Dynamics of a growing dust particle cloud in a direct-current argon sputtering glow discharge

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1. Introduction

The dynamics of a growing tungsten nanoparticle cloud is investigated. The particle are produced from the sputtering of a tungsten cathode in a direct-current (DC) low pressure argon glow discharge. The dust particle size distribution (PSD) and the dust particle concentration are measured by light extinction spectrometry (LES) at different height above the anode. Electron microscopy measurements and Raman spectroscopy of the nanoparticles collected at the centre of the anode are also performed in order to study their shape and composition. Laser light scattering at 90° of a vertical laser light sheet passing through the plasma is used to investigate the dynamics of the dust cloud.

2. Experiment

A detailed description of the experimental set-up is given in Ref.[1, 2]. The tungsten nanoparticles are grown in a dc argon glow discharge initiated between a tungsten cathode of 10 cm in diameter and a stainless-steal grounded anode. A static argon pressure of 0.6 mbar (no gas flow) is set during the experiments.

LES consists in passing through the cloud of particles to be analysed, a collimated and polychromatic beam with spectral intensity $I_0(\lambda_i)$ and wavelengths λ_i. The directly transmitted spectral intensity $I(\lambda_i)$ is collected and directed towards a spectrometer via an optical optical system with a small acceptance angle. The beam transmission T_{λ_i} is given by: $T_{\lambda_i} = I(\lambda_i)/I_0(\lambda_i) = \exp(-\tau(\lambda_i) \cdot L)$ where L is the probing distance and $\tau(\lambda_i)$ is the particle system turbidity. The turbidity is the product of the particle number concentration N and the mean extinction cross section of the particles, which are illuminated by the probing beam. The mean extinction cross section is an integral quantity depending on the properties of each particle and its statistical weight in the particulate medium. From the measured transmission spectra, it is thus possible to recover the dust particle concentration and the PSD. Details about the inversion procedure can be found in [3].

3. Results

Laser light scattering of a vertical laser sheet, set above the anode showed that the dust cloud was pushed towards the edge of the discharge and the anode[2]. In addition, the evolution of the PSD and particle concentration were studied by LES (see Fig.1). This diagnostic, based on the polychromatic analysis of the transmited light through a dust cloud has revealed a phase of growth by agglomeration, followed by the appearance of a second nanoparticle generation. Results have also shown that the latter appeared in the space freed by the first nanoparticle generation.

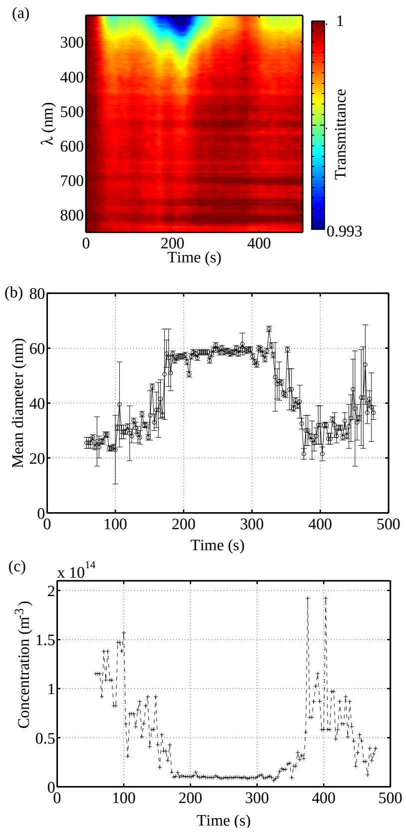

Fig. 1: *(a) Evolution of the transmittance at different wavelength as a function of time, 2.8 cm above the anode for a 500 s discharge. (b) Recovered evolution of the particle mean diameter. (c) Recovered evolution of the dust particle number concentration.*

References

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[3] F. Onofri, S. Barbosa, O. Toure, M. Woniak, and C. Grisolia, 2013, *J. Quant. Spectrosc. Radiat. Transfer* **126**, pp 160.