A Comparison between Electroluminescence Models and Experimental Results

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Electrical insulation ages and degrades until its eventual failure under electrical stress. One cause of this relates to the movement and accumulation of charge within the insulation. The emission of a low level of light from polymeric materials while under electrical stressing occurs before the onset of currently detectable material degradation. This light is known as electroluminescence (EL) and under an ac electric field is thought to relate to the interaction of charge in close proximity to the electrode-polymer interface. Understanding the cause of this light emission gives a very high-resolution method of monitoring charge interaction and its influence on material ageing.

A possible cause of this light emission is the bipolar charge recombination theory. This theory involves the injection, trapping and recombination of charge carriers during each half cycle of the applied field [1]. This work compares two models that to simulate the EL emission according to this bipolar charge recombination theory. Model 1 assumes a fixed space charge region and all injected charge is uniformly distributed in this region with charges able to either become trapped or to recombine with opposite polarity charge carriers [2]. This recombination relates directly the excitation needed for the emission of a photon of light as measured in experiments. Model 2 develops on this by accounting for the transport and extraction of charge with an exponential distribution of trap levels rather than a uniform distribution [3]. Figure 1 shows a good correlation between the two models and experimental data. The full paper will describe the models in more detail and present results comparing the simulated and experimental results under various applied waveforms. Model 1 and model 2 both provide a good correlation with experimental data but model 2 allows a greater understanding of the space charge profile in the region close to the electrodes as well as the shape of the conduction current.

Further work involves developing these models to support changes in the charge trapping profiles due to material ageing and supporting simulated results with measured conduction current.

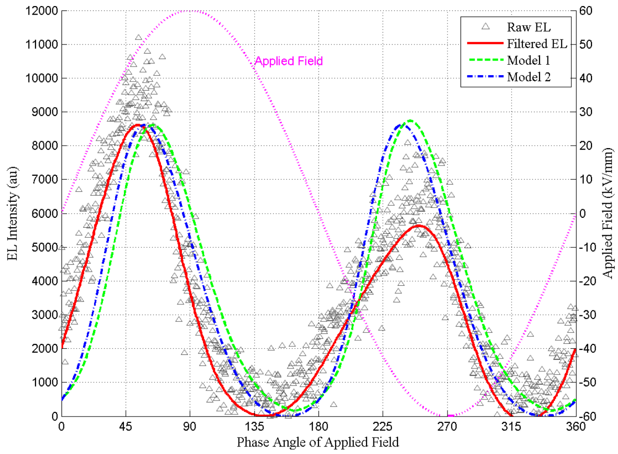

Figure 1: Phase resolved electroluminescence emission and simulation results under a 50Hz sinusoidal $6kV_{pk}$ applied field

[1] A. Mohd Ariffin and P. L. Lewin, “Phase-Resolved Measurement and Modelling of Electroluminescence Phenomenon in Polyethylene Subjected to High Electrical Stress”, *International Conference on Condtion Monitoring and Diagnosis*, 2008

[2] A. Mohd Ariffin, N. Mat Tajudin, S. Sulaiman, et. al., “Comparing Simulation Results and Experimental Measurements of Electroluminescence Phenomenon in Dielectric Materials”, *IEEE International Symposium on Electrical Insulation*, 2010

[3] F. Baudoin, D. H. Mills, P. L. Lewin, et. al., “Contribution to the Modelling of Electroluminescence in High Voltage Polymeric Materials”, *Conference on Electrical Insulation and Dielectric Phenomena*, 2010