W/STEEL BONDING VIA PULSE PLASMA SINTERING (PPS)

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The main objective of the European Long Term technology R&D programme is to develop and qualify materials and fabrication technologies required for the in-vessel components (Breeding Blankets and Divertor) of DEMO and beyond. In a modular He-cooled divertor concept the tungsten parts will be joined with steel (ODS EUROFER) [1]. Due to a large difference in thermal expansion coefficients of W ($4\text{-}6\times10^{-6}$ K^{-1}) and ODS steel ($10\text{-}14\times10^{-6}$ K^{-1}) the fabrication of a reliable W/steel joints requires special bonding techniques. The difference in CTE could result in large stresses at the interfaces during manufacturing and/or operation leading to cracking, delamination and a reduced lifetime of the components.

Currently developed methods of bonding tungsten, tungsten alloy WL10 and ODS EUROFER steel are based on brazing with nickel and cobalt [1-3]. The presence of activated elements in the braze material is the main drawback of this concept.

The main objective of the current study was to develop a new joining technology of tungsten and steel using Pulse Plasma Sintering, PPS. Different materials were used as a transition layer in order to decrease the thermal stresses gradient. Four different materials containing only low activation elements were tested in this context: Fe, Ti, 25wt.% Fe-Ti and 86wt.% Fe-Ti. The interlayer materials were fabricated at different sintering parameters and their structures examined to detect possible flaws. The optimized sintering process has been used to produce test joints which have been subjected to thermal fatigue resistance tests. Results of these tests prove feasibility of PPS fabrication of W-steel components.

[1] P. Norajitra et al., Fusion Engineering and Design, 81, 2006, 341-346
[2] P. Norajitra et al., Fusion Engineering and Design, 84, 2009, 1429-1433
[3] G. Ritz et al., Fusion Engineering and Design, 84, 2009, 1623-1627