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Wear Resistance and Thermal Stability of Tungsten Boride Layers Deposited by Magnetron Sputtering

Authors : Justyna Chrzanowska, Jacek Hoffman, Dariusz Garbiec, Łukasz Kurpaska, Piotr Denis, Tomasz Moscicki, Zygmunt Szymanski

Abstract : Tungsten and boron compounds belong to the group of superhard materials and its hardness could exceed 40 GPa. In this study, the properties of the tungsten boride (WB) layers deposited in magnetron sputtering process are investigated. The sputtering process occurred from specially prepared targets that were composed of boron and tungsten mixed in molar ratio of 2.5 or 4.5 and sintered in spark plasma sintering process. WB layers were deposited on silicon (100) and stainless steel 304 substrates at room temperature (RT) or in 570 °C. Layers deposited in RT and in elevated temperature varied considerably. Layers deposited in RT are amorphous and have low adhesion. In contrast, the layers deposited in 570 °C are crystalline and have good adhesion. All deposited layers have a hardness about 40 GPa. Moreover, the friction coefficient of crystalline layers is 0.22 and wear rate is about 0.67•10-6 mm3N-1m-1. After material characterization the WB layers were annealed in argon atmosphere in 1000 °C for 1 hour. On the basis of X-Ray Diffraction analysis, it has been noted that the crystalline layers are thermally stable and do not change their phase composition, whereas the amorphous layers change their phase composition. Moreover, after annealing, on the surface of WB layers some cracks were observed. It is probably connected with the differences of the thermal expansion between the layer and the substrate. Despite of the presence of cracks, the wear resistance of annealed layers is still higher than the wear resistance of uncoated substrate. The analysis of the structure and properties of tungsten boride layers lead to the discussion about the application area of this material.

Keywords : hard coatings, hard materials, magnetron sputtering, mechanical properties, tungsten boride
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