Dielectric Breakdown Strength of Polyethylene Nanocomposites

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The term "nanometric dielectrics" or simply "nanodielectrics" was introduced in 1994 when Lewis [1] anticipated the potential property changes that would benefit electrical insulation due to nano-sized inclusion. Such materials, containing homogenous dispersion of small amount (normally less than 10wt%) of nanoparticles (with at least one dimension in nanometre range) in host matrix, are of specific dielectric interest. Although much effort has been put forth to investigate the potential dielectric benefit of such newly emerging materials, many uncertainties remain unanswered, and much remains to be explored [2].

Current experimental work is to investigate the preparation of nanodielectrics via solution blending approach. Polyethylene blend composed of 20wt% of high density polyethylene (HDPE) in low density polyethylene (LDPE) is proposed as the base polymer, with varying content of nanosilica (between 0wt% and 10wt%) as the fillers. Although expensive, solution blending method, when compared with melt compounding method, is expected to provide better dispersion of nanoparticles in polymers, thus providing qualitative data in understanding the behaviour of nanodielectrics [3].

Upon successful preparation of polyethylene nanocomposites, breakdown strength based on ASTM Standard D149-87 is to be conducted to determine the feasibility of such dielectric materials in engineering point of view. Figure 1 illustrates the schematic diagram of the breakdown test configuration. The samples are placed between two 6.3mm diameter steel ball bearings immersed in silicone fluid. AC voltage at a preset ramp rate will be applied until the samples fail and the values of breakdown voltages will be recorded and analysed using two-parameter Weibull distribution. Based upon top-down research approach, the underlying physics and chemistry associated with dielectric property changes will then be explored.

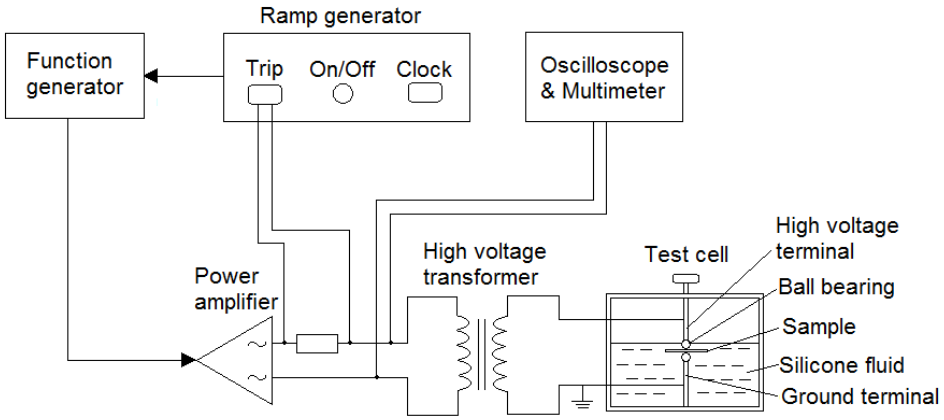

Figure 1: Dielectric breakdown test configuration.

[1] T. J. Lewis, ''Nanometric Dielectrics'', *IEEE Transactions on Dielectrics and Electrical Insulation*, vol. 1, no. 15, pp. 812-825, 1994.

[2] M. F. Frechette, A. Vijh, L. Utracki, M. L. Trudeau, A. Sami, C. Laurent, P. Morshuis, A. S. Vaughan, E. David, J. Castellon, D. Fabiani, S. Gubanski, J. Kindersberger, C. Reed, A. Krivda, J. Fothergill, F. Guastavino and H. Alamdari, "Nanodielectrics: A Panacea for Solving All Electrical Insulation Problems?" *IEEE International Conference on Solid Dielectrics*, 2010.

[3] T. Tanaka, G. C. Montanari and R. Mülhaupt, "Polymer Nanocomposites as Dielectrics and Electrical Insulation – Perspectives for Processing Technologies, Material Characterization and Future Applications", *IEEE Transactions on Dielectrics and Electrical Insulation*, vol. 11, no. 5, pp. 763-784, 2004.