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Effect of Si and N addition on oxidation resistance of magnetron sputtered Zr-B-C films

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The Zr-B-C films prepared in our laboratories by nonreactive magnetron sputtering have showed an enhanced hardness (37 GPa), high electrical conductivity and resistance against oxidation up to 600°C. In the present paper, the effect of Si and N addition on high temperature behavior of Zr-B-C films is systematically investigated with aim to extend oxidation resistance of the films to higher temperatures. The Zr-Si-B-C-(N) films with hardness ranging from 20 to 30 GPa were deposited on Si(100) substrates by dc pulsed magnetron co-sputtering of a single B_4C-Zr-Si target (with a fixed 15% Zr fraction in the target erosion area) in argon or nitrogen-argon gas mixtures. The Si and N content in the as-deposited films was varied in a wide range by the Si fraction in the target erosion area and by the N_2 fraction in the nitrogen-argon gas mixtures, respectively. The oxidation resistance of the Zr-Si-B-C-(N) films was investigated in synthetic air using a symmetrical high-resolution Setaram TAG 2400 thermogravimetric system. Changes in the structure, elemental composition and surface morphology of the films subjected to oxidation tests were analysed by X-ray diffraction, Rutherford backscattering spectroscopy, spectroscopic ellipsometry and optical microscopy. Preliminary results show that the addition of Si positively affects the oxidation resistance of the Zr-B-C films resulting in the reduction of mass gains. The Zr-Si-B-C films deposited with the 20% Si fraction in the target erosion area are oxidation resistant up to 650°C and the mass gain detected at 800°C is less than 0.01 mg/cm^2. The addition of N into the Zr-Si-B-C films results in a further shift of the onset of oxidation to higher temperatures. The films deposited with the 20% Si fraction in the target erosion area and with the 15% N_2 fraction in the gas mixture are oxidation resistant at least up to 1000°C.

Keywords
Zr-Si-B-C-(N)
oxidation resistance
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