# CO-SPUTTERED W/FE INTERLAYERS FOR JOINING TUNGSTEN TO STEEL

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The divertor of fusion power plants is exposed to high energetic particles resulting from the fusion reactions; the surface of plasma facing material will be subjected to a high heat load as well as to physical and chemical sputtering processes.

Tungsten has been selected as a structural material in the DEMO (DEMOnstration) fusion power plant as refractory, low activation and high Z material. However, its use as a structural material is restricted to the high temperature parts which shall be connected to the low temperature parts made of the reduced activation ferritic/martensitic steel EUROFER97. The joint of these materials is very difficult because of several reasons, as the large differences of their melting temperature, the large mismatch of their coefficients of thermal expansion, the high thermally induced residual stresses at the interface during joining processes.

This work reports on the activity of co-sputtered W/Fe interlayers for joining tungsten to steel.

Iron and tungsten can be gradually co-sputtered on W substrates to obtain graded interlayers able to minimize CTE mismatch, then subsequently joined to steel by hot pressing.

Sputtering is a promising technology for manufacturing graded interlayers for joining tungsten to steel to be used in plasma facing fusion components. The main advantage of sputtering is the homogeneity and high thermal conductivity of sputtered layers, if compared to the intrinsic porosity and relatively low thermal conductivity of plasma sprayed ones.

A comparison of two sputtering methods to obtain Fe/W graded layers on W substrates, compared with Fe/W direct bonding has been carried out.

The sputtering is performed by a customized Kenosistec™ equipment with four 3 inch cathodes that can be powered up with DC, RF and pulsed DC. One cathode is designed for magnetic materials. The selected deposition atmosphere was Ar to avoid on-fly reactions and to reach the maximum deposition rate. The deposition pressure was dynamically controlled by a motorized and computer controlled throttle valve and a gas regulators that allow to fine tuning of gas flowing and pressure in a wide range of values during deposition. The RF generators can power the cathodes up to 300 W, while the DC one can reach 500 W. Moreover the DC generator can be used as Pulsed DC generator with a maximum frequency of 100 kHz. The W substrate can be heated up during deposition up to 450 °C and can be plasma etched before deposition to increase adhesion of the deposited layers.

Three deposition parameters (pressure, power and time) were changed to optimize the deposited layers; Bruker Dektak Stilus™ profilometer was used to measure the sputtered layer thickness on triplicate for each sample. The calculated atomic ratio between iron and tungsten in the layers were: 50% tungsten – 50% iron and 70% tungsten - 30% iron, with deposition rate of 15 nm/h.

TEM, SEM, EDS, XPS and preliminary mechanical characterization by single lap-shear tests have been made on Fe/W joined samples, showing an excellent mechanical strength at room temperature. High flux test are ongoing.