Accepted Manuscript

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PII: S0301-679X(17)30330-4

DOI: 10.1016/j.triboint.2017.06.042

Reference: JTRI 4802

To appear in: *Tribology International*

Received Date: 27 March 2017

Revised Date: 26 April 2017

Accepted Date: 29 June 2017

Please cite this article as: Iqbal Z, Merah N, Nouari S, Shuaib AR, Al-Aqeeli N, Investigation of wear characteristics of spark plasma sintered W-25wt%Re alloy and W-25wt%Re-3.2wt%HfC composite, *Tribology International* (2017), doi: 10.1016/j.triboint.2017.06.042.

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Investigation of Wear Characteristics of Spark Plasma Sintered W-25wt%Re Alloy and W-25wt%Re-3.2wt%HfC Composite

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Abstract:

Wear characteristics of monolithic W-25wt%Re alloy spark plasma sintered at 1500^{o}C, 1700^{o}C and 1800^{o}C and W-25wt%Re-3.2wt%HfC composite sintered at 1800^{o}C, have been investigated. Higher sintering temperature of W-Re alloys resulted in higher relative density, microhardness and thermal conductivity and consequently better tribological characteristics. Wear resistance was improved with the addition of 3.2wt% HfC to W-25wt%Re matrix. SEM analyses revealed that the dominant wear mechanism in monolithic alloys was abrasive in nature while that in the composite was mostly adhesive with the presence of HfC debris and pullout sites. The coefficient of friction (COF) of the monolithic W-25wt%Re alloy increased with increasing sintering temperature. W-25wt%Re-3.2wt%HfC composite showed lower average COF and specific wear rate than those of its monolithic counterpart.

Keywords: W-Re-HfC Composite; Spark Plasma Sintering; Wear characteristics; FSW Tool Materials

1. Introduction

Tungsten has extremely high elastic modulus and highest melting point among the metals and therefore it is considered as a candidate tool material for solid state welding of steel and high temperature alloys [1]. Although pure tungsten possesses sufficient strength at high temperatures, its use is limited due to its low toughness at ambient temperature. Tungsten is also susceptible to embrittlement and has higher ductile to brittle transition temperature. It has also tendency for recrystallization at temperatures higher than 1200^{o}C [2]. In order to alleviate these detrimental effects, Rhenium is added as an alloying element. Incorporation of Rhenium in tungsten lowers the ductile-brittle-transition temperature and elevates the recrystallization temperature [3]. Tungsten and its alloys are usually synthesized by powder metallurgy techniques as these materials have high melting points. Mechanical alloying is commonly utilized for synthesizing materials which are difficult to synthesize by conventional techniques. One of the key issue in powder processing is to choose a suitable consolidation method which

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