Time resolved analysis of low pressure misty plasmas used for nanocomposite thin film deposition

S. Chouteau[1,2], A. Durocher-Jean[2], M. Richard-Plouet[1], A.Granier[1], L. Stafford[2]

[1] *Institut des Matériaux de Nantes Jean Rouxel, Nantes, France*

[2] *Département de Physique, Université de Montréal, Québec, Canada*

Misty plasmas have recently emerged as a promising tool in the context of nanocomposite (NC) multifunctional thin films deposition. Among the many strategies aiming for the growth of high quality nanocomposite thin films, combining sol-gel-synthesized nanoparticles and plasma has been shown to be quite attractive [1]. In these 'misty' plasma experiments, liquid colloidal solutions are injected as droplets during matrix deposition, as a direct supply of nanoparticles. We recently developed such a hybrid reactor, operating in the mTorr range, for the growth of high-purity inorganic nanocomposites. Deposition of NC films made of anatase nanoparticles (provided by a colloidal solution containing methanol and propylene carbonate as solvents) embedded in a SiO_2 matrix was investigated [2]. Although NC film growth is now fairly well understood [3], the impact of liquid injection itself on the plasma species still calls for attention.

In this work, 1-ms pulses of various pure liquids (water, methanol, propylene carbonate) were injected in 3-mTorr inductively coupled rf plasmas (ICP) generated from pure Ar. Optical emission spectroscopy is used to probe the temporal evolution of three fundamental plasma parameters during pulsed liquid injection in an inductively coupled argon plasma at low-pressure. Time-resolved measurements of metastable argon density, electron temperature, and electron density are determined from radiation trapping analysis and particle balance equations of selected argon 1s and 2p levels [4]. Pulsed liquid injection is found to induce a sudden drop in metastable density and electron temperature, and an increase in electron density. These results are attributed to the lower ionization thresholds of the injected molecular species compared to the one of argon.

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