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Structuring surfaces from thin film metallic glasses: bottom-up and top-down approaches

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Obtaining new nanostructured surfaces is of crucial importance in the development of modern industry. Metallic glasses (MGs) have emerged as a new class of materials with remarkable properties compared with their crystalline counterpart. Meanwhile, phase separation phenomenon is widely observed in thin films and has been thoroughly studied in order to manipulate the resulting functional properties. Here, we explore two routes for surface structuring supported on the separation of amorphous and crystalline phases of initially grown thin film metallic glasses. First, we developed a novel and simple bottom-up approach, applicable to a broad range of alloys, for the design of adjustable multifunctional surfaces. We demonstrate that the composition-driven transition to the crystalline state occurring in thin film metallic glasses offers an excellent scenario for the fabrication of two-phase crystalline-amorphous nanostructures. The resulting surface topography can be controlled by thickness and composition, consequently, surface-related properties such as optical reflectance and wettability are manipulated to a large extent. Second, a top-down approach is developed based on laser irradiation of thin film metallic glasses, allowing the generation of ripples known as laser-induced periodic surface structures (LIPSS). We report on the laser-induced structural changes occurring at the surface and near-surface in thin film metallic glasses. Sputter-deposited Zr-Cu thin films, largely known for their good glass forming ability, were used as a model system. Transmission electron microscopy has been used to study the evolution of the film structure, microstructure and composition after laser irradiation, shedding new light on the laser-amorphous material interaction process. Our results delve into the control of surface topography and related functional properties in thin films, opening new avenues for future applications.

Keywords
Thin film metallic glass
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sputtering
phase separation
LIPSS