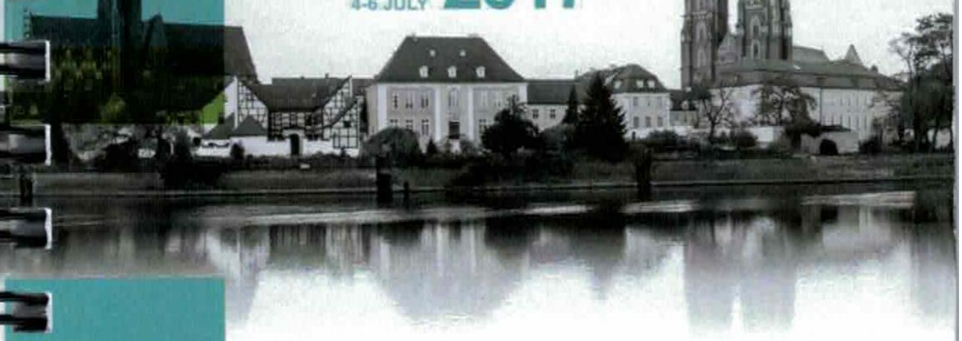
CNM 2017 WROCŁAW

5th Conference on Nano- and Micromechanics

WROCŁAW POLAND 4-6 JULY 2017



BOOK OF ABSTRACTS

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Comparison of tungsten borides layers deposited by laser pulse and magnetron sputtering

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Keywords: magnetron sputtering, pulsed laser deposition, superhard materials, tungsten borides

Introduction Tungsten and boron compounds belong to the group of superhad materials and their hardness could exceed 40 GPa [1]. Moreover, these materials could be even harder when they are deposited in the form of a layer [2]. In this study the characterization of microstructure, chemical composition and mechanical properties of the tungsten borides layers deposited by laser pulse and magnetron are presented.

Materials and methods

All layers were deposited from the same target with the boron to tungsten ratio of 2.5. Properties of this target are presented in [3]. During pulsed lased deposition (PLD) the Nd:YAG laser (Quantel YG 981 E10) with a wavelength of 355 nm, repetition rate of 10 Hz and pulse duration of 10 ns was used. The spot area was 3.5 mm^2 and density of laser radiation (fluence) was 5 J/cm^2. In the magnetron sputtering (MS) process the power supplied to the magnetron cathode was 60 W and process occurred in argon pressure of $9.8 \cdot 10^{-3}$ mbar (gas flow of argon was 19.2 mL/min).

SEM and TEM images were taken by Hitachi SU-8000 and JEOL JEM-2100, respectively. XRD measurement were made with the use of Bruker D8 Discover (Cu radiation source, 1.5418 Å). Nanoindentation tests were carried out with diamond Vickers tip under the load of 10 mN. Hardness was calculated using the Oliver-Pharr method.

Results and discussion

Pulsed laser deposited layer has droplets on its surface and the droplets size varied from tens nm to several µm. The process of droplets formation was registered by ICCD camera and showed that droplets were ejected after the plasma plume had stopped interacting the target surface (about 2000 ns after laser pulse) and droplets ejection ended after 6 μs. This observation makes it easy to see that the application of the rotary shading could allow to deposit homogenous and smooth PLD layers without any debris on its surface. Further analysis of PLD layer shows that it has nanocrystalline microstructure and hexagonal WB_3 phase with cell parameters a = 5.200 Åand c = 6.313 Å. Nanoindentation test shows that layer has a hardness of 47 GPa.

Layer deposited by magnetron was very smooth (Ra = 0.002 μm) and had columnar microstructure with column diameter of about 40 nm. XRD diffraction pattern of layer deposited by magnetron has only one diffraction line, positioned at 28.8$^o 2\theta$. TEM analysis (figure 2) allow to determine phase composition and cell parameters of the layer. Magnetron sputtered layer has hexagonal α-WB structure with cell parameters a = 3.128 Åand c = 16.559 Å. Nanoindentation test shows that layer has a hardness of 70 GPa under.

Summary In this work WB_3 layer was deposited by laser pulse and $\alpha - WB$ layer was deposited by magnetron. Both WB_3 and α-WB layers were superhard. In the examined parameters range the magnetron sputtering leaded to the deposition of layer with significantly lower boron content than layer deposited by PLD. Still, magnetron deposited layer

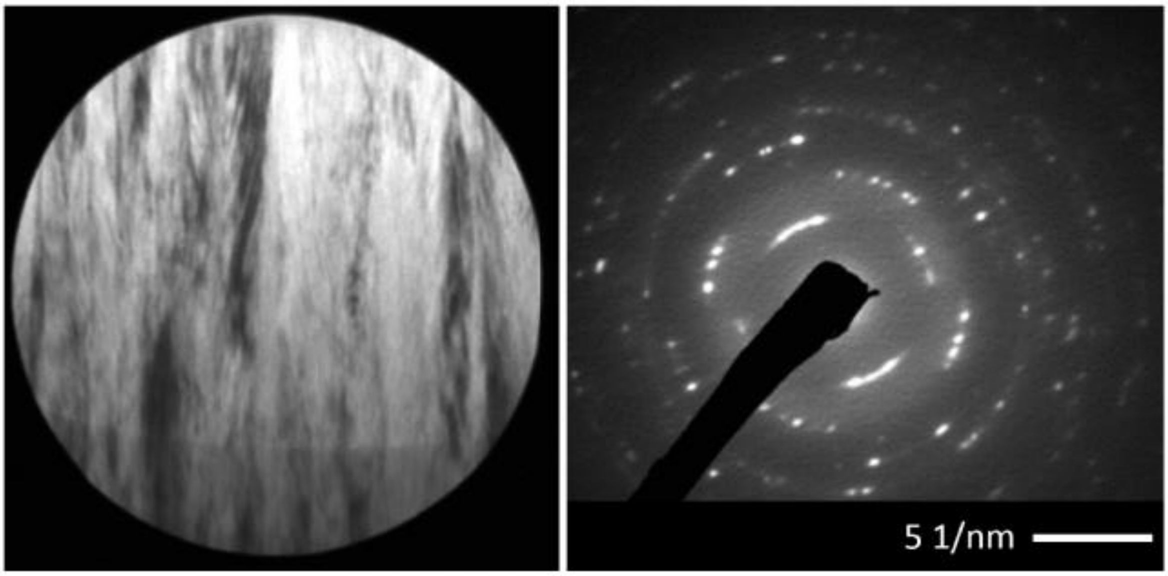

Fig. 1: Selective area electron diffraction of the layer deposited by magnetron with sputtering power of 60 W

had better mechanical properties because it is more homogenous, smooth and harder than layer deposited by laser pulse.

Acknowledgments

This work was supported by the NCN (National Science Centre) Research Project: 2015/19/N/ST8/03928

References

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