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Refractory metal alloying: a new method for improving mechanical properties of tungsten heavy alloys

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ABSTRACT

Influence of mechanically alloyed tungsten-rhenium powders on the microstructure and mechanical properties of liquid phase sintered 89W-7Ni-3Fe-1Re heavy alloy was studied. Heat treatment and swaging were conducted on alloys prepared using both conventionally blended and mechanically milled powders. The results indicated the formation of bcc solid solution by high energy milling of tungsten and rhenium powders. The corresponding particle and the crystallite size decreased after high energy milling. Grain size and contiguity of the milled alloy were significantly lower than those of conventional counterpart. The alloy prepared using high energy milled W-Re powder exhibited relatively superior balance of strength, ductility and impact toughness. These findings suggest that refractory powder mechanical alloying prior to sintering is beneficial for improving the mechanical properties of tungsten heavy alloys.

Keywords: Mechanical milling, tungsten heavy alloy, grain refinement, mechanical properties.

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1. Introduction

Tungsten heavy alloys with superior mechanical properties have attracted considerable attention for kinetic energy penetrator applications [1, 2]. Conventional tungsten alloys in sintered plus heat treated condition exhibit tensile strength and elongation in the range of 700-1100 MPa and 20-30 % [3, 4]. However, for penetrator application, superior mechanical properties especially strength are essential in order to realise enhanced ballistic performance. While improved properties are mainly achieved through thermo-mechanical

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