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Tracking of cycling growth of hydrocarbon plasma polymer nanoparticles by in situ diagnostics

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Recent works have shown the potential applicability of gas aggregation cluster sources (GAS) for the synthesis of plasma polymer nanoparticles (NPs). However, deep understanding of the fundamentals of the NP formation is still lacking because the research has been focused mainly on ex-situ analysis of the NPs rather than on the processes taking place inside the cluster source. In this work, we simultaneously employed optical emission spectroscopy, mass spectrometry and digital camera to monitor in situ the phenomena occurring during the synthesis of hydrocarbon NPs by plasma polymerization of n-hexane. The voltage on the electrode and the deposition rate of the NPs were also real-time tracked. A 3-inch RF electrode was operated at a constant power of 50 W in a 4.6 % mixture of n-hexane with argon. Cycling instabilities in the deposition process were detected. The temporal measurement of both the voltage and the deposition rate revealed the period of oscillations to be about 80 s. These oscillations correlated with the instabilities observed in the mass spectra where analogous oscillations of the n-hexane molecular peak were detected. The temporal instabilities were further proved by optical emission spectra in which the intensity of the Ar spectral line was seen to oscillate with the same period. A phenomenological description was suggested to describe the cycling growth of the NPs and their ejection from the discharge zone.
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