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Controlling Composition of Particles Grown in Dusty Plasmas[1]
STEVEN LANHAM, JORDYN POLITO, XUETAO SHI, PAOLO ELVATI, ANGELA VIOLI, MARK J. KUSHNER, Univ. of Michigan — Low pressure plasmas are appealing for growing high quality nanoparticles (NPs) with customizable properties including size and chemical composition. Due to the highly non-equilibrium plasma environment, NPs may be produced with compositions difficult to achieve through traditional methods, for example core-shell and hyper-doped. The flux of reactive species to the NPs can be tuned based on the plasma operating conditions. However, the reactivity of species which grow NPs can be functions of the surface composition which in turn depends on the plasma conditions. In this work, results of a computational investigation of growing silicon containing NPs in laboratory plasmas sustained in Ar/SiH_4 at pressures of a few Torr will be discussed. A 3D kinetic model for dust particle trajectories and growth, the Dust Transport Simulator (DTS), was coupled with a multi-fluid plasma simulator, the Hybrid Plasma Equipment Model (HPEM), for this work. Kinetic algorithms have been added to the DTS to track the composition of NPs and account for changing effects of surface reactivity on growth rates. Reactive sticking coefficients for small silane radicals (e.g., SiH_x) with larger NPs were obtained from Molecular Dynamics simulations. Results for growth rate and composition of Si NPs as a function of process parameters – power, flow rate, gas mixture – will be discussed, as well as the potential for growing more complex NPs.

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