Anisotropic behaviors in metallic thin films obliquely sputter-deposited

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For the deposition of GLAD thin films by sputtering, it is commonly admitted that the one-dimensional nature of the shadowing process yields directional column growth [1]. On the other hand, there is no clear mechanism restricting the transverse growth of the column cross-section, i.e. in the direction perpendicular to the particle flux. This asymmetry may lead to columns with an elliptical cross-section and a significant fanning of the columns shape [2]. The motivation of this study is to understand the correlations between this structural asymmetry in tilted columnar metallic thin films and their anisotropic properties in terms of electrical conductivity and surface acoustic wave propagation. To this aim, various metallic films (W, Au, Mo, Zr, Ag, Cu …) have been first deposited by GLAD sputtering using a constant inclination angle of 80° and an argon sputtering pressure of $4.0x10^{-3}$ mbar. It is shown that the tilted column angle and, particularly the elliptical shape of the columnar structure strongly depend on the nature of the sputtered metal. Metallic films like W or Mo exhibit a clear fanning of the columns cross-section, which leads to important anisotropic behaviors of electrical resistivity and sound velocity. Other metallic films like Au, Ag or Cu give rise to a more isotropic columnar growth and thus, no significant anisotropic behaviors. Emphasis is finally put on W films. A systematic change of the argon sputtering pressure from $2.5x10^{-3}$ up to $1.5x10^{-2}$ mbar allows tuning the column angle and more interestingly, morphology of the columnar microstructure: from elongated to nearly circular shape as the pressure increases. Here again, some anisotropic behaviors are investigated and discussed as a function of the argon sputtering pressure.

Keywords:
Metallic films, tilted columns, fanning, anisotropy, electrical resistivity, acoustic wave propagation

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[2] A. Barranco *et al.*, Prog. Mater. Sci., 76 (2016) 59.