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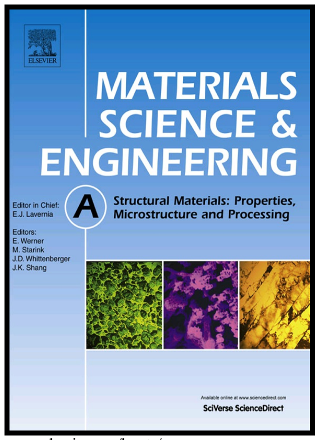

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Room and Ultrahigh Temperature Mechanical Properties of Field Assisted Sintered Tantalum Alloys

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Abstract: Refractory metal alloys such as tungsten and tantalum have long been primary materials of use in high temperature applications. The difficulty of processing tungsten and tantalum alloys makes the job of economically fabricating components from these alloys challenging. Furthermore, despite their intended use at elevated temperatures, limited research work has been to done to evaluate mechanical properties of these alloys at elevated temperatures. In this work, the mechanical properties of three tantalum alloys, pure Ta, Ta-10vol%W, and Ta-10vol%W-1.5vol%TiC are studied using a range of mechanical testing procedures. Pure tantalum is found to display improved ductility at both room and elevated temperatures in comparison to alloyed samples. Addition of both 10vol%W and 1.5vol%TiC addition is found to result in comparable high-temperature strength and ductility in comparison to 10vol%W addition, and improved hardness and flexural strength at room temperature. XRD and EDS analysis paired with microscopy of sintered materials and there fracture surfaces suggest this improvement is associated with solid solution strengthening occurring at Ta-W grain boundary regions. Analysis of sample fracture surfaces reveals indications of increased sample ductility at elevated temperatures for all alloys shown by tearing of tensile bar surfaces near the fracture regime and formation of river patterns and other ductile features.

Introduction

Metallic alloys of tantalum (Ta) and tungsten (W) have been extensively used for a variety of high-temperature applications including nuclear reactor radiation shields[1,2] and rocket nozzles[3]. The high melting point and strong *d*-orbital bonding within these materials allow them to maintain strength and hardness at elevated temperatures beyond those of other common metallic systems such as nickel, titanium, and aluminum[4]. Due to their refractory nature, these materials cannot be processed using conventional techniques. Generally plasma based techniques such as