§89. Development of Measurement Method of Tritium Retention in an Individual Dust Particle

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In ITER, metallic dust containing tritium will be produced by erosion of full metal wall by hydrogen isotopes plasma. Due to a technical difficulty of tritium removal from the dust, increase of tritium retention in the vessel will be a great safety concern. Nevertheless, tritium retention behaviors in metallic dust such as alloys and composites of tungsten (W), beryllium and steels are not understood. We have started to develop a safety handling technique of dust containing tritium and measurement method of tritium retention (tritium measurement) in dust using a fine powder sample to simulate dust in fusion devices. In the previous study[1], we have quantitatively observed tritium retention in an individual titanium (Ti) particle with several tens μm in diameter using an imaging plate (IP). In the present study, we have examined tritium retention in W particles with IP and beta-ray induced X-ray spectroscopy (BIXS)[2].

The sample used was polygonal particles of tungsten (W) as shown in Fig. 1. The sizes of the W particle was 50 μm in diameter in average, which were prepared by passing the particles through several mechanical sieves.

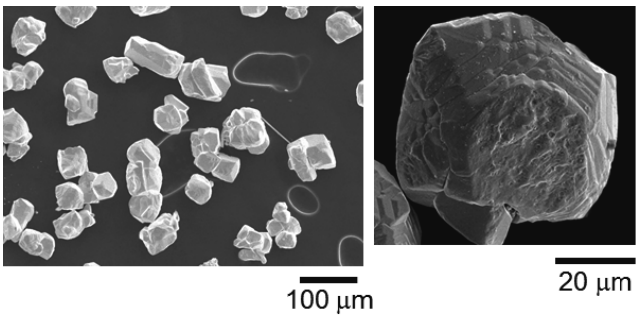

Fig. 1 Microstructures of W particles

Hydrogen including tritium (H(T)) was loaded to the sample particles by gas absorption. The sample particles of several mg in weight were kept in a quartz tube sealed with a fine quartz wool plug to prevent projection hazards during H(T) loading by gas absorption. H(T) loading was conducted at 793 K for 2 h to allow homogeneous H(T) distribution in the sample particles by diffusion. After the loading, the sample particles including T were kept on a storage sheet made of an adhesive rubber to avoid unexpected projection hazards.

T retention in/on W particles was directly observed by a tritium imaging plate technique (TIPT)[1] at Kyushu University. BIXS was conducted for the Ti sample at Hydrogen Isotope Research Center, University of Toyama.

Figure 2 shows T distribution of the W sample. In the figure, T radioactivity was higher as colors becomes from back to white and one pixel was 50 x 50 μm^2. Distribution of spots showing highest T radioactivity well corresponded to that of the individual W particle with 50 μm in diameter. Note that T radioactivity was also observed several tens μm apart from the W particle. This was caused by emission of T β-ray from the surface of W particle through air to IP.

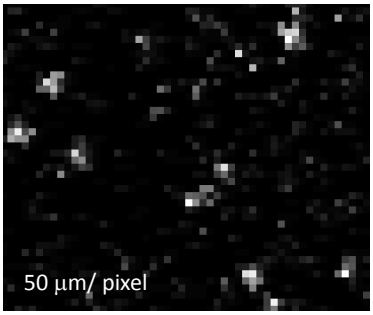

Fig. 2 T distribution in the W sample

Figure 3 shows spectra of BIXS for the W sample. Due to very low tritium retention in the sample, spectra originated from W was very low. Further measurement more than 24 hours will be needed to identify them. Broader spectrum for Ar indicates that tritium may be retained mainly at the surface of the W particles. Note that rather higher spectra around 4.5 keV was attributed to Ti. This was caused by contamination of the W sample with the Ti sample used in the previous study during handling of the samples but showing a potential usage to distinguish T retention in dust composed of several metals or their alloys.

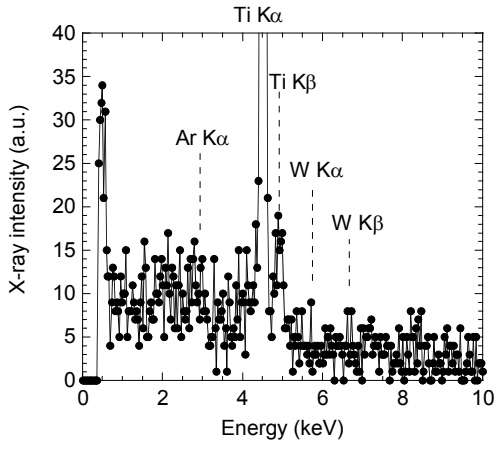

Fig. 3 BIXS spectra for the W sample

1) Otsuka, T. and Hatano, Y.: Phys. Scr. T167 (2016) 014010.
2) Matsuyama, M. et al.: J. Nucl. Mater., (2004) 752.