Effects of the terrace and grain faces on the surface roughness scaling of gold polycrystalline thin films

C. González, R. Henriquez, L. Moraga, R. Muñoz and M. Flores
Departamento de Física, Facultad de ciencias Físicas y Matemáticas, Universidad de Chile, Chile.

There is significant interest in the structure of deposited metal thin films due to their wide application as critical components in electronic, magnetic, and optical devices. The functionality of these films is determined by their physical structure, which includes surface roughness, grain-size distribution and crystallographic orientation. As an example, the charge transport in gold polycrystalline thin films is strongly determined by, among other mechanisms, the electron-surface and the electron-grain boundary scattering [1].

Surface structures that preserve a similar morphology upon a change of magnification and a rescaling of the third dimension are termed self-affine and play a central role in the understanding of the growth mode of the films. For a self-affine growing surface, the roughness can be expressed like $\sigma \sim L^{\alpha}$, where L is the length over which the roughness is measured and α is the spatial scaling exponent [2].

We report a study of the surface roughness of gold polycrystalline thin films evaporated onto mica. Several thicknesses were prepared for this study. The films surface topography was imaged with a STM, with length scale from 10 nm to 1500 nm. STM-topographic images are displayed in the Fig.1, and from those images the characteristic RMS values over ten images have been obtained. L vs σ is displayed in the Fig.1, showing an anomalous behavior. Different roughness regimes are identified and tree different α exponents are well defined from the best fit of the experimental data (solid line). The length scale where the exponent changes is comparable to the lateral size of the terrace and grain diameter.

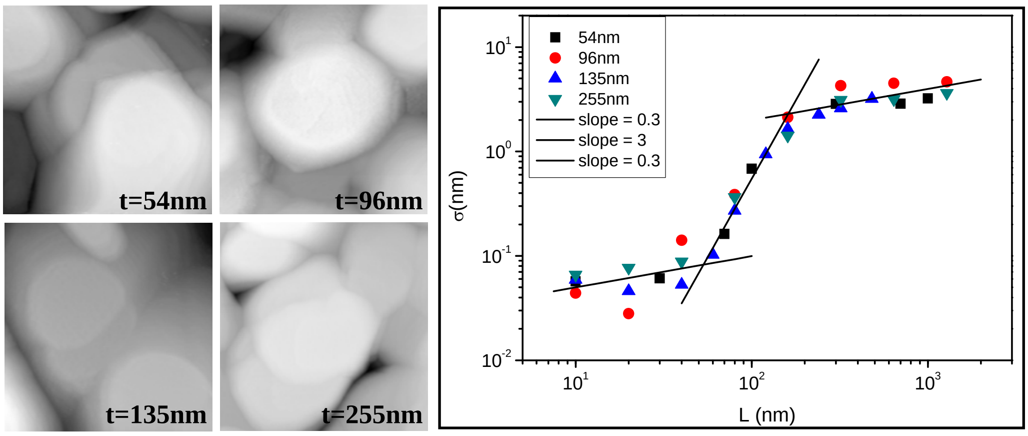

Fig.1 Left panel: STM-topographic images of Au polycrystalline thin films for different tickness (t). Right panel: Surface roughness (σ) dependence of the length scanning (L).

Keywords: Surface roughness, Au polycrystalline thin films, scanning tunneling microscopy.

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[2] J. Krim et al., Phys Rev. Lett **70**, 57 (1993).

e-mail correspondente author: mflorescarra@ing.uchile.cl