The Role of Bernard-Marangoni Instability on the Percolation Scaling of Electrical Networks in Polymer/MWCNTs Hybrid Films

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We employed various amorphous polymers such as polycarbonate, poly(methyl methacrylate), polystyrene, and poly(styrene-co-acrylonitrle) and MWCNTs to fabricate transparent, electrically conductive polymer/CNT hybrid films. In solution casting process, some films showed ring-shaped cells composed of MWCNTs. These cells were formed by Bernard-Marangoni instability during solvent evaporation. We found that the electrical conductivity of hybrid films strongly depends on the shape of Bernard-Marangoni cells. There may be two driving forces on the Bernard-Marangoni instability; surface tension gradient and buoyancy. The surface tension gradient is affected by temperature and concentration; Ma_T, Ma_C. All polymer/CNT hybrid films used in this study showed the lowest surface resistivity near the value of Ma_T 25 which is onset point of instability. We present a percolation scaling model for the explanation of these phenomena.