Seminar

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Institute for Plasma Research

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Title: In-house Preparation and Optimization of Dip Coating Solution for Er_2O_3 Thin Film Development for Hydrogen Permeation Barrier Application

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Date: 03^{rd} December 2024 (Tuesday)

Time: 02.00 PM

Venue: Seminar Hall, IPR

Abstract

Al_2O_3, AlN, CaO, Er_2O_3 and Y_2O_3 are promising candidates as hydrogen isotope permeation barrier coating in Nuclear Fusion Reactor. Er_2O_3 and Al_2O_3 are presently leading materials for this application [1,2]. Er_2O_3 has been considered as a favourable candidate as an electrically insulating coating to tackle MHD in liquid Li cooled breeding blanket concept [3]. Later on, it was shown that Er_2O_3 coating is also one of the best hydrogen permeation barrier [4]. Er_2O_3 coating deposited on two different substrates (fused silica and P91 steel) by dip coating technique with Metal-organic decomposition (MOD) using commercially available solution has been studied by us previously with encouraging results [4-5]. The cost and import dependence of such solution is a big difficulty in up-scaling this process. In the present study, objective is to develop indigenous solutions of Er_2O_3 for its coating through Metal-Organic Decomposition (MOD) by dip coating technique.

$Er(NO_3)_3 \cdot 5H_2O$ is used as precursor dissolved in Ethylene glycol methyl ether as alcohol based solvent[6]. Different viscosity adjusters like Monoethanolamine (MEA), Diethanolamine (DEA), Poly(ethylene glycol) bis(amine) are tried to add in the desired concentration in above solution and such solutions were characterized for their final viscosity to ensure that they are within appropriate range. The viscosity of the dipping solution is one of the most important parameter determining the quality of the resultant coating. The coatings with different solutions varying viscosity adjuster or its concentration were characterized by X-ray diffraction (XRD) and scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDAX) for crystal structure, surface morphology and elemental composition, respectively. The X-ray diffraction results show that the coating is invariably crystalline with more or less (2 2 2) preferential orientation of Er_2O_3 cubic phase. EDAX clearly shows presence of erbium and oxygen on the coated surface seen under SEM. The stoichiometry helps us determine the uniform coverage of the coating and also gives qualitative information about the thickness. Comparative study of Er_2O_3 thin films grown using the developed different dipping solutions and commercial solution is done and direction to further experiments for optimization of the concentration of the viscosity adjuster is determined.

The variation of Poly(ethylene glycol) bis(amine) as a viscosity adjuster from 0.1% to 3% concentration shows improve and optimize the microstructure and uniformity of the coating. 0.1.% shows highly unstable coating with no complete coverage of the substrate surface. Whereas, the coating using 3% concentration shows complete substrate covering layer. XRD results show that Er_2O_3 forms in pure cubic crystal structure phase with almost perfect preferred orientation of (222) plane with Poly(ethylene Glycol) Bis (Amine) (PEGBA) 3%. Hence, systematic variation of Poly(ethylene glycol) bis(amine) concentration in the solution and its effect on the resultant coating is planned as future experiments for the optimization. We also plan to measure Hydrogen/Deuterium

permeation barrier efficiency of the coating from optimized solution and compare the same with the commercial solution.

References:

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