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Interaction of low energy carbon ions with tungsten surface

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Synopsis We performed measurements using low energy carbon ions (200 eV and 1000 eV) as projectile and tungsten surface as target. The main aim of our work was to get data for the sputtering yields in this projectile and target combination. Surprisingly, instead of the weight loss of the target material, we obtained weight gain. We also observed an interesting energy dependent feature of the process.

In our work we used the experimental set up shown schematically in fig.1 [1]. Measurements were performed in the plasma chamber of a Secondary Neutral Mass Spectrometer (SNMS), (model SPECS INA-X). The sputtering ion beam was extracted from a radio-frequency CH_4 gas-plasma. The plasma was sustained at a pressure of 1 x 10^{-3} mbar and at an RF power of ~ 150 W. Using the mass spectrometer, we identified the main ionic species of the plasma as H^+ and CH_x^+ (x=0-4) ions, which are the products of the dissociation of CH_4. The predominant (80%) ion component of the plasma was the CH_3^+ ion. The experimental sample configuration within the plasma chamber is also shown in Fig.1. A circular shielding aperture (diameter: 11 mm) was mounted in front of the plane of the sputtered tungsten plate. The sample was placed just below this aperture; the sample-plasma distance was 1.5 mm. The specimen is electrically insulated from the shielding aperture, which is at the same potential as the walls of the plasma container. When the sample is negatively biased with respect to the plasma, an ion current is extracted (~1 mA), which impinges at normal incidence onto the sample surface (~1 cm^2). During the sputtering, the temperature of the sample did not exceed the temperature of 100º C. The tungsten plate was weighed on Sartorius M3P electronic microbalance before and after bombardment in order to determine the mass change. After sputtering, a weight increase was detected at both ion energies. At 200 eV for 40 minutes and at 1000 eV for 20 minutes sputter time, the weight surplus was 65 μg and 75 μg, respectively [2]. According to the SNMS investigations, the weight increase was caused by a gradually deposited carbon layer on the surface of tungsten plate. The carbon film was transparent (diamond like) at the ion energy of 200 eV. In contrast to this finding, at 1keV projectile energy, a graphite-like, not transparent film was observed on the tungsten surface.

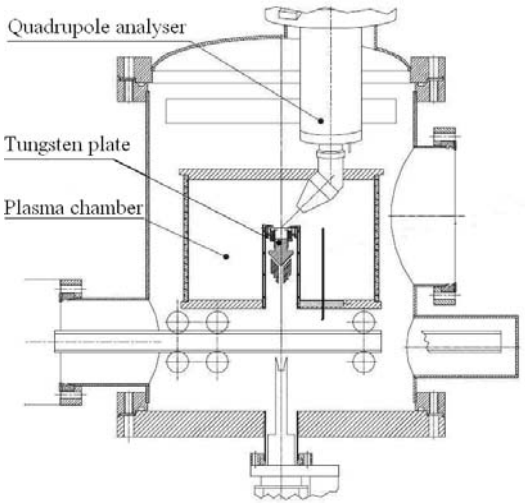

Fig.1. Schematic diagram of the experimental set up.

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