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Rational Design of Composite Interlayer for Diffusion Bonding of Tungsten–Steel Joints

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ABSTRACT`

Large residual stresses and brittle intermetallic compounds are two detrimental factors in the mechanical reliability of tungsten–steel joints. In this work, we conduct a rational design of interlayer structure to tackle these two pitfalls by combining finite element model (FEM) and Hume–Rothery rules. The FEM results show that the selection of interlayer materials for tungsten–steel joining depends not only on thermal expansion mismatch, but also on the plastic deformation of interlayer. In practice, it is better to relax the residual stress by a soft interlayer with high ductility than to transfer the stress from W by a hard interlayer with a low coefficient of thermal expansion. However, the Hume–Rothery rules indicate adding a single interlayer cannot prevent the formation of brittle intermetallic compounds. A composite interlayer design is then proposed in this study to minimize the possibility of intermetallic compounds formation in the meantime reduce the residual stress. Using V/Cu and V/Ni as typical examples, we demonstrate that composite interlayer can greatly improve joint performance because of the lower residual stresses and less detrimental intermetallic compounds.

Keywords: Intermetallic; Residual stress; Tungsten; Diffusion bonding; Interlayer.

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