511e A Reaction Model for Plasma Coating of Nanoparticles in Hydrocarbon Plasma

Alexander L. Yarin, Beniamino Rovagnati, Farzad Mashayek, and Themis Matsoukas

A detailed chemical kinetics scheme of the reactions occurring in a CH4/H2 plasma is used to model the deposition of amorphous carbon films onto submicron particle suspended in the plasma. The model includes electron-neutral, ion-neutral and neutral-neutral reactions and solves for the radial distribution of species in the vicinity of the particle. Concentration profiles are obtained by solving simultaneously the diffusion equation for all species that deposit on the particle surface, and the Poisson equation for the charge-carrying species. To accommodate the low-pressure environment, the continuum equations are solved to within one mean-free path from the particle surface while kinetic theory is used to treat phenomena inside the vacuum sphere, namely, at distances shorter than one mean-free path. The solution is then obtained by matching the kinetic and continuum calculations at the edge of the vacuum sphere. The calculation produces the distributions of charged and non-charged species, the mean particle charge, and the deposition rate of hydrogenated amorphous carbon. We present calculations at various plasma conditions and discuss the results and the observed trends in light of available experimental data.