A Raman Microprobe Study of Corona Ageing in a Controlled Atmosphere

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Raman microprobe spectroscopy is widely used in the analysis of polymers due to its high spatial resolution and its ability to characterise the exact chemical composition of a material and, for this reason, it can be applied to study electrical ageing in solid dielectrics. For example, it enables us to probe the chemical processes involved in electrical treeing, whereby solid polymer is converted into decomposition products through a number of electrical processes [1].

This study takes a novel approach to this problem through ex-situ experiments that seek to reproduce the chemistry of electrical treeing in bulk. Plaque specimens of a range of polymers, including polyethylene, polystyrene, PEEK and silicone rubber, were subjected to surface ageing via corona discharge, and the residual products on both the sample surface and the high voltage electrode (as seen in figure 1) were characterised by Raman microprobe spectroscopy. These experiments were performed as a function of applied voltage, electrode geometry etc both in air and within a closed cell that enabled the atmosphere to be controlled and adjusted. The resulting Raman fingerprints were compared with those previously identified within electrical trees [2,3].

After corona discharge was applied to the samples, despite a large change in surface texture, no residues were seen on the sample and few chemical changes were detected via Raman spectroscopy, thus implying that erosion of the material occurs by fragmentation of the polymer. Analysis of the electrodes aged in air and nitrogen, revealed varying evidence of sp^2 hybridized carbon, and fluorescence, both of which are products previously associated with the processes involved in electrical treeing. The similarity in these results and previous published works [2,3] suggest that there are common processes involved between corona surface ageing and electrical treeing especially when an inert atmosphere is used.

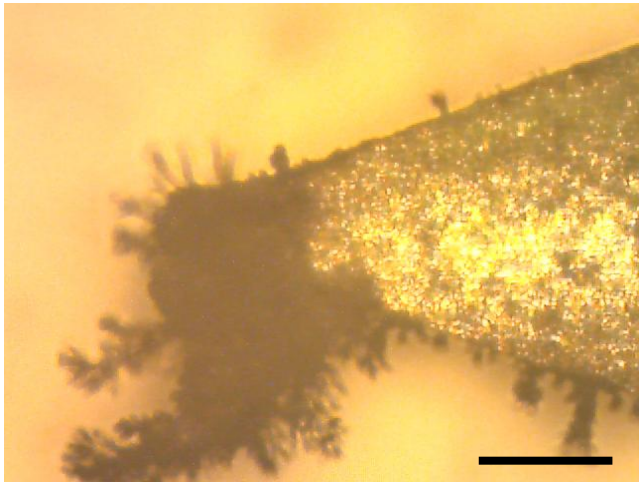

Figure 1: Optical image of deposit found on electrode of aged Si rubber (scale bar = 10µm).

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[2] X.S. Liu, A.S. Vaughan, and G. Chen, "A Raman spectroscopic study of bulk and surface ageing phenomena in polyethylene". Annual Report Conference on Electrical Insulation and Dielectric Phenomena: p. 145-148, 2003.

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