

ELASTIC PROPERTIES OF METALLIC THIN FILMS : 2D SYNCHROTRON XRD ANALYSIS AND IN SITU TENSILE TESTING

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Mechanical behavior characterization of polycrystalline thin films in relation with their microstructure is the preliminary step for the development of technological applications. However, in situ study of this relationship between mechanical properties and microstructure still remains too rarely explored. The considered approach in our work consists in preparing thin films with controlled microstructure, characterizing the mechanical response of these films thanks to the development of diffraction based techniques, and finally interpreting experimental results using mechanical modeling of elastic grain interaction for example [1, 2]. This method is applied to model thin films such as tungsten (elastically isotropic) and gold (strongly anisotropic) [3] which are deposited on Kapton substrates by using well controlled ion beam sputtering techniques. The mechanical response is then characterized in the elastic and plastic domains through in situ tensile testing in diffractometers available at our laboratory and at synchrotron beam lines [1 - 3]. The use of synchrotron radiation (high flux, tunable wavelength) together with bi-dimensional CCD detectors, leads to quick recording of diffraction rings for all diffracting phases (Au, W, Au/W multilayers) during tensile testing. This combination allows accurate and reliable determination of intragranular strains (few seconds in the present case at 11.3.1 ALS beam line) [1, 4] against several hours in our laboratory). $\sin^2\psi$ analysis is then applied to a large number of tests which then brings more detailed information on the mechanical behavior of thin films.

[1] P.Goudeau, D.Faurie, B.Girault, P.-O. Renault, E. Le Bourhis, P. Villain, F. Badawi, O. Castelnau, R. Brenner, J.-L. Bechade, G. Geandier, N. Tamura (2006) "Strains, stresses and elastic properties in polycrystalline metallic thin films: in situ deformation combined with x-ray diffraction and simulation experiments", Material Science Forum 524-525, pp. 735-740.

[2] D. Faurie, P.-O. Renault, E. Le Bourhis, Ph. Goudeau, O. Castelnau, R. Brenner, G. Patriarche (2006) "Elastic behavior of polycrystalline thin films inferred from in situ micromechanical testing and modeling", Applied Physics Letters 89 (6), 061911.

[3] D. Faurie, P.-O. Renault, E. Le Bourhis, Ph. Goudeau (2006) "Study of texture effect on elastic properties of Au thin films by X-ray diffraction and in situ tensile testing", Acta Materialia 54, pp. 4503-4513.

[4] <http://www-als.lbl.gov/>, <http://xraysweb.lbl.gov/BL1131/1131website/>