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Hybrid Carbon Black/Carbon Fiber Polymer Composites: Effect of Particulate and Fibrilar Filler Combined Presence on the Structure and Electrical Behavior

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Electrically conductive polymer composites continue to be of scientific and technological interest. Decreasing the filler percolation content and increasing the electrical conductivity continue to be a challenge. Composites based on polymers as a matrix and conductive fillers, particulate or fibrilar, have been quite intensively studied. In the present study electrical conductivity and morphology of injection molded polypropylene based composites containing two conductive fillers, carbon black (CB) and carbon fibers (CF) were studied. Injection moldings containing both, CB and CF, where the content of each filler was above its own percolation threshold, resulted in similar or lower values of overall composite volume resistivity compared with the resistivity of systems filled only with CB at the corresponding content. However, the resistivity of two-filler systems was always higher than the resistivity of systems filled only with CF at the corresponding content. The morphology and fiber length analysis of the injection molded composites were quite intriguing. Fiber orientation in the injection molded two-filler systems was found to be almost perpendicular to the melt flow direction, with no significant skin-core fiber orientation patterns, contrary to the typically observed fiber orientation in injection molded fiber filled composites. Moreover, the CF breakage in the presence of the CB was found more intense than when just CF was used, resulting in shorter fibers with narrower length distributions. This unexpected fiber behavior is responsible for the unexpected electrical behavior. However, the coexistence of CB and CF electrically conductive networks, supporting each other, was confirmed, in spite of the mechanical disturbances caused by the combined presence of fibrilar and particulate fillers. Of interest is the effect of the particulate CB presence on the orientation and length distribution of the CF. A flow pattern is proposed to explain these observations.