AC Breakdown Property of Nano-TiO_2 and Micro-Silica filler Mixture of Epoxy Based Composites

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Abstract : In this paper, various kinds of epoxy based nanocomposites were made and AC breakdown properties of nano-TiO_2 and micro-silica filler mixture of epoxy based composites were studied by sphere to sphere electrode. Moreover, nano- and micro-filler combinations were adopted as an approach toward practical application of nanocomposite insulating materials. AC breakdown test was performed at room temperature (25℃), 80℃ and 100℃. The result shows breakdown strength about non-filled, nano-scale TiO_2, micro-scale silica and nano-TiO_2/micro-silica filled epoxy composites.

Key Words : nano, epoxy composite, mold transformer, breakdown, dependence temperature

1. Introduction

Many studies have shown that addition of a few weight-percentages of nano fillers improves the dielectric and insulation properties of nanocomposites. However, few studies have evaluated them from the viewpoint of practical application. In this paper, AC breakdown property of epoxy based nanocomposites was studied at room temperature, below and upper Tg. Main focuses is temperature dependence for breakdown strength following size and contents of fillers.

2. Material and Test

The epoxy resin without fillers (BE), epoxy resin filled micro silica (MS), nano TiO2 (NT) and epoxy resin containing nano TiO2 and micro silica (NTMS) were prepared. An epoxy resin[100phr], hardener[82phr], accelerator[1.5phr] and fillers were mixed by High Speed Emulsifier and Planetary Centrifugal Mixer for 30 minutes. These epoxy composites mixed were poured into a stainless steel mold and performed casting, curing.

An AC voltage of 50Hz was applied electrode system at a continuous rising speed (0.6 kV/sec) to measure its insulation breakdown strength. The insulation breakdown strength was measured by sphere to sphere stainless steel electrode system. Specimen and electrode system were impregnated with insulating oil into Oil bath and it was applied so that keeping temperature of oil continuously by oil circulation system. The test was carried out at room temperature(25℃), below Tg(80℃) and upper Tg(100℃) of epoxy composites.

3. Result and discussion

Figure 5 shows that scale parameter change of each specimen by Webull plotting about temperature. Temperature dependence coefficient of MS, being in general used as mold transformer insulating material, is confirmed -0.23 x 10-2/℃. Temperature dependence coefficient of NTMS5, it is lower than other specimens, is calculated -0.61 x 10-3/℃.

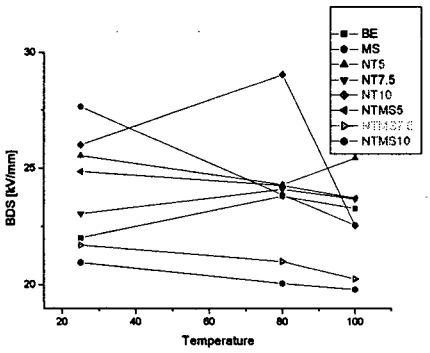

Figure 1. Variation in breakdown strength of specimens about temperature

4. Conclusion

Temperature dependence coefficient of NTMS, nano-TiO2 and micro-silica filler mixture of epoxy based composites, it is lower than other specimens, is calculated -0.61 x 10-3/℃ - -0.90 x 10-3/℃. When the contents of nano-TiO2 particles increased further at NTMS, breakdown strength was reduced prerequisite of Coulomb blockade effects no longer exists.

It was confirmed that breakdown strength is little different at room temperature, but it was improved at high temperature from result that temperature dependence coefficient of NTMS5 is 26.5% than MS.

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