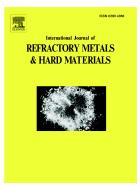
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Rational Design of Composite Interlayer for Diffusion Bonding of Tungsten–Steel Joints

Yunzhu Ma, Wentan Zhu, Qingshan Cai^{*}, Wensheng Liu, Xinkuan Pang, Chaoping Liang

State Key Laboratory of Powder Metallurgy, Central South University, Changsha 410083, PR China

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.

^{*} Corresponding author. Tel.: +86 731 88877825; fax: +86 731 88836476.

E-mail address: cai2009pm@163.com, caiqingshan@csu.edu.cn (Q.S. Cai).

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