§7. Development of Oxide Insulator Coating Process in Advanced Liquid Breeder Blanket Systems

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The electrical insulating coating on the interior surface of the wall of duct tubing of liquid metal (Li) breeder blanket system is an attractive means for restraining Magneto-hydrodynamic (MHD) pressure drop. Vanadium alloy has been developed as a promising blanket material. [1] And Er_2O_3 was selected as one of the best candidate material for MHD insulating coating because of higher compatibility with Li.

In this report, Er_2O_3 thin film was fabricated on the V alloy substrate by metalorganic chemical vapor deposition (MOCVD) method which has advantages as films can be deposited in large area at high growth rates with high reproducibility, and which has a possibility of inner surface coating of pipe-shaped substrate.[2]

Two kinds of β-diketonates of Er were synthesized; tris[dipivaloylmethanato]erbium ($Er(DPM)_3$) and tris-[isobutyrylpivaloylmethanato]erbium ($Er(IBPM)_3$).

Preparation of Er_2O_3 thin films was carried out by means of the hot-wall typed quartz tube reactor. Deposition condition of Er_2O_3 films was shown in Table 1. Size of Si(100) and V alloy substrates was 5 x 20 mm.

Thickness and crystal structure of the thin films were estimated with a fluorescent X-Ray analyzer (XRF) and X-Ray diffractometer (XRD).

Table 1. Deposition condition of Er_2O_3.

precursors	$Er(DPM)_3$, $Er(IBPM)_3$
substrate temperature	450~575℃
Ar carrier gas flow rate	200 sccm
O_2 gas flow rate	100 sccm
chamber pressure	10-30 torr
deeposition time	30 min
substrate	Si(100), V alloy

From endothermic peak in the thermal gravity and thermal differential analysis (TG-DTA) curves of synthesized $Er(IBPM)_3$ molecule, the melting point was estimated to 140°C. All amount of the precursor was evaporated in argon flow, and the residue of 15% was observed in dried air. This indicates that $Er(IBPM)_3$ is liable to be oxidized by oxygen in air.

Er_2O_3 thin film was fabricated on Si(001) substrate using $Er(IBPM)_3$ as a precursor at 450 – 550°C. Fig. 1 shows the XRD patterns of the obtained films. The XRD patterns was not observed in the sample prepared at 450°C. The peak at 29° of 2θ was attributed from Er_2O_3(222), which increases with increasing the substrate temperature.

Then, Er_2O_3 thin film was fabricated on V alloy substrate using $Er(DPM)_3$ as a precursor at 570°C. Fig. 2 shows the XRD pattern of the obtained film. Preparation of single phase of Er_2O_3 film was observed; peaks of 21°, 29°, 34°, 36°, 48° and 58° correspond to $Er(DPM)_3$(211), (222), (400), (411), (440) and (611), respectively.

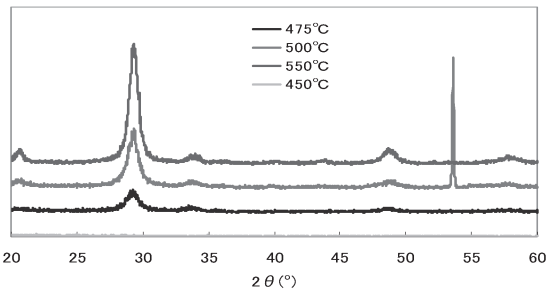

Fig. 1. XRD patterns of the Er_2O_3 films deposited on Si(001) substrate with ($Er(IBPM)_3$) as a precursor.

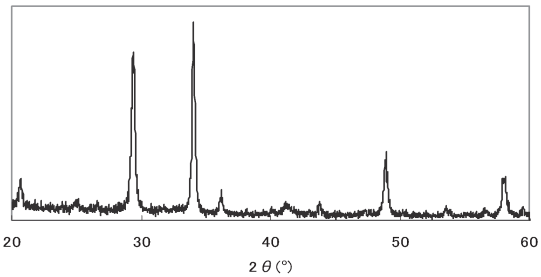

Fig. 2. XRD pattern of the Er_2O_3 film deposited on V alloy substrate at 575°C with ($Er(DPM)_3$) as a precursor.

1) Muroga, T. et al.: Review of advances in development of vanadium alloys and MHD insulator coating, J. Nuclear Mater., **367-370** (2007) 780-787.
2) Hishinuma, Y. Tanaka, T. Nagasaka, T. Muroga, T. Tasaki, Y. and Yoshizawa, S.: Er_2O_3 Coating on V and V-4Cr-4Ti Alloy through MOCVD Process for Advanced Liquid Breeder Blankets, 13th Inter. Conf. Fusion Reactor Mater., Nice, France, Dec, 2007.