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WC-Ni-Cr-based self-lubricating composites fabricated by pulsed electric current sintering with addition of WS_2 solid lubricant

Xin-yang Huang[a,b], Jin-hua Wang[a,b], Hai-quan Zhang[a,b], Jing Ren[c], Qing-feng Zan[a,d], Qian-ming Gong[e], Bin Wu[a,b,*]

[a] Institute of Nuclear and New Energy Technology, Collaborative Innovation Center of Advanced Nuclear Energy Technology, Tsinghua University, Beijing 100084, China

[b] The Key Laboratory of Advanced Reactor Engineering and Safety, Ministry of Education, Beijing 100084, China

[c] State Key Laboratory of Tribology, Department of Mechanical Engineering, Tsinghua University, Beijing 100084, China

[d] Beijing Key Laboratory of Fine Ceramics, Institute of Nuclear and New Energy Technology, Tsinghua University, Beijing 100084, China

[e] School of Materials Science and Engineering, Tsinghua University, Beijing 100084, China

* Corresponding author: wu-bin@tsinghua.edu.cn

ABSTRACT

Self-lubricated WC-Ni-Cr-based composites with WS_2 were fabricated by pulsed electric current sintering at different temperatures and pressures. The density and hardness of the composites were investigated, and the densification effects of sintering temperature and pressure were discussed. The applied pressure over 250 MPa along with a sintering temperature as low as 950 °C could densify the sintered composite while protecting the disulfide from decomposition. The tribological properties of the composites were also tested under sliding wear conditions in air. The composite with WS_2 sintered under high pressure could provide a lower friction coefficient than WC-Ni-Cr cermet without the addition of WS_2. The test results are discussed together with the morphology of the polished surfaces and wear tracks. The presence of WS_2 and sulfur element in the composites was analyzed with the help of scanning electron microscopy, Raman spectroscopy and energy-dispersive X-ray spectroscopy. WS_2 in the composite appears to be transferred to the contact area with other wear debris during sliding and reduces the friction coefficient.

Keywords: cermet; disulfide; spark plasma sintering; hardness; anti-wear; self-lubrication

1 Introduction

WC-based cermets could serve as bearing parts and mechanical face seals in ionizing radiation fields [1]. However, their coefficients of friction (COFs) under dry sliding conditions [2] still need to be lowered to extend the service life. Various solid lubricants such as fluorides [3,4] and graphite [5] have been introduced into the WC-based self-lubricating composites to reduce friction and wear. Besides, MoS_2 and WS_2 are also excellent solid lubricants with even better lubricating performance. To date, however, they are mainly mixed into WC-based powders to prepare coatings by spraying. Few studies on the preparation of self-lubricating composite bulk materials with disulfide lubricants distributed throughout the body have been reported.

Self-lubricating composite bulk materials with disulfide lubricants could have longer endurance than the coatings, although the preparation by powder metallurgy methods would be rather difficult [6]. Powder metallurgy method is a practical way to prepare hard composites with addition of cemented carbides [7] without melting or casting processes,