Carbon And Tungsten Nanoparticle Growth In Sputtering DC Discharges

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Low pressure, low temperature plasmas can generate particulates from complex chemical reactions, which develop up to the appearance of solid particles. Extensive analysis were devoted to the formation of silicon nanoparticles in silane-based RF plasmas, relevant for PECVD applications [1,2]. The formation of carbonaceous nanoparticles was also investigated either in hydrocarbon RF plasmas [3,4] or from the sputtering of RF graphite cathodes [5]. Researches on this topic in other ionization systems remained for a long time weak or inexistent.

We report on the nanoparticle formation in DC discharges. We study the growth of carbon and tungsten nanoparticles from cathode sputtering by argon plasmas. Low frequency instabilities due to the agglomeration growth as well as the void instability that take place in RF discharges [6] are not observed in DC discharges. On the other hand, the growth features in sputtering DC discharge depend on the cathode material, graphite or metal. We also show that the electrostatic coupling between the plasma and growing nanoparticles presents characteristics according to the sputtered material [7,8]. In particular, for a fixed discharge current, the loss of free electrons in the plasma during the nanoparticle charging is compensated by a spontaneous increase of the discharge voltage and consequently by an increase of the gas discharge ionization in the negative glow. When tungsten is used, the electron loss is compensated by the tungsten ionization (low ionization potential of tungsten compared to that of carbon) during relevant plasma duration and not by an increase of the discharge voltage.

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