Dual-phase CuZr thin film metallic glasses (TFMGs) deposited by PVD magnetron sputtering: bias voltage and thickness dependency of structure, hardness, and wear resistance

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Abstract:
Bulk metallic glasses (BMGs) show appealing mechanical properties including high hardness, desirable corrosion resistivity, and thermal characteristics[1],[2]. BMGs suffer from brittleness due to their short-range structure and lack of the dislocation-like crystalline defects. The thin film configuration (TFMGs) has received a lot of attraction in recent decades due to additional interesting properties as high strength, ductility sometimes beyond 10%, and notable corrosion and wear resistance[3],[4]. In this study, the structure of crystalline Cu/Zr and novel multilayered dual-phase CuZr TFMGs deposited by PVD magnetron sputtering are compared for different deposition conditions (0V, 100V, 150V, 200V bias voltage) and various coating thicknesses (230nm, 420nm, 620nm, 700nm). Films characterization has been done by XRD, SEM, TEM, XPS, and Profilometer. Hardness and wear resistance relative to deposition conditions were studied by nano-indentation and pin-on-disc respectively. Improved mechanical properties are observed in dual-phase CuZr TFMG sample in comparison with crystalline Cu/Zr and mono-phase CuZr films. According to our observation, increasing bias voltage act as a double edge sword: it leads to an increase in mechanical properties then decreases above 150V. Higher thickness leads to a decline in mechanical properties. Overall, the best mechanical properties were achieved for 150V bias and below 500nm dual-phase metallic glass thin film.

Keywords: Metallic glasses, Thin films, Cu-Zr alloys, Magnetron sputtering.

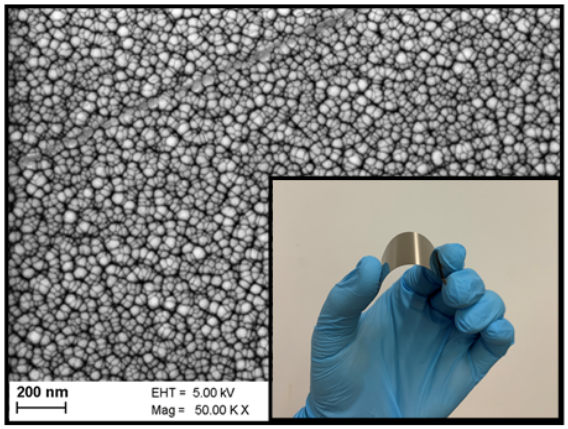

Figure 1: Hard enough Flexible CuZr TFMG with columnar nano-structure.

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