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Optical emission spectroscopy of deposition process of W-Al-B coatings obtained by HiPIMS/DCMS hybrid technique

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Tungsten borides because of their properties, like hardness and thermal stability, may be a potential alternative to traditional superhard materials (diamond and cubic boron nitride) or typical materials for tool coatings (TiN, TiAlN etc). Tungsten borides can be furtherly enhanced by alloying with various metals. In this regard, addition of aluminium can increase oxidation resistance of diboride-based materials [1].

High power impulse magnetron sputtering (HiPIMS) technique is already well-used for deposition of high quality coatings. Flux of highly energetics species have a significant influence on deposited coatings and its properties. Due to this, plasma behaviour during HiPIMS should be extensively studied.

In this work we present the study of deposition of W-Al-B thin films by HiPIMS/DCMS technique. WB_{2.5} and AlB₂ targets were co-sputtered in various parameteres of WB_{2.5}-HiPIMS/AlB₂-DCMS. Plasma behaviour was investigated via optical emission spectroscopy to obtain intensities and distribution of atoms and ions of tungsten, aluminium and boron. Due to lower deposition rate of dual than single magnetron set-up it was very important to perform examination of plasma plume behaviour. Mechanical properties were evaluated by nanoindentation technique, microstructure was observed using scanning and transmission electron microscopy (SEM, TEM). Chemical and phase composition were measured by ToF-ERDA and X-ray diffraction (XRD), respectively.

Addition of Al into WB₂ structure lowered the hardness of deposited films form 29 to 17 GPa at ≈ 0.7 Al/(W+Al) atomic ratio. Crystalline coatings were only obtained for Al/(W+Al) ratio between 0.05-0.2.

[1] B. Wicher, O.V. Pshyk, X. Li, B. Bakhit, V. Rogoz, I. Petrov, L. Hultman, G. Greczynski, "Superhard oxidation-resistant $\text{Ti}_{1-x}\text{Al}_x\text{B}_y$ thin films grown by hybrid HiPIMS/DCMS co-sputtering diboride targets without external substrate heating", *Materials & Design*, Volume 238, 2024

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