymeric insulators has been shown to improve key characteristics of the material, such as thermal behaviour, mechanical strength and resistance to long-term degradation. Unlike traditional microcomposites, these advantages do not come at the price of electrical strength; investigations have shown that nanocomposites have similar or greater electrical strength when compared to their unaltered polymer form.

This study focuses on the change in impulse breakdown strength of epoxy resin when nanoparticles are introduced into the host material. Nanocomposite samples are produced by mixing epoxy resin with zinc oxide nanoparticles at concentrations of 0.5, 1 and 2 wt%; unaltered epoxy resin samples are also produced to act as a control in the experiment. During mixing, nanoparticles are likely to cluster together, so ultrasonic waves are applied to the mixture to encourage their dispersion. Once cured, the samples are analysed with an electron microscope to ensure that the nanoparticles have been adequately dispersed.

Each sample is subjected to high voltage impulses of increasing magnitude until a breakdown through the bulk of the sample is achieved. The test cell uses a needle-sphere electrode configuration (36 μm needle radius) with a gap of 6 mm to generate an electrical field sufficient to cause bulk breakdown of the sample. The interior of the test cell is filled with oil to prevent the occurrence of flashover events. Bulk breakdown of an unaltered epoxy sample is achieved by an impulse with 222 kV peak voltage and rise time of 100 ns.

In future experiments, the samples will be electrically prestressed before the impulse is fired, with the aim of observing any changes in space charge behaviour within the nanocomposite samples.

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