§25. Structural Analysis of Insulator Coating for Advanced Bleeding Blanket after Heavy Ion Irradiation

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1. Introduction

The MHD pressure drop for liquid metal and permeation control of tritium are the critical issue to develop the liquid metal and molten salt bleeding blanket for nuclear fusion reactor. In recent research results, NIFS (Nuclear Institute for Fusion Science) was succeeded to form Er_2O_3 thin coating via Metal Organic Chemical Vapor Deposition (MOCVD) process as a new technology for broad and complicated shaped areas on the inner surface of the pipe[1]. We could gain the perspective of future.

In this work, we conducted the Cu^{2+} ion irradiation simulated neutron irradiation to study the change of insulator coating microstructure prepared via MOCVD process by neutron one.

2. Experimental method

Er_2O_3 coating samples on SUS 316 substrates were fabricated by the MOCVD apparatus in NIFS. The thickness of metal substrates are 1mm, and Er_2O_3 coating were about 300-400 nm for the thickness. Cu^{2+} ion irradiation was carried out by tandem ion accelerator in RIAM (Research Institute for Applied Mechanics Kyushu University). And ion source was 2.4 MeV Cu^{2+} ion. The irradiation of 0.01-1.50 dpa conducted on the surface of Er_2O_3 samples prepared by MOCVD method at room temperature, and some samples were irradiated for 0.15 dpa in 573 K and 773 K. XRD (Plillips Xpert system), scanning electron microscopes (SEM (Hitachi S3500)), and transmission electron microscope (TEM (JEOL 4010T)) were used for analysis of microstructure in all samples. The cross sectional samples for TEM observation were prepared by FIB method. FIB was Hitachi FB-2100.

3. Results

The typical XRD pattern of the surface area on the Er_2O_3/SUS coating after Cu^{2+} ion irradiation of 1.50 dpa at room temperature is delineated in Fig. 1(a). The peaks for Er_2O_3 and SUS316 substrate show and it revealed that the microstructure of Er_2O_3 could keep after Cu^{2+} ion irradiation. Fig. 1(b) is SEM image of the surface area on the Er_2O_3/SUS coating after Cu^{2+} ion irradiation. We could observe the microstructure like cracks and confirm that the surface structure changed significantly before and after the irradiation of 1.50 dpa. TEM image and SAED of the cross sectional area on the Er_2O_3/SUS coating after Cu^{2+} ion irradiation at room temperature show in Fig.2. From the result of analysis of SAED (selected area electron diffraction) obtained from the Er_2O_3 coating after the irradiation, the patterns were able to index for C-rare earth structure of Er_2O_3. It means that Er_2O_3 could coat after the irradiation. Therefore, it is possible to confirm that Er_2O_3 microstructure has good stability during the irradiation for 1.50 dpa range. On the other hand, it could be observed the peaks for Er_2O_3 and SUS316 substrate from the samples irradiated 0.15 dpa at 773 K as like Fig. 1. In this result, it Er_2O_3 coating could keep in this condition, too. From XRD analysis of two samples, we confirmed clearly that the orientation of Er_2O_3 became different in changing the irradiation conditions.

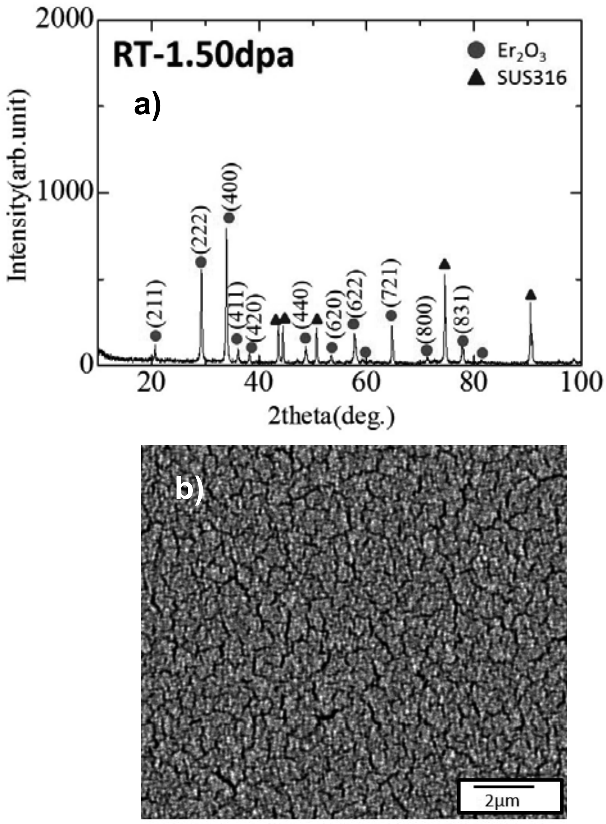

Fig.1 Typical XRD pattern and SEM image of the surface area on the Er_2O_3/SUS coating after Cu^{2+} ion irradiation at room temperature

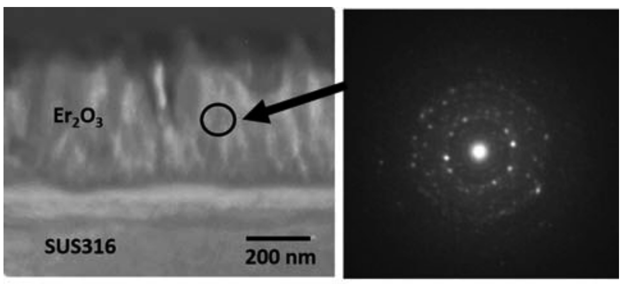

Fig.2 TEM image and SAED of the cross-sectional area on the Er_2O_3/SUS coating after Cu^{2+} ion irradiation at room temperature

1) Y. Hishinuma, T. Tanaka, T. Tanaka, T. Nagasaka, Y. Tasaki, A. Sagara and T. Muroga: Fusion Eng. Des. **86** (2011) pp.2530-2532.