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Dr Tomasz Moscicki studied at the Faculty of Power and Aeronautical Engineering Warsaw University of Technology in Warsaw. In 2007, he received a Ph.D. title at the Institute of Fundamental Technological Research PAS, Warsaw, Poland. In 2017, he obtained the title of doctor habilitus (D.Sc.) in mechanical engineering. From February 2019 he is a member of the Scientific Council of IPPT PAN. From January 2020 he is head of Division of Technological Laser Applications in Department of Experimental Mechanics. Also in 2020 he obtained a professors position at IPPT PAN. In his works, he mainly deals with the structural and mechanical properties of superhard materials such as transition metal borides. Actually, during his work he studies the influence of deposition parameters on properties of thin films deposited by Pulsed Laser Deposition (PLD), Magnetron Sputtering (MS) and also hybrid method PLD+MS.

He is also expert in laser technologies such as laser welding, laser ablation, nanoparticle synthetizing and he studies a plasma induced during those processes. His interests include not only experimental research but also theoretical modeling of the mechanical and thermal properties of deposited films, which is the topic of his current research project. He co-authored over 40 journal papers cited over 730 times (H – 15). He has been a manager of four projects funded by Polish agencies (NCN, NCBiR). He received 4 individual and team awards for academic achievements from the Director of Institute of Fundamental Technological Research PAS (between 2016-2022). He was a reviewer above 70 scientific articles and was an expert in National Science Center of Poland (above 50 projects applications) in mechanical and material engineering.

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Theoretical and experimental studies of superhard W-Ti-B coatings deposited using the HiPIMS method

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High-power impulse magnetron sputtering (HiPIMS) is thin film deposition from standard magnetrons using pulsed plasma discharges, where a large fraction of the material used in the deposition process arrives at the workpiece as ions instead of commonly used neutrals. HIPIMS utilizes extremely high power densities of the order of kW/cm^2 in short pulses of tens of microseconds at low duty cycle (on/off time ratio) of < 10%. Distinguishing features of HIPIMS are a high degree of ionisation of the sputtered material and a high rate of molecular gas dissociation. The benefit of having an ionized deposition flux is that it can be guided and manipulated by electric and magnetic fields. This allows for increased control of the microstructure and properties of the coatings.

In this work as an example the superhard (H>40 GPa) and "flexible" $(W,Ti)B_2$ coatings are presented. The "flexible" means that ceramic films are characterized by increased ductility and high crack resistance. The deposited coatings are dense, partially crystalline and possess void free microstructure. Such interesting properties can be obtained by two different ways: addition of alloying element to WB_2 hexagonal structure and choosing of optimal condition of deposition such us substrate temperature, additional polarization of substrate (bias voltage) and selection of HiPIMS parameters like power, pulse duration and frequency.

The explanation of special features of presented coatings is not ease and need studies in different scales, starting from atomic scale. In this work potentially superhard $W_{1-x}Ti_xB_2$ polymorphs hP6-$P6_3$/mmc-WB_2 and hP3-P6/mmm, were thoroughly analysed with titanium doping in the range of x=0-25%, within the framework of the first-principles density functional theory, from both a structural and a mechanical point of view. The obtained results were subsequently compared with the properties of material deposited by the magnetron sputtering method (fig. 1).

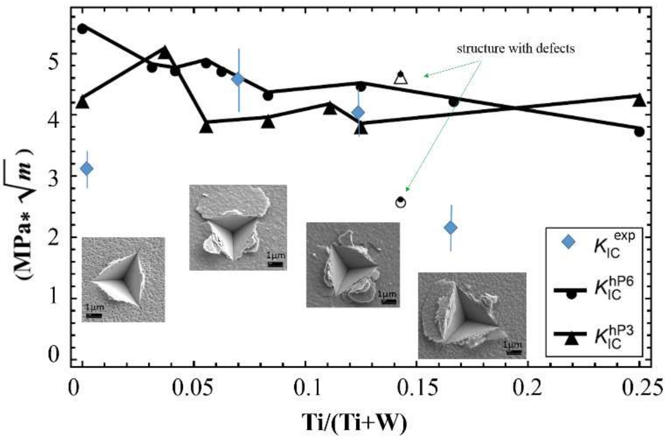

Figure 1. Theoretical and experimental fracture toughness of W-Ti-B coatings

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