DIFFUSION BONDING OF TUNGSTEN AND EUROFER 97 USING INTERLAYERS

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Tungsten is one of the highest temperature resistant materials. It has the highest melting point and lowest vapour pressure of all metallic elements. Due to its resistance against the physical and chemical erosion and its low term activation and transmutation it is selected for fusion reactors as armour material to prevent the components of the divertor from the high energetic plasma particles. In the helium cooled divertor concept for DEMO tungsten is even foreseen as a structural material in the transition area to the basic structural material EUROFER 97. Therefore a joining technique between polycrystalline tungsten and EUROFER 97 has to be developed.

To joint both materials by direct diffusion bonding some difficulties caused by the differences in the material properties must be taken into consideration. It is well known that EUROFER97 and tungsten have a large mismatch on thermal expansion (by a factor of about 3), which can induce a grave residual stresses in the material especially at the bonding interface. The condition at the interface becomes more worsen due to the formation of brittle intermetallic phases. These results in a very brittle bonding seam after diffusion bonding. In previous investigations, the bonded samples could not survive the heat treatment required to recover the optimized state of EUROFER97 [1]. Based on these facts, it is necessary to improve the diffusion bonding method to overcome both problems.

The objective of this work is to prove the possible improvement of the joining after the diffusion bonding with the subsequent heat treatment by using an inter layer from a material, which has a thermal expansion coefficient in between those of the materials to be bonded. The bonded samples are characterized by means of tensile and Charpy impact tests in order to determine their strength and ductility. Subsequently the fracture surfaces are investigated by SEM. Optical light microscopy is used to prove the soundness of the interfaces. For information about the possible formation of the brittle intermetallic phases at the bonding seams, the chemical compositions close to the interface are analyzed by AES. In addition, the influence of these phases on the mechanical properties at the bonding seams is characterized by the indentation hardness tests.

[1] W.W. Basuki, J. Aktaa; ICFRM-14, Sapporo 2009, to be published in Journal of Nuclear Materials.