§39. Application of Intense Particle and Laser Beam Apparatuses to Surface Ablations of Reactor Plasma Facing Components

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The reactor plasma facing components are ablated with the high flux pulsed radiations of various kinds including photons and particles. It is very important to know the conditions in reactor chambers after these ablations. In the worst case of IFE, the produced mists of the wall materials remain at the chamber center and prevent the survival of the injected fuel targets. In the worst case of MFE, diverter surfaces cannot survive under the severe conditions of the ITER-ELM modes. We continued to investigate how the candidate materials respond to (1) such intense particle beams (which are produced with the fusion reactions) and to (2) such intense laser lights (which leak from the main laser driver lights to irradiate the fuel targets).

An intense pulsed proton source and various pulsed lasers were used to ablate various sample materials. The surface analyses after the beam irradiations were performed with various diagnostic tools in the various authors' institutes. The most recent results concerning these research works were published, for example in reference [1-2].

Various candidate materials for diverter surfaces were irradiated with an electron beam apparatus at JAEA Naka Laboratory (JEBIS) to investigate the response against the ELM-like electron beam thermal loads [3-4].

The vacuum pressure of the irradiation chamber, electron beam acceleration voltage, current, and time duration were $2x10^{-2}$Pa, 65kV, 2.00A 1ms (or 1.5ms). The thermal loads on the material surface (960-200MW/m^2) were measured with calorimeters simultaneously. The surface craters were measured with a frame camera and a surface profiler. The depth of the crater valley was plotted against a typical surface line. Examples of the results were shown in figures with the abscissa and the ordinate as the ablated depth and the total (accumulation) numbers of shots on the same sample spot. In the case of the heat load with 1ms duration, the ablated thickness of CFC (Carbon Fiber Composite), W and C was about 0, 20 and 120 micron, respectively, and there was no thickness change with the increase of the heat load accumulations on the same spot. On the contrary, the thickness changed from about 150 to 650 micron, with the increase of the heat load accumulations on the same spot from 1 to 20, in the case of CFC with 1.5ms duration. In place of the ablation depth, the total volume of the crater valley was also measured. An additional surface temperature measurement with an infrared camera was also performed to check the qualitative behavior of the surface temperature

There may be graphite surface condition changes from original to amorphous after the above e-beam irradiations in some cases. We investigated our graphite surfaces with a Raman scattering diagnostic tool in Kyushu Univ.. A preliminary result is shown in Fig. 1. The left is the Raman intensity distribution as a function of shifted wave number for the both cases of irradiated and non-irradiated surfaces. These have two peaks, and one of the peak (G-peak) widths vs. the intensity ratio of the both peaks (I_D/I_G) are shown on the right. The cases of our graphite come on the left-lower place, which shows the surface is not amorphous. The other points in the same figure came from various references.

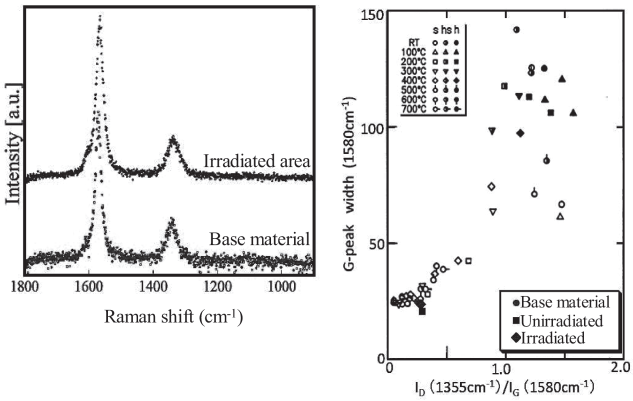

Fig.1. Raman shifted spectra and the analysis.

In November 2007, the first author became a member of Inst. Laser Tech. and Inst. Applied Flows, and retired from Tokyo Tech. in March 2008. One laser and one ion beam machine were moved from Tokyo Tech. to the second branch of Inst. Applied Flows in Isezaki city, Gunma prefecture in March 2008.

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2)Kasuya, K., Ozawa, S., Sato, M., Shimoda, K., et al., Annual Report of National Institute for Fusion Science, (2006) 512
3)Kasuya, K., Ozawa, S., Suzuki, S., Esato, K., Akiba, M., et al., Proc. IEEE Symposium on Fusion Engineering, June 17-21, Albuquerque, NM, USA, OA-4 (2007).
4)Kasuya, K., Norimatsu, T., Tanabe, T., et al., Summary of IAEA Second RCM (CRP-Pathway to IFE), Prague, May19-23, 2008, to be published.