Spectroscopic investigation of carbon and tungsten dust in magnetized and non-magnetized hydrogen plasma

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1. Introduction

For instance, in the context of fusion device, the presence of dust has become an important topic considering potential safety hazard and plasma contamination [1]. The ITER Organization proposed to begin operation with a full-tungsten armoured divertor regarding his low erosion yield and low retention characters with hydrogen. However, surface morphology changes due to particle loading, e.g. blistering, cracking, could enhanced erosion and promote dust production [2]. Data on the mechanisms and sources of tungsten dust production are not yet identified and investigations are needed to predict dust inventory and consequence in plasma stability. The study of dust is less convenient in fusion device because of technological restrictions that prevent the use of relevant diagnostic related to dust. We propose here to study the mechanisms of dust formation in heterogeneous phase using carbon and tungsten targets (biased) exposed to argon and hydrogen plasma. The study of carbon dust growth was undertaken to provide a set of reference conditions and methods to allow a better understanding of tungsten dust formation considering the facility to synthesize carbon dust.

2. Experimental

We focus our work on low pressure high density microwave discharge. The device is capable of reproducing flux and ion energies comparable to estimated characteristics of the far edge plasma at ITER divertor [3]. The plasma produced was basically low-temperature non-equilibrium plasma with smooth distribution of the plasma characteristics. We can use types of microwave source, a magnetized source (ECR) and non-magnetized source to predict the influence of magnetic field in dust dynamic. The formation of carbon nanoparticles was investigated using infrared quantum cascade laser absorption spectroscopy (QCLAS), mass spectrometry (MS) and laser extinction/diffusion method. The combined use of these diagnostics allow to access to information about species which playing a role in carbon dust formation besides being able to access to dust dynamic. For tungsten dust studies, we have used Optical Emission Spectroscopy (OES) and laser extinction/diffusion method.

3. Results

First results indicate that carbon and tungsten dust can be synthetised from the surface material even if the pressure is too low to initiate nucleation process. We also saw that obtained dust exhibit a particular behaviour with unusual high velocity in magnetized environment. The figure 1 presents a picture of dust dynamic obtained by diffusion of carbon particle by laser sheet (90°) in magnetized plasma and a typical laser extinction spectrum (with 2 same experiment to prove the repeatability of the process).

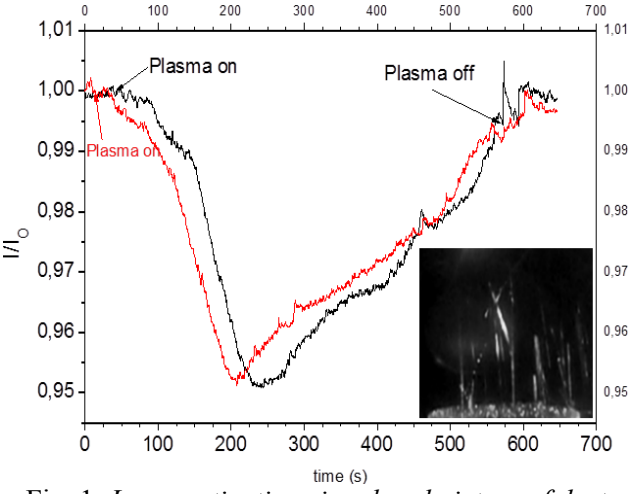

Fig. 1: *Laser extinction signal and picture of dust with high velocity*

These results will be discussed and a mechanism of dust production will be proposed by mean of spectroscopic investigation as well as dust dynamics in magnetized plasma according to laser extinction/diffusion results.

References

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[3] Ouaras, K., et al., Journal of Plasma Physics, 2014. **80**(Special Issue 06): p. 833-841.