§33. Suitability of SiC/SiC Composite as Fusion Reactor Material

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SiC/SiC composite is a candidate material for plasma-facing material and structural components of a fusion reactor owing to its low induced activation, low atomic number, high thermal shock resistance and good thermal conductivity. In the demo reactor, the SiC/SiC composite may be employed as the blanket structure material and the plasma facing material at the divertor region.

In the present study, first we considered the suitable use of this material for the blanket. It is conformed that the compatibility of SiC/SiC with Li-Pb in a liquid metal breeding blanket is superior so that use of SiC/SiC as a flow channel insert between He and Li-Pb coolants is suitable. On the other hand, SiC/SiC composite has high fracture toughness for the thermal shock and low chemical erosion. Thus, the SiC/SiC composite is attractive as the divertor material. However, the chemical erosion of present SiC/SiC composite is not precisely investigated so far. In the present study, the chemical erosion of SiC/SiC composite made by liquid sintering process was also investigated by using the deuterium ion irradiation followed by thermal desorption spectroscopy[1].

The deuterium ion irradiation was conducted by changing the ion fluence (0.2 ~5 x 10^{18} /cm^2). After the irradiation, the sample was heated from RT to 1273 K. During the heating, desorption rates of gases containing deuterium were measured by QMS. Fig.1 shows the thermal desorption spectra of D_2 after deuterium ion irradiation at different fluences. The desorption spectrum has two peaks at 1000 K and 1200 K. The lower and higher peaks correspond to the de-trappings of deuterium from the bonds of Si-D and C-D, respectively. Fig.2 shows the desorbed amount of D-containing gases as a function of deuterium ion fluence. The deuterium retained in the SiC/SiC composite desorbed in the forms of D_2, HD, HDO, CD_4 and C_2D_4. The total amount of desorbed deuterium saturated at the fluence of 5 x 10^{18} /cm^2.

A ratio of the desorbed amount of hydrocarbons (CD_4 and C_2D_4) to the total amount of desorbed deuterium is important for carbon-based materials, from the view point of chemical erosion. At the fluence of 5 x 10^{18} /cm^2, this ratio was 6.4 %, which is much smaller than the value of graphite (25 %). The present experiment clearly showed that the chemical erosion of SiC/SiC composites under fuel hydrogen irradiation was much smaller compared with graphite.

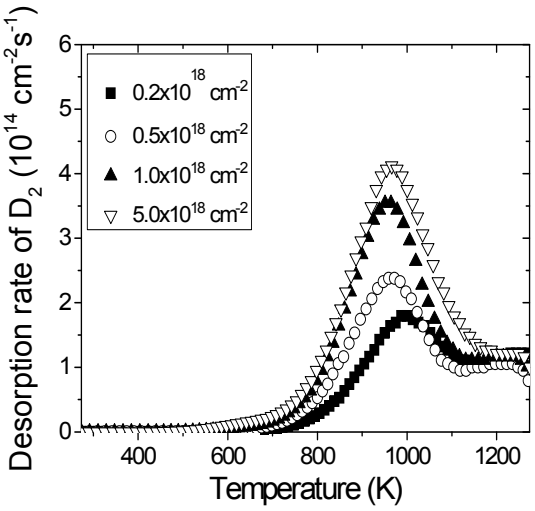

Fig.1 Thermal desorption spectra of D_2 after deuterium ion irradiation at various fluences.

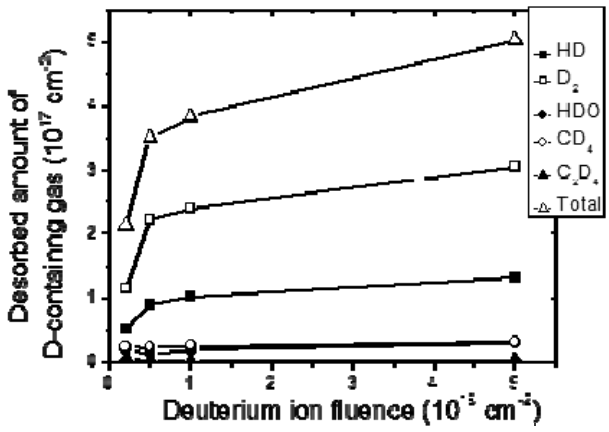

Fig.2 Desorbed amount of D-containing gases versus deuterium ion fluence.

1) Y. Nobuta et al, To appear in J. Vac. Soc. Jpn. (2011)