§94. Development of Measurement Method of Tritium in Dust

Otsuka, T. (Kyushu Univ.),
Hatano, Y. (Univ. Toyama),
Saze, T.

Metallic dust containing tritium (T) will be produced by erosion of full metal wall with interactions of hydrogen isotopes plasma in ITER[1]. 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 fully understood. In the Broader Approach (BA) project, analyses of chemical compositions, microstructures and retention of hydrogen isotopes in the dust produced in the JET ITER Like Wall campaign has been started. The challenge is to clarify correlations of tritium retention with microstructure and chemical composition of the dust. We have started to develop a safety handling technique of dust containing tritium and measurement method of tritium retention in an individual metallic particle simulating dust by means of a tritium imaging plate technique (TIPT)[2].

The sample used was atomized spherical particles of titanium (Ti). Ti was representative of exothermic hydrogen solution metals and was suitable for T retention study in the particle without considerations of T release. The sizes of the Ti particle was 100 μm in diameter (hereinafter referred as Ti-100μm particles), which were prepared by passing the particles through several mechanical sieves.

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. H concentration in the individual Ti particle was adjusted to be 0.8 at%. Since T concentration in the loading gas was $T/H=1.1 \times 10^{-4}$, the amounts of T in the Ti-100μm particle was estimated to be 42 Bq/particle.

Tritium imaging plate technique (TIPT) was conducted as shown in Fig. 1: The sample particles including T were kept on a storage sheet made of an adhesive rubber to avoid unexpected projection hazards during TIPT. Then, T radioactivity, i.e. deposited energy from T β-ray to an imaging plate (IP), was measured for 1 h at room temperature (RT) and two dimensional profile of the T radioactivity was obtained as a T profile. Resolution of the T profile was 50 μm which was a minimum reading pixel of the IP reading apparatus.

Figure 2 (a) and (b) show a photograph and a T profile in the same area for the Ti-100μm particles. In the T profile, T radioactivity is higher as a color changes from blue, green, yellow to red. T radioactivity was highly localized as many spots in a region (2 x 2 pixels). Distribution of the localized spots in the T profile well represented actual distribution of the particles shown in Fig. 2 (a).

TIPT was applied to investigation of T retention in the individual particle made of Ti with 100 μm in diameter. Distribution of T radioactivity obtained by TIPT well corresponded to that of the particles, demonstrating that TIPT is a very useful tool to identify location of dust and its T retention characteristic in practical cases of dust analyses in fusion experimental devices.

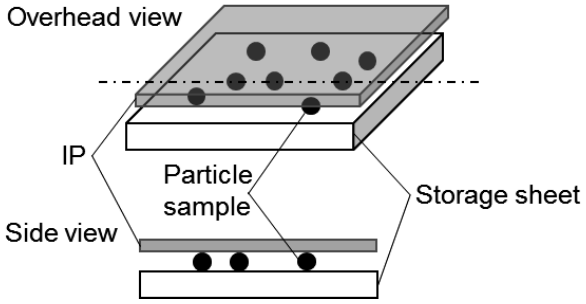

Fig. 1. Schematics of TIPT

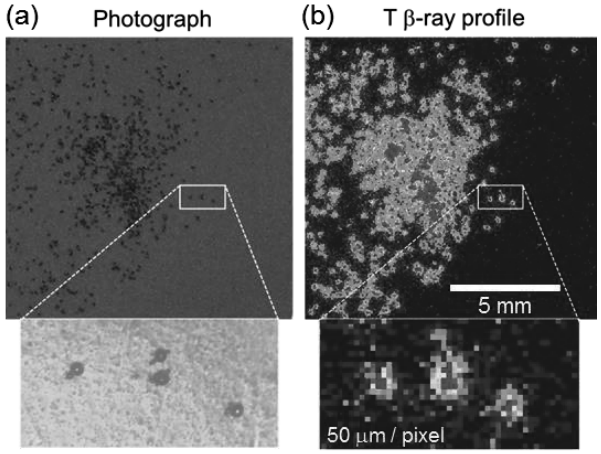

Fig. 2. (a) Photograph and (b) T profile for the Ti-100μm particles

1) Winter, J.: PHYSICS OF PLASMAS 7 (2000) 3862.
2) Otsuka, T., et al.: J. Nucl. Mater. 415 (2011) S769.