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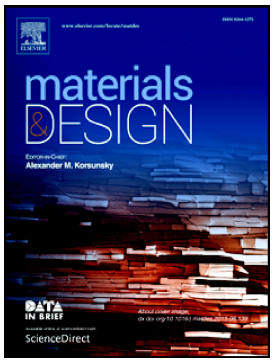

Enhancement of hardness, modulus and fracture toughness of the tetragonal (Fe,Cr)2B and orthorhombic (Cr,Fe)2B phases with addition of Cr

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Enhancement of hardness, modulus and fracture toughness of the tetragonal $(Fe,Cr)_2B$ and orthorhombic $(Cr,Fe)_2B$ phases with addition of Cr

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Abstract

This study analyzes the influence of Cr content on hardness H, elastic modulus E and fracture toughness K_{IC} of the M_2B boride by means of nanoindentation experiments. Additionally, properties of the $Fe_3(C,B)$ phase are determined. Samples of the M_2B phase are casted and microstructurally characterized by means of scanning electron microscopy, energy dispersive spectroscopy and X-ray diffraction. At a Cr content higher than 14.7 atom% the M_2B phase transforms from tetragonal into orthorhombic structure. The tetragonal M_2B type possesses an optimum of H (21±1 GPa), E (373±6) GPa and K_{IC} (3.5±0.7 MPa$\sqrt{m}$) at 4-5 atom% Cr. The hardness, modulus and toughness of the orthorhombic M_2B phase increase with Cr content and reach values of H = 27±0.7 GPa, E = 473±9 of and K_{IC} = 3.26 ±0.8 MPa$\sqrt{m}$ at maximal investigated Cr content of 55 atom%. The hardness of the M_2B phases decreases around 2.3-3.2 GPa as a function of indentation depth, which is known as the indentation size effect. Hardness and fracture toughness of M_2B phase outperform conventionally used M_7C_3 carbides and are similar to MC-carbides. Findings can be used in novel alloying approaches in order to optimize the performance and reduce cost of tool steels.

Keywords: Fracture toughness, borides, nanoindentation, steel, boride, Fe-C-B-Cr