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Plasma-surface interactions: relationships between gas phase chemistry and film growth

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In direct continuation of previous work, a coaxial injection microwave excited plasma torch operating at atmospheric pressure is applied to synthesizing of nanometer and micrometer thick SiOxHyCz films from hexamethyldisiloxane precursor on Si(100) substrates. Herein we report on the plasma-surface interactions related to each stages of film growth. In a first part, we investigate the atomistic processes occurring in the early stages of film growth and their relationships with the plasma chemistry. In this way, the physical principles of nanoscale assembly processes are examinated and correlated with OES plasma phase diagnosis in the vicinity of the substrate surface. The involved surface mechanisms include adatom diffusion on terraces, along edges and around island corners; nucleation and dynamics of the stable nucleus; atom attachment to and detachment from terraces and islands. Our results show that plasma-controlled self-assembly is a promising way to design large regular arrays of nanostructures. In a second part, characterizations of micrometer thick SiOxHyCz films are performed and strong links with initial stages of film growth are established. Based on experimental results, a film growth scenario with deposition time is finally proposed and supported by hydrodynamic numerical simulations of the plasma jet.

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