Topical Symposia
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TSP-1 Transparent nc-Z_rB_2/a-BN Films for Protection of Optical Devices*, Philipp Kiryukhantsev-Korneev (kiruhancev-korneev@yandex.ru), A. Kozlova, K. Kozlova, E. Levashov,* National University of Science and Technology "MISiS", Russia

Protection of optical devices (portholes and solar cells, solar collectors, etc.) from abrasive effects can be provided by the use of wear - and erosion-resistant ion-plasma coatings, including those based on oxygen-free ceramics. The use of hard and optically transparent Zr-B-N films is promising. Ceramic nanocomposite films were deposited by DC and pulsed DC magnetron sputtering of ZrB/2/ target in the Ar+$N_{/2/}$ gas mixtures. The targets were manufactured by means of self-propagating high-temperature synthesis. The structure, chemical and phase composition of films were studied by high resolution transmission and scanning electron microscopy, X-ray diffraction, X-ray photoelectron spectroscopy, Raman and infrared spectroscopy, energy-dispersive analysis, and glow discharge optical emission spectroscopy. The films were characterized using nanoindentation, sliding pin-on-disk, impact ball-on-plate, abrasive calowear, and scratch tests. The refraction index, coefficients of transmittance (Tr) and reflectance were measured by Cary 5000 Agilent + UMA attachment for wavelength range from 200 to 2500 nm. Results obtained show that films deposited at low nitrogen partial pressure predominantly consist of nanocrystallites of hexagonal ZrB2-phase, 1-20 nm in size and amorphous regions. N-rich films exhibit amorphous structure (a-BN) with nanograins of Zr-contained phases. Specific optical properties were observed for these Zr-B-N coatings including Tr=70-100%. The hardness of 15-37 GPa and Young’s modulus of 150-470 GPa were determined for films deposited onto alumina substrates. Coatings demonstrated friction coefficient 0.2-0.4. The addition of nitrogen significantly increased wear resistance in sliding and impact conditions. The work was supported by the Russian Foundation for Basic Research (Agreement No. 19-08-00187)

TSP-2 Novel AuAgSI Thin Film Metallic Glasses With Outstanding Electrical and Mechanical Properties*, **Lisa-Marie Weniger (lisa-marie.weniger@stud.unileoben.ac.at)**, O. Glushko, C. Mitterer,* Montanuniversität Leoben, Austria*; J. Eckert,* Erich Schmid Institute of Materials Science, Austrian Academy of Sciences, Austria

Gold based thin film metallic glasses (TFMGs) on polymer substrates combine the high elastic strain limit, low electrical conductivity and superior chemical properties of noble metallic glasses with the flexibility of polymers. This work systematically investigates the novel AuAgSi system to gain fundamental knowledge about thin film metallic glasses as well as tune the composition towards optimized electrical and mechanical properties.

$Au_{85-x}Ag_xSi_{15}$ TFMGs were deposited by magnetron sputter deposition on polymer substrates from the respective three elemental targets. Different compositions with x varying between 0 and 85 at% were fabricated and compared to Au and AgSi. Film thicknesses ranging between 12 nm and 1000 nm were deposited to investigate possible size effects within this system. The amorphous state was confirmed by X-ray diffraction; additionally, time-dependent measurements were performed to prove stability of the TFMGs. The three-component films with Ag contents between 20% and 60% were amorphous and stable over the observed period of two months. In contrast, AgSi and AuSi as well as $AuAg_{10}Si_{15}$ and $AuAg_{70}Si_{15}$ were crystalline. Moreover, the binary systems were unstable showing spontaneous phase separation or even film delamination with time.

In case of crystalline metals, the resistivity of a thin film drastically increases for thickness below 10-20 nm. Contrary to this behavior, metallic glasses like AuAgSi exhibit a constant resistivity over a wide range of film thicknesses. The investigated AuAgSi TFMGs have a lower resistivity than crystalline gold with thicknesses below 13 nm. Additionally, a negative coefficient of resistance was found within this system, which could prevent overheating in potential microelectronics applications these TFMGs.

Mechanical properties of AuAgSi TFMGs were systematically characterized by monotonic tensile tests combined with in-situ resistance measurements. The critical strain, at which cracks are generated and propagate homogeneously, is at least 3% for all amorphous compositions and even higher for film thicknesses below 25 nm. Scanning electron microscopy characterization revealed a fracture morphology characteristic for metallic glasses with two distinct types of shear bands. The high elastic strain limit of the investigated TFMGs results in excellent bending fatigue properties. After 50,000 cycles with an effective bending strain of 1.25%, AuAgSi TFMGs did not exhibit any damage, whereas massive fatigue damage was induced in the crystalline Au sample. This outstanding cyclic performance makes AuAgSi TFMGs a promising candidate for flexible microelectronic devices.

TSP-3 Fe-based Thin Film Metallic Glass Coated on Porous Substrates as an Alternative Photocatalysts for Decolorization of Dye in Industrial Wastewater*, **Bryan Hubert (bryan_hubert_alim@yahoo.com)**,* National Taiwan University of Science and Technology,Taiwan*; J. Chu,* National Taiwan University of Science and Technology (NTUST), Taiwan*; P. Yiu,* National Taiwan University of Science and Technology, Taiwan

Fe-based thin film metallic glasses (TFMGs) with different atomic compositions were fabricated by magnetron sputtering deposition on various porous substrates to act as a catalyst for dye decolorization. This method showed high potential for effectively coated TFMGs with lower heat required and low-cost process, while Fe-based TFMGs coated on various kind of porous substrates i.e. filter paper exhibited higher color removal efficiency and faster dye decolorization performance compared to the bare filter paper. This result was occurred due to Fe-based TFMGs was a zero-valent iron which had an amorphous atomic packing structure to activate sulfate radical as a reactive species to decompose organic material in dye solution become non toxic substance and its surface contact area enhancement.

The synthesized TFMGs were first characterized by Scanning Electron Microscopy (SEM) and Energy Dispersive Spectroscopy (EDS) to check its morphology, deposition quality, and chemical composition, followed by X-Ray Diffraction (XRD) to confirm its amorphous structure. Photocatalytic activity of TFMGs that involved peroxymonosulfate (PMS) activation on the degradation of typical industrial dye in wastewater, were investigated under combination of various parameters, such as LED irradiation, dye concentration, PMS concentration, film thickness, and catalyst amount. The reusability of TFMGs as a catalyst were also studied in this experiment by repeating the degradation process for multiple times. The result was further discussed in this study by the related authors.

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