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Electrical percolation threshold in Ag–DLC nanocomposite films prepared by RF-sputtering and RF-PECVD in acetylene plasma

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Abstract

Silver–diamond like carbon (Ag–DLC) nanocomposite films were deposited on glass and silicon substrates by co-deposition of RF-sputtering and RF-PECVD method in acetylene plasma. The effects of deposition time on creation of conductive percolation pathway in Ag–DLC nanocomposite films were investigated. The films were characterized by XRD pattern, AFM images, UV–Vis and FTIR spectra. Pressure of chamber's variation over time was illustrated the rate of carbon and silver deposition changing. The results showed that nanoparticles' size and surface roughness was increased by increasing deposition time. Surface plasmon resonance peak's red shift in optical absorption spectra of samples could be depends on silver nanoparticles' scale up. Based on electrical measurements, electrical percolation threshold was observed only in the film with 35 min deposition time. Pathway was created for electric current by Ag nanoparticles' moving in carbon matrix due to sp3 bonds and silver content in the films. The aging effect was studied for sample #2 in the threshold of percolation, where obtained Ag nanoparticles memorize its previous pathway. This investigation provides a better understanding for electric properties of Ag–DLC nanocomposite based on the percolation theory.