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Effect of the Vertical Pressure on the Electrical Behaviour of the Micro-Copper Polyurethane Composite Films

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Abstract : Abstract- Materials with a combination of transparency, electrical conductivity, and flexibility are required in the growing electronic sector. In this research, electrically conductive and flexible films have been prepared. These composite films consist of dispersing micro-copper particles into polyurethane (PU) matrix. Two sets of samples were made using both spin coating technique (sample thickness lower than 30 µm) and materials casting (sample thickness lower than 100 µm). Copper concentrations in the PU matrix varied from 0.5 to 20% by volume. The dispersion of micro-copper particles into polyurethane (PU) matrix were characterised using optical microscope and scanning electron microscope. The electrical conductivity measurement was carried out using home-made multimeter set up under pressures from 1 to 20 kPa through thickness and in plane direction. It seems that samples made by casting were not conductive. However, the sample made by spin coating shows through-thickness conductivity when they are under pressure. The results showed that spin-coated films with higher concentration of 2 vol. % of copper displayed a significant increase in the conductivity value, known as percolation threshold. The maximum conductivity of 7.2 × 10-1 S•m-1 was reached at concentrations of filler with 20 vol. % at 20kPa. A semi-empirical model with adjustable coefficients was used to fit and predict the electrical behaviour of composites. For the first time, the finite element method based on the representative volume element (FE-RVE) was successfully used to predict their electrical behaviour under applied pressures.

Keywords : electrical conductivity, micro copper, numerical simulation, percolation threshold, polyurethane, RVE model
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