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Properties of (W,Zr)B_{2-z} Protective Coatings Deposited by RF Magntron Sputtering Method

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Abstract:
Plasma-deposited protective and tribological coatings have a significant role in many areas of today's industry. In tools, industry coatings lead to increased tool life and a larger variety of work-pieces from different materials. The most popular thin films based on nitrides lead to a significant improvement in the life of tools and the quality of machined parts [1]. However, there are applications in which nitride coatings are not enough to fulfil the requirements. In this work magnetron sputtered WB_2 coatings doped with 8, 11 and 16 at% zirconium were analysed using energy dispersive spectroscopy, X-ray diffraction and nanoindentation tester. Deposited coatings are superhard and having hardness above 44.5 GPa. W-Zr-B coatings have a hardness higher than WB_{2-z} and at the same time have a lower Young modulus due to change of microstructure (Fig. 1). Thermal treating tests (annealing and cycling thermal loads) indicate higher stability of Zr doped coatings. The annealed coatings possess better mechanical properties because they are less prone to cracking and have a lower Young's modulus. In the case of cycling thermal loads the hardness and Young's modulus of coatings grow due to thermal residual stresses. Also changing of unstable α-WB_2 to ω-W_2B_5 phase is observed in the case of coating without zirconium. Plasma - deposited W-Zr-B films with very high hardness, improved resistivity to cracking and good thermal stability are competitive to commonly used nitrides and are a good candidate as a protective and tribological coatings.

Keywords: protective coatings, magnetron sputtering, tungsten borides, superhard materials, thermal stability

Acknowledgement This work was funded by project SUPERCOAT; project number: TECHMASTRATEG-III/0017/2019

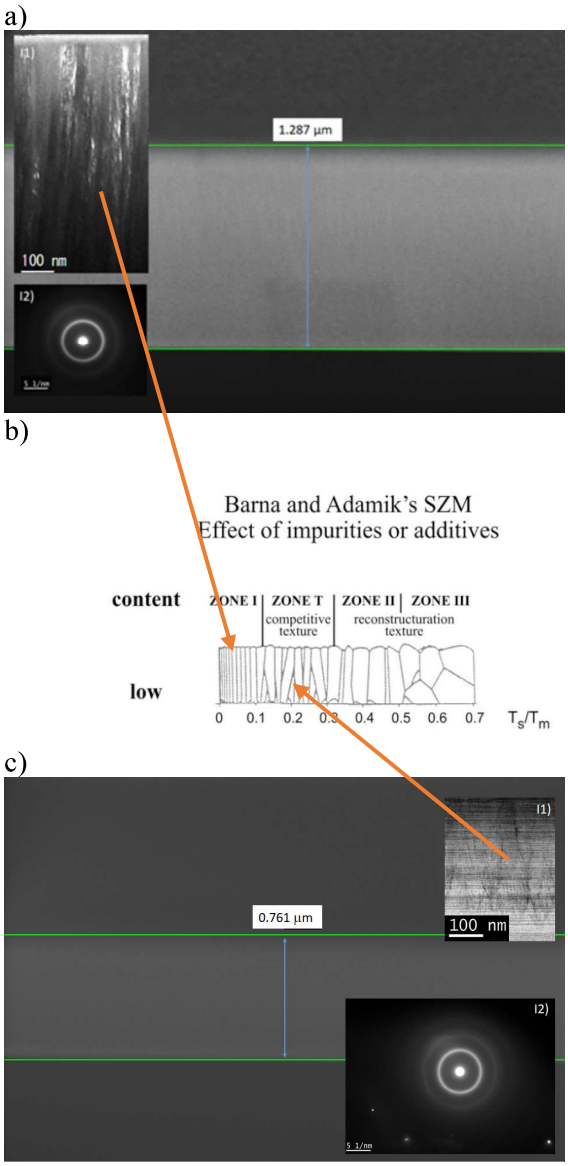

Figure 1: . Cross-section of deposited layers. a) SEM , BF STEM (insert 1) images and SAED pattern (insert 2) of W-B coating, b) effect of the amount of added element into one-phase coating on its microstructure according to Barna and Adamik structural zone model (SZM) c) W-Zr-B coating, 16 at% zirconium

References:

1. Haubner, R., Lessiak, M., Pitonak, R., Köpf, A., Weissenbacher, R. (2017) Evolution of conventional hard coatings for its use on cutting tools, *Int. J. Refract. Met. H.*, 62, 210-218.