380d Film Deposition on Electrostatically Suspended Nanowires by Pecvd in Dusty Plasma Reactor

Themis Matsoukas and Jin Cao

We have developed a novel radio-frequency glow discharge reactor for the deposition of thin films, ranging from ultra-low thicknesses of few nm to upwards of 100 nm, onto nanowires and submicron particles by dusty-plasma PECVD. We seed the plasma with gold nanowires to produce an electrostatically suspended cloud of airborne particles and then introduce a hydrocarbon to initiate deposition of amorphous hydrogenated carbon films onto the suspended particles. We demonstrate that stable trapping of both particles and nanowires is possible over extended periods of time (up to 90 min in some experiments). In this semi-batch system, particles remain in the plasma throughout the experiment while gaseous reactants are flown continuously. By controlling the deposition time we are able to produce radially uniform coatings with thicknesses that range from 3 nm to more than 150 nm. We present measurements of the deposition rate and show that it obeys a linear growth law. From the distribution of film thicknesses among particles and nanowires we infer the existence of a distribution of deposition rates. A population balance model is formulated which allows us to quantify the distribution of deposition rates. This distribution is wide, quasi-exponential, and its presence is attributed to spatial inhomogeneities within the discharge volume. The behavior nanowires is qualitatively similar to those of spherical particles, used as a control, but the deposition rate on nanowires is about 4 times larger on nanowires. This is attributed to the difference in the charge-to-mass ratio of nanowires versus spherical particles which leads to different spatial distribution in the discharge.