Evaluation of frictional anisotropy of metallic thin films deposited by GLAD

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During the last few decades, the versatility and properties of thin films have been heavily studied and various applications have been developed. The Glancing Angle Deposition (GLAD) is one of the newest techniques to emerge and is based on sputtering deposition following a grazing incidence. As a result, thin films can be produced with complex architectures such as vertical and inclined rods, helical columns and zig-zag shapes. Controlling these geometries allows to obtain optimal optical and thermoelectric properties, and in some cases an important anisotropy. However, although these physical properties are well studied, thin films deposited via GLAD technique may have structural features that also lead to singular mechanical and tribological properties that have not yet been fully addressed by the scientific community. Thus, this study aims to fill some of the gaps in the understanding of mechanical and tribological behaviors of this type of material and the presence of anisotropy. For this purpose, 400 nm thick thin films of tungsten (W) were deposited following different deposition angles: 0°, 30°, 40°, 50°, 60°, 70°, 80° et 85°. To evaluate their degradation modes present, increasing load scratch tests from 0.01 N to 8.00 N were performed. Then, constant load scratch tests were done at three different force levels to verify their friction behavior. In order to evaluate the presence of anisotropy, all the tests were done following eight directions of solicitation. The results of friction coefficients show that for deposition angles above 50°, a well-identified frictional anisotropy for W is observed between the transversal and longitudinal directions. However, for smaller deposition angles, isotropic behavior or different anisotropies are observed. The variability of the responses is related to the different microstructures and roughness, and especially, to the evolution of morphology from dense films to nanocolumns with elliptical shapes. Moreover, even though tensile cracks are present in most scratch traces, several degradation modes are observed, and the force values at which the defects occur change as function of the solicitation angle.