Seminar

==========

Institute for Plasma Research

==========

Title: Tungsten-Tantalum Thin Films Performance in Fusion Tokomaks

Speaker: Dr. Santosh Konuru

Vellore Institute of Technology, Tamilnadu

Date: 17th April 2023 (Monday)

Time: 03:30 PM

Venue: Join the meeting online:

https://meet.ipr.res.in/join/3678968586?be_auth=OTU4NzI3

(Conference ID: 3678968586; Password: 958727)

Abstract

The focus of this presentation is the study and characterization of Tungsten-Tantalum thin films for use as plasma facing materials in a fusion Tokamak. Specifically, we will investigate the effect of adding Tantalum to Tungsten thin films to improve their ductility and adhesion. Comparatively soft Tantalum (Ta) is used to impart ductile properties in the Tungsten thin films at room temperature condition. RF magnetron sputtering process is used to deposit the films on to the Reduced Activation Ferritic Martensitic Steel (RAFM). Initially, W is deposited on RAFM substrates with RF sputtering method and behavior of the thin-film system is studied by analyzing for adhesion, morphology and hardness properties. Sputtering parameters are fixed by the initial studies, and further optimization of parameters to attain the best adhesion, less hardness and best morphology for the W thin film is carried out using Taguchi L9 orthogonal array. From the optimization studies of W, parameters are selected and are used for the W-Ta composite film sputtering process. Ta percentage in the composite film is optimized by using Taguchi L9 orthogonal array again with the process parameters selected from W study to attain the best ductility, adhesion and morphology. In this study, thin film's adhesion is assessed by both qualitatively and quantitatively via indentation test and Nano scratch tests. Hardness and modulus of the films are analyzed by nanoindentation analysis and morphology is checked with Field Emission Scanning Electron Microscope (FESEM). The chemical analysis of the developed films is also done by Electron Diffraction Spectroscopy (EDS) method. From this study, it is concluded that addition of 5%Ta improved the plastic deformation by 66% and toughness by 479% of the W film at room temperature condition, implying the composite film is a ductile and tougher film at room temperature condition. Cr as interlayer is found to increase the adhesion strength for W and W-Ta composite coatings and also can enhance the topcoat morphology. Thin-film coatings of W-5%Ta and W-20%Ta with Cr as the interlayer are found to have the best adhesion properties with high critical load and defect-free morphology.

However, no studies have been conducted to provide information on the behavior of these composite films when exposed to plasma. In irradiated conditions, the effect of Ta in the Tungsten thin film will be investigated. Finally, an optimised composite ratio for TungstenTantalum films will be proposed in order to achieve a longer life cycle plasma facing material. Composite and W films will be deposited on RAFM and P91 steel substrates using RF sputtering process. Prior to plasma treatment, the thin films developed will be tested for their mechanical, surface, adhesion, and chemical properties. These will be subjected to plasma treatment and irradiated. The mechanical, chemical, thermal, and physical properties of the well-adhered irradiated composite films will be evaluated and compared to the non irradiated films. Based on the data generated after the plasma treatment, the Ta content of the composite films will be optimized to obtain better properties.