DEVELOPMENT OF W COATINGS FOR FUSION APPLICATIONS

C. Ruset[1], E. Grigore[1], H. Maier[2], R. Neu[2], H. Greuner[2], M. Mayer[2], G. Matthews[3]

[1] *National Institute for Laser, Plasma and Radiation Physics, Bucharest, Euratom-MEdC Association Romania*
[2] *Max-Plank Institut für Plasma Physik, Euratom Association, 85748 Garching, Germany*
[3] *Culham Centre for Fusion Energy, Euratom Association, Abingdon, UK*

Corresponding author: ruset@infim.ro

As a material for plasma facing components (PFC) in fusion devices tungsten has a few advantages over carbon. These are mainly in connection with low sputtering rate and low fuel retention. On the other hand, the use of bulk W creates problems associated with its higher electrical conductivity, difficulty in machining and heaviness. A solution to overcome these disadvantages seems to be W coating of carbon based materials (Carbon Fiber Composite-CFC or Fine Grain Graphite-FGG). By this way the advantages of both W and carbon materials could be used simultaneously. Unfortunately this solution is accompanied by a new problem, which is the adhesion of the coating to the substrate under high thermal stresses specific for PFC.

The paper makes an overview on the W coatings deposited by various methods on carbon materials (CFC and FGG). Vacuum Plasma Spray (VPS), CVD and PVD techniques are analyzed in respect with the characteristics and performances of the W coatings.

A particular attention is paid to the Combined Magnetron Sputtering and Ion Implantation (CMSII) technique, which was developed during the last 4 years from laboratory to industrial scale and is successfully applied for W coating (10-15 μm and 20-25 μm) of more than 2,000 tiles for the ITER-like Wall project at JET and ASDEX Upgrade [1].

This technique involves simultaneously magnetron sputtering and high energy (tens of keV) ion implantation. Due to the ion bombardment a stress relief occurs within the coating enabling its growth without delamination to a relatively large thickness. At the same time the surface mobility of the deposited atoms is increased and an extremely dense, pore free, nano-structure is produced [2]. In addition, in order to adjust the thermal expansion mismatch between CFC and W, a Mo interlayer of 2 – 3 μm is currently used. The coatings have been characterized in terms of structure, thickness and chemical composition using SEM, XRD, optical microscopy and Glow Discharge Optical Spectrometry techniques.

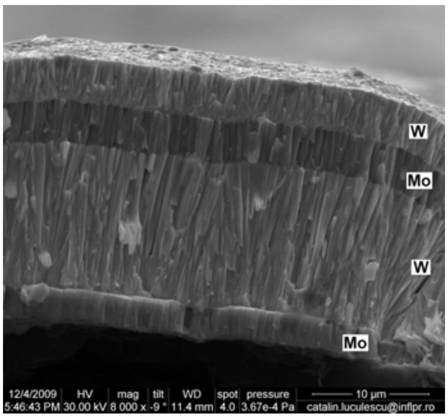

Figure 1:W/Mo marker

The same technology was used to deposit on particular tiles W/Mo markers with the aim to measure the erosion rate in the JET divertor. A marker is a multilayer structure as that shown in Fig.1. The total thickness of the coating is approx. 23 μm.

In order to achieve thicknesses and respectively lifetimes comparable to those of VPS coatings, the CMSII technology was extended to 50 μm. These coatings were successfully tested in GLADIS ion beam facility up to 23 MW/m^2 in screening regime followed by a cycling at 10.5 MW/m^2 / 5 s / 150 pulses.

Further investigations are in progress aiming deposition by CMSII technique of reliable W coatings with a thickness up to 100 μm.

[1] C. Ruset et al., Fusion Engineering and Design 84 (2009) 1662–1665
[2] C. Ruset et al., Phys. Scr. T128, (2007), 171 – 174