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The dust from arcing on nanostructured tungsten surface

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In recent studies, arcing was found to occur on the surface of nanostructured tungsten (W) by combined exposure to pulse and steady-state plasmas [1]. Arcing can be a great impurity source in fusion devices. However, little is known about the formation of dust from the sample due to arcing. Therefore, in this study, arcing was induced on a nanostructured W sample by pulsed plasma exposure in the Pilot-PSI device to investigate dust formation.

Pure W samples (Nilaco Co. Ltd.) with diameter and thickness of 30 mm and 1 mm, respectively, were used for the experiments. After polishing the samples, the nanostructures were prepared by the exposure to helium plasma in the linear plasma device NAGDIS (NAGoya DIvertor Simulator)-II. The incident ion energy was controlled by the biasing voltage and was approximately 75 eV. The exposure was conducted at a surface temperature of about 1330°C with an ion flux and fluence to the samples of 1.1×10^{22} $m^{-2}s^{-1}$ and 8.0×10^{25} m^{-2}, respectively. The prepared nanostructured W samples were exposed to hydrogen (H) pulse and steady-state plasmas in Pilot-PSI. The pulse duration was ~1 ms. Fig.1 shows the experiment set-up of Pilot-PSI. The sample was at the floating potential, which was monitored during the exposure in Pilot-PSI. The surface temperature was measured with a fast infrared (IR) camera (FLIR SC7500-MB). The emissivity for the IR camera was fixed at ε= 0.99, which was assumed for the nanostructured W. The magnetic field was lasted for a duration of 5 s and the surface temperature was maintained below 800 °C. The pulse plasma was triggered ~2.5 s after the start of the H plasma exposure. The temperature of the sample increases during the pulse, which has a duration of 1 ms. The sample surface was observed with a fast visible camera (Phantom v12.1). A spectrometer monitored the emission lines of W and H. The electron temperature and density were measured by Thomson scattering. In order to collect dusts ejected from the sample, several aluminum plates were placed in the Pilot-PSI vacuum chamber. After the exposure, surface and the cross-section of the sample were analyzed by using FE-SEM (Field Emission Scanning Electron Microscope) and FIB (Focused Ion Beam).

By the simultaneous exposure to H pulsed and steady-state plasmas, arcing occurred on the surface of the nanostructured W. Arcing was initiated and was observed in the periphery of the pulsed plasma exposed area. In addition, dusts from the sample surface was observed by the fast camera during the pulse plasma exposure (Fig. 2). In addition, WII line (385.15 nm) was observed by the spectrometer. The results support the fast camera results that the W dust released from nanostructured W sample surface.

[1] M. Yajima, *et al.* (submitted to Fus. Eng. Des.).

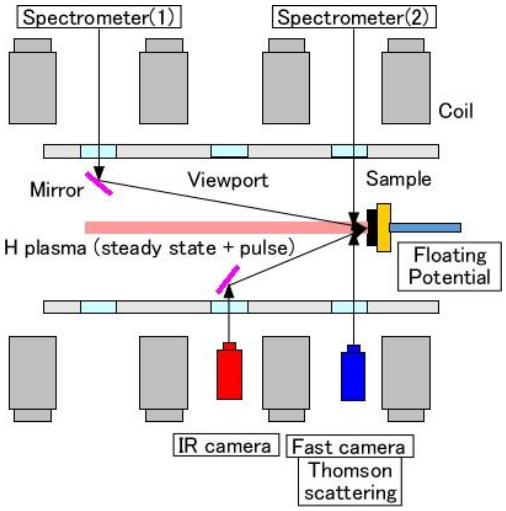

Fig.1) The experiment set-up of Pilot-PSI.

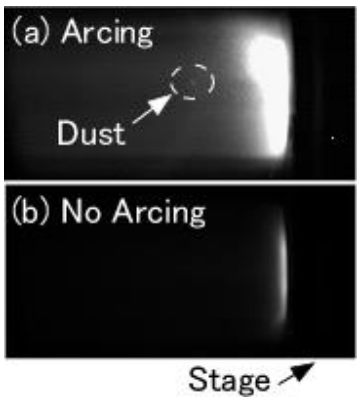

Fig.2) Observation of sample surface during pulse plasma exposure.