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Comprehensive Analysis of Metal Dust Particles in JET-ILW, and Impact on Fusion Reactor

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Generation and accumulation of metal dust particles are important issues in material migration of the Plasma Facing Components (PFCs) such as tungsten (W) and Beryllium (Be) from viewpoints of the plasma operation, maintenance and safety in accidents for ITER and Demo. On the other hand, analysis results of the material components and the internal structure of the dust particle are few because plasma experiment devices are limited and analysis procedures/devices are not well established. Analysis results of, in particular, Be dust particles are important for ITER, which have not been reported.
A comprehensive analysis of collected dust and divertor tiles in the Joint European Torus (JET) ITER-like Wall (ILW) after the first campaign in 2011-2012[1] has been carried out at the International Fusion Energy Research Centre (IFERC) in order to identify dust characteristics such as structures, material components and hydrogen isotope retention. After the first campaign of the JET-ILW operation in 2011-2012, dust particles were collected from 92% of the divertor surface area. Totally about 1 gram was collected: 0.7 g and 0.3 g from the inner and outer divertors, respectively [1]. The analysis started from a large-size dust flake, i.e. 40-120 micron, to determine material components both on the surface and in the cross-section by cutting the dust particle using a focused ion beam. For the flake-type Be-base dust particle, it was found that the damaged Be crystal structure contained a larger oxygen component near the surface (˜2 micron) measured by transmission electron microscopy and electron probe micro analyser, respectively. Deuterium (D) retention in small weight of dust particles (4.4 mg) was evaluated to be 1.2 x 10ˆ21 atoms/g by thermal desorption spectrometry, which corresponds to 8.2 x 10ˆ20 atoms for all dust particles collected from the inner divertor (0.7 g). This result firstly suggests that contribution of dust particles to the total retention in experiment is small, i.e. less than 1% of the total retention in deposition layers of the inner divertor target.
In this paper, a detailed characterization, which is a relationship between retained hydrogen isotopes and compositions of JET-ILW dust particles, will be presented.
[1] A. Widdowson, et al., Phys. Scr. T159 (2014) 014010.

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Primary author: Dr ASHIKAWA, Naoko (National Institute for Fusion Science)

Co-authors: Dr BARON-WIECHEC, Aleksandra (UKAEA); Dr WIDDOWSON, Anna (UKAEA); Dr HAMAGUCHI, Dai (Japan Atomic Energy Agency); Mr KUROTAKI, Hironiri (Japan Atomic Energy Agency); Dr TANIGAWA, Hiroyasu (Japan Atomic Energy Agency); Dr KIM, Jae-Hwan (Japan Atomic Energy Agency); Dr GRZONKA, Justyna (Warsaw University of Technology); Dr HEINOLA, Kalle (University of Helsinki); Dr ISOBE,

Kanetsugu (Japan Atomic Energy Agency); Dr OYAIDZU, Makoto (Tritium Technology Gr., Fusion Research Development Directorate, Japan Atomic Energy Agency); Dr RUBEL, Marek (KTH, Royal Institute of Technology); Dr HARA, Masanori (University of Toyama); Dr NAKAMICHI, Masaru (Japan Atomic energy Agency); Dr TOKITANI, Masayuki (National Institute for Fusion Science); Dr MIYAMOTO, Mitsutaka (Shimane University); Dr ASAKURA, Nobuyuki (Japan Atomic Energy Agency); Dr MASUZAKI, Suguru (National Institute for Fusion Science); Dr NAKANO, Suguru (Japan Atomic Energy Agency); Dr OTSUKA, Teppei (Kyushu university); Prof. HATANO, Yuji (Hydrogen Isotope Research Center, University of Toyama); Dr TORIKAI, Yuji (University of Toyama); Dr YAMANISHI, toshihiko (Japan Energy Atomic Agency)

Presenter: Dr ASHIKAWA, Naoko (National Institute for Fusion Science)

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