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Effective elastic constants estimation in multilayered thin films

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Abstract:

Understanding the mechanical behaviour of nanostructured thin films in terms of their specific microstructure is of utmost importance in the development of technological applications [1]. At nanometre length scales, mechanical properties are significantly altered [2]. The processes responsible for these changes are not yet fully understood but are believed to be caused by grain-surface and grain-boundary volumes becoming dominant over the bulk. In the case of elastically anisotropic layers, changes can be further caused by the influence of the thickness on the grains orientation distribution.

In this presentation, we will show a study on the elastic properties of metallic polycristalline multilayers deposited by magnetron sputtering. In a first time, we will describe a 2-scale transition model for estimating their effective elastic constants from the intrinsic properties of elementary constituents (grains), taking into account

(i) the thickness ratio of each kind of layer

(ii) the grains orientation distribution in each kind of layers

In a second time, we will confront this model to experimental data obtained by acoustic techniques (Brillouin light scattering, picosecond ultrasonic) and nanoindentation. The effect of crystalline orientations (developed during the elaboration process) and layer thickness will be discussed.

[1] Meyers, M. A., Mishra, A., and Benson, D. J. Mechanical properties of nanocrystalline materials. Prog. Mater. Sci., 2006, 51, 427.

[2] Arzt, E. Size effects in materials due to micro-structural and dimensional constraints: a comparative review. Acta Mater., 1998, 46, 5611.