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BOOK OF ABSTRACTS

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Properties of spark plasma sintered bulks and coatings made of tungsten diboride alloyed with Cr, Mo, Re and Zr

Abstract

Tungsten borides due to theirs properties can be an alternative to superhard materials. While they possess high hardness, chemical and thermal resistance, they are easier to manufacture than diamond and cubic boron nitride. Tungsten borides in bulk form can be produced without employing high pressures (>5GPa), and in case of coatings there is no need to use processes with high plasma density. To enhance the properties of tungsten diboride (WB_2), we have synthesized and characterized solid solutions of this material with chromium, molybdenum, rhenium and zirconium. The obtained materials were subsequently deposited as a coatings. Various concentrations of these transition-metal (TM) elements, ranging from 0.0 to 24.0 at. %, on a metals basis, were made. Spark plasma sintering (SPS) was used to synthesize these refractory compounds from the pure elements. Elemental and phase purity of the both samples (sinters and coatings) were examined using energy-dispersive X-ray spectroscopy (EDS) and X-ray diffraction (XRD), and microindentation was utilized to measure the Vickers hardness under applied loads of 200 gf. XRD results indicate that the solubility limit is below 8 at. % for Mo, Re, Zr, and below 16 at. % for Cr. Above this limit both diborides $(W,TM)B_2$ are created. Addition of TM caused decrease of density and increase of hardness and electrical conductivity of sinters. In the case of coatings with Zr the hardness grows even more and reaches 40 GPa – superhardness limit. Deposited coatings $W_{1-x}TM_xB_{2-z}$ (x=0.08—0.24, z=0.2—0.07) are homogenous, smooth, hard and also refractory in case of addition of zirconium. One hour annealing with 700°C did not change structure and improve hardness of zirconium alloyed films.

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