Proceedings of the Canadian Society for Mechanical Engineering International Congress
32nd Annual Conference of the Computational Fluid Dynamics Society of Canada
Canadian Society of Rheology Symposium
CSME-CFDSC-CSR 2025
May 25–28, 2025, Montréal, Québec, Canada

EXTENSIONAL RHEOLOGY OF PP/PS/MWCNT ELECTRICALLY CONDUCTIVE POLYMER COMPOSITES: IMPACT ON ELECTRICAL PROPERTIES

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ABSTRACT

Polymer blends with co-continuous morphologies have gained significant attention due to their potential as electrically conductive materials when filled with conductive fillers, such as carbonaceous nanoparticles. These advanced materials are widely used in applications such as electronics, sensors, energy storage devices, and electromagnetic (EM) shielding. The co-continuous structure of these blends enables efficient distribution of conductive fillers, achieving what is known as double percolation. In this state, the filler is primarily located within one polymer phase or at the interface between phases, significantly reducing the percolation threshold – the critical concentration needed for the material to exhibit electrical conductivity. This not only improves performance but also reduces production costs by minimizing filler usage. Despite these advantages, the electrical properties of such composites can be significantly affected during processing and post-processing. Deformations encountered in manufacturing processes like film extrusion, blow molding, and other techniques can disrupt the conductive network, leading to a deterioration or the complete disappearance of electrical conductivity. Therefore, understanding how extensional and shear flows impact the electrical performance and morphology of these composites is crucial for optimizing their functionality in end-use applications such as EM shielding and electronics packaging. In this study, the extensional rheology of polypropylene/polystyrene blends filled with multiwall carbon nanotubes (PP/PS/MWCNT) was systematically investigated. Composites with varying MWCNT concentrations (0–5 wt.%) were prepared using conventional melt mixing. Transient stress growth experiments were conducted at various Hencky strain rates using a universal extensional fixture (UXF) on an Anton Paar MCR 702e TwinDrive rheometer. Extensional results were compared to shear rheology findings to examine differences in electrical properties. The evolution of electrical conductivity during applied shear deformation was monitored using a rheometer coupled with an impedance meter, while changes in conductivity following extensional deformation were evaluated with the 4-probe method.