§30. Microstructure Analysis of Oxide Ceramics Coating on Liquid Blanket Components

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An electrically insulating coating of an oxide ceramics is one of the attractive methods for reducing the magneto hydrodynamic (MHD) pressure drop which is a critical issue for liquid lithium fusion reactor blankets, and a ceramic coating for the inner wall would also be necessary to suppress the hydrogen permeation in a molten salt type blanket systems. Recently, Hishinuma et al. have succeeded techniques for large area coating fabrication of Er_2O_3 layers by using the Metal Organic Chemical Vapor Deposition (MOCVD) process in gas phase [1]. In this study, cross-sectioned TEM samples of Er_2O_3 coating layers on the Ni and Si substrate were fabricated by the focused ion beam (FIB) method, and their microstructures have been investigated by SEM and TEM to understand the growth mechanism fundamentally.

Fig. 1(a)-(c) show secondary ion micrograph (SIM) images of coated Er_2O_3 film on Ni substrate. Small crystallines appeared on its surface and its mean size was about 100nm as shown in Fig. 1(c). Fig. 1(d) shows TEM image obtained from cross sectioned TEM sample fabricated by FIB from the region marked by a rectangular in Fig. 1(b). The thickness of Er_2O_3 film was about 100nm, and it is equal to the mean size of crystallines on the surface of Fig. 1(c).

Fig. 2(a) and (b) show SIM images of coated Er_2O_3 film on Si substrate heated at 550C. Just small crystallines can be seen on the surface and there are no defects on it. Fig. 2(b) shows the SIM image where the region to fabricate the cross-sectioned TEM thin sample from there. Fig. 2(c) shows the cross-sectioned TEM image. There is the Er_2O_3 film of 500 nm in thickness and this region was analyzed as Er_2O_3.this film consisted of small crystallines and those crystallines grew perpendicular to the Si substrate.

Fig. 3(a) and (b) show SIM images of coated Er_2O_3 film on Si substrate heated at 575C. The SIM image of Fig. 3(a) is similar to Fig. 2(a), but, its crystallines were coarser than Fig. 2(b) and its shows cracks. Fig. 3(c) shows the cross-sectioned TEM image fabricated from the region marked by a rectangular in Fig. 3(a). the columnar structure is more clear than Fig. 2(c) and the thickness Er_2O_3 film was about 1.1 μm which is double of Fig. 2(c).

[1] Y. Hishinuma, T. Tanaka, T. Tanaka, T. Nagasaka, S. Yoshizawa, Y. Tasaki, T. Muroga, J. Nuclear Materials, 2011.

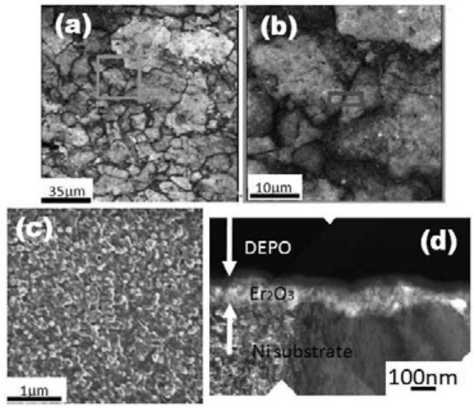

Fig. 1 Er_2O_3 film on the Ni substrate.
(a) - (c)SIM images and (d) cross - sectioned TEM image.

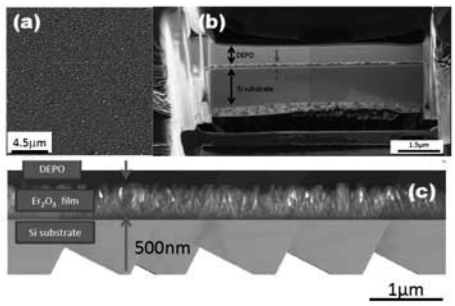

Fig. 2 Er_2O_3 film on the Si substrate heated at 550C. (a) and (b)SIM images and (c) cross - sectioned TEM image.

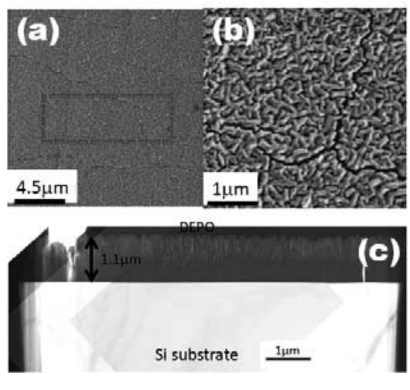

Fig. 3 Er_2O_3 film on the Si substrate heated at 575C. (a) and (b)SIM images and (c) cross - sectioned TEM image.