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P3.196 Investigation of Fe-W interfaces in graded Fe/W composites for the first wall of DEMO

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For the European demonstration power plant, four types of breeding blankets are under consideration. All designs agree in the basic materials selection, that is Eurofer used as structural material and tungsten used as armour material. Detailed thermo-mechanical finite element analyses show that a direct joint of these materials will not last over the anticipated lifetime of the blankets due to thermally induced macro stresses and strains.

An approach to cope with the thermal mismatch of W and steel is to implement a graded steel/W or Fe/W layer in the joint that re-distributes macro stresses. A novel, two-stages process has shown promising results in fabricating graded Fe/W composite materials. It includes, firstly, energetic mixing of Fe and W powders of several Fe/W ratios using a planetary mill. In a second step, Fe/W powders of different ratios are stacked and consolidated by mechanical pressure and electric heating within milliseconds. The process is referred to as Electro Discharge Sintering (EDS). Very short duration at elevated temperatures prevents the precipitation of intermetallic phases and, hence, allows assigning well-tailored properties to the graded composite. Analyses have shown that Young's modulus, strength and thermal expansion of Fe and W converge well across the graded layer whereas thermal conductivity remains on the Fe-level.

The current contribution focusses on Fe-W interfaces of the composites. Fe/W powders with 25, 50 and 75 vol.% W were mixed for 2, 4 and 8 hours and consolidated with identical EDS parameters (80 kN uniaxial pressure, 400 kA current). Based on a microstructural analysis, the impact of energetic mixing on Fe-W interfaces, and on physical and mechanical parameters is discussed. For selected samples, results of micro cantilever bending experiments that are carried out in a scanning electron microscope are presented. In-situ micro mechanical testing allows relating interface qualities to microstructures and mixing parameters.

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