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Preparation of Hard Yet Moderately Ductile Mo2BC Thin Films by Pulsed-DC Magnetron Sputtering

Stanislava Debnárová, Pavel Soucek, Petr Vasina, Lukáš Zábranský, Vilma Buršíková

Faculty of Science, Masaryk University, Brno, Czech Republic

debnarova@mail.muni.cz

A thin film deposited on the surface of a tool can substantially influence its durability and performance. The most frequently used coatings in industry are ceramic coatings with great hardness and stiffness. However, these coatings are quite brittle, which can cause the formation and spreading of cracks. To prevent the formation of cracks, the material of the film should exhibit ductile behaviour. The combination of high hardness and moderate ductility has been discovered in the nanolaminate Mo_2BC. Mid frequency pulsed-DC magnetron sputtering was used to deposit thin Mo_2BC films. This method was chosen, because it is relatively simple and therefore industry-friendly. The energy necessary for the formation of a crystalline film was provided by the ion bombardment enhanced by the use of pulsed voltage and possible optional application of bias on the substrate. The ion flux onto the substrate was increased nearly by a factor of 3 by employing 350 kHz pulsing at duty cycle of 65% compared to DCMS. Utilizing pulsed DC yielded 1.6-1.9 incoming bombarding ions to 1 stuck atom of the film. Moreover the deposition process of co-sputtering of Mo, B4C and C targets was proven to be very stable and repeatable. The coatings were very smooth with average roughness of < 0.5 nm. Grazing angle of incidence X-ray diffraction was used in order to estimate the level of crystallinity. Thin films prepared without any external heating were amorphous. Thin films prepared at 320°C and 550°C were partially crystalline. Not reaching full crystallinity can be partly due to non-optimal chemical composition for stoichiometry. Even though the coatings shown hardness of > 20 GPa and no cracks were propagating from the residual indents indicating good fracture toughness. This research has been supported by the project CZ.1.05/2.1.00/03.0086 funded by European Regional Development Fund and project LO1411 (NPU I) funded by Ministry of Education, Youth and Sports of Czech Republic. The Czech Science Foundation is acknowledged for the financial support of this work - project 15-17875S.

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