§9. R&D Test of In-situ Dust Collection Using Silica Aerogel

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Dust generation in the fusion device and its ejection to the confined plasma are potential problems for impurity accumulations and tritium retentions. Movements and characteristics of the dust particles have been measured by different diagnostics such as fast visible and IR TV cameras, laser scattering, and electrostatics detector (developed by C. Skinner in PPPL) in stellarator/heliotrons and tokamaks. Surface analysis on the first wall can provide properties and compositions of dust particles, but information of the dust dynamics at the implantation or deposition is lost.

Silica (SiO_2) aerogel has been used as a dust collector in space plasma field: an aerogel (a silicon-based solid with a porous) has sponge-like structure in which 99 % of the volume is empty space. Thus, collided or deposited dust particles are trapped into the aerogel, and they are remained after vacuum vent. Then, information of the dust transport such as trapped angle and velocity as well as the particle properties such as size, shape and morphology will be evaluated by surface analysis. Four kinds of Silica aerogels with different densities, 0.020-0.061g/cc, were provided by KEK/JAXA.

For the first step of the diagnostics R&D, aerogel with the highest surface density (0.0061g/cc) was chosen, and characterizations of the aerogel in high level vacuum, for example, measurement of QMS for out gassing and vacuum effect for structure of aerogel itself were completed.

For the second step, Silica aerogel was exposed to H_2 glow discharge cleaning (GDC) during 20 hours in LHD. Two kinds of materials, i.e. aerogel and Si samples, are installed on the same holder, and two holders are located as shown in Fig. 1. Here, only the upper side is faced to the glow anode. These holders are set on the movable probe system at the lower port (4.5) in LHD. Figures 2 and 3 show photos of Si and Silica aerogel surfaces by optical microscope, respectively, after exposure to GDC. Diameters of dust particles are less than 50 microns, which are similar between the two targets, i.e. Si and aerogel surfaces. On the other hand, number of dust particles on the aerogel surface is smaller than that on the Si sample, and particularly small dust particles less than 10 micron is very few. From analysis at the cross-section of the aerogel by optical microscope, dust particles are deposited only on the surface, i.e. implantation into the aerogel is not found. From the previous dust analysis in LHD, movable dust particles on Si samples were observed during vacuum vent process, suggesting that dust particles on the Si sample are deposited after GDC. Such influence on dust particles on the aerogel was less than that on Si. Since magnification of the optical microscope is limited, future analysis using scanning electron microscope (SEM) is planned. A laboratory experiment and analysis of the dust particles on the different material surfaces is also prepared in SUT.

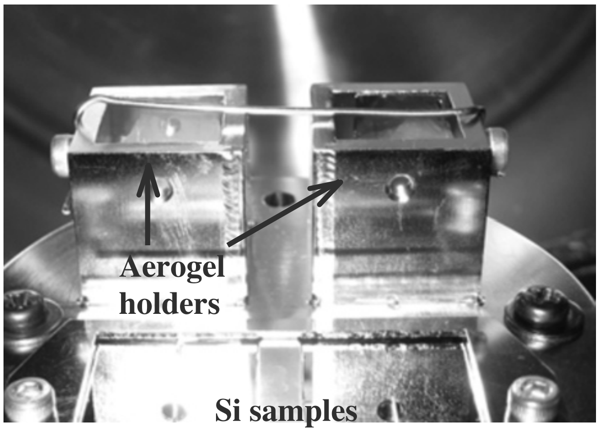

Fig. 1. Sample holder for SiO2 aerogel on the movable probe system. Upper direction is facing the plasma.

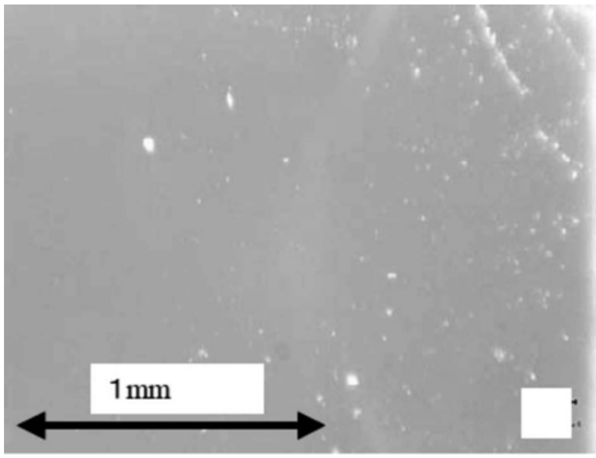

Fig. 2. Surface of Si sample after exposed to glow discharge.

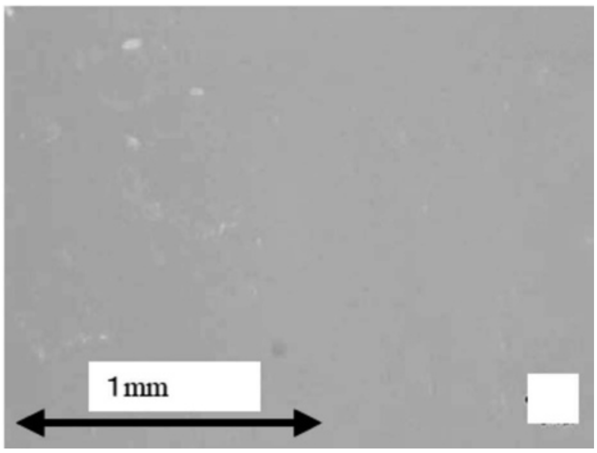

Fig. 3. Aerogel surface after exposed to glow discharge.