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In Situ Analysis of Two-Dimensional Distribution of Stresses in Growing Films

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It has been evidenced that lattice strains have drastic effects on mechanical, electrical and magnetical properties of solids. This points out the importance of precise and detailed structural and strain determinations in layered materials. Ion irradiation allows one to modify, in a controlled way and in the solid state, the structural characteristics of a material. Although the role of ion bombardment during film growth is now well demonstrated, only a few studies have adressed the role of irradiation on residual stresses. Furthermore, in situ studies of stress kinetics are practically absent.

In our setup laser interferometer is installed in a window of a vacuum chamber and provides in situ monitoring of 3D surface profiles. In vacuum chamber there is sample, on which surface film (Ag, Al, Au, TiO_2, etc.) is deposited during ion beam bombardment (E=0.1..10keV). Expanded beam of He-Ne laser covers sample surface area of 40 mm in diameter. Obtained interference fringes may be photographed or recorded by VCR (for dynamical analysis). Simple counting of interference fringes provides accuracy of 0.15um for profile measurements, and additional intensity measurements enable to increase the accuracy up to 1nm.

Original image analysis technique is used to enhance quality of the interference pictures, mark interference fringes and measure their coordinates. This data provides 3D surface profile relative to the reference surface. Real 3D strain profile (see fig.1) is obtained as a difference of two such profiles before and during some investigated process. Smoothing of the 3D strain profile and implementation of a model describing mechanism of the deformations enable to determine 2D field of integral stress (see fig.2) responsible for the measured strain.

Measured 3D surface profile

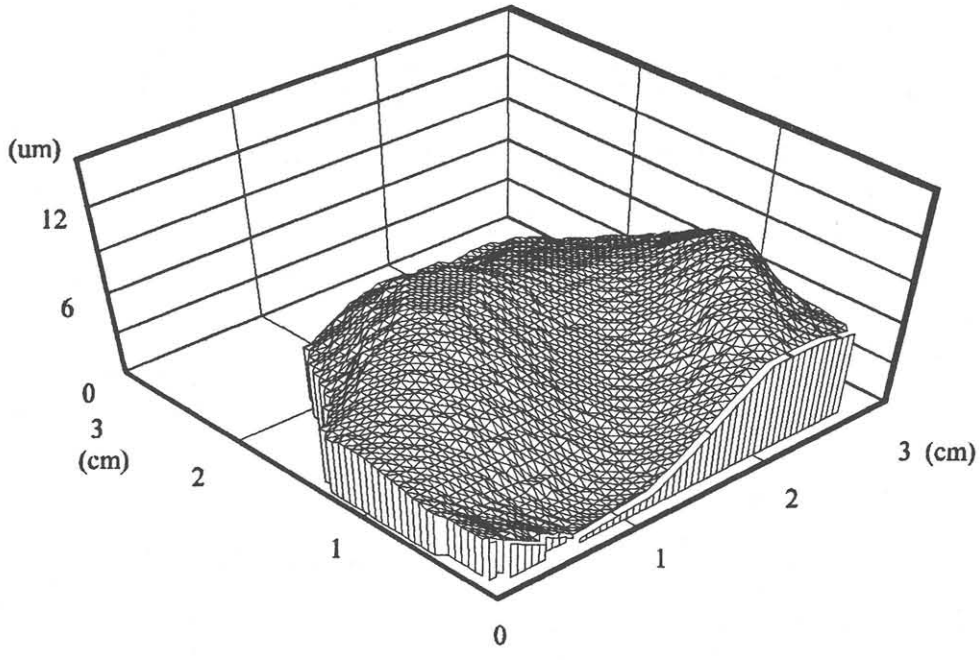

Fig.1

2D stress field

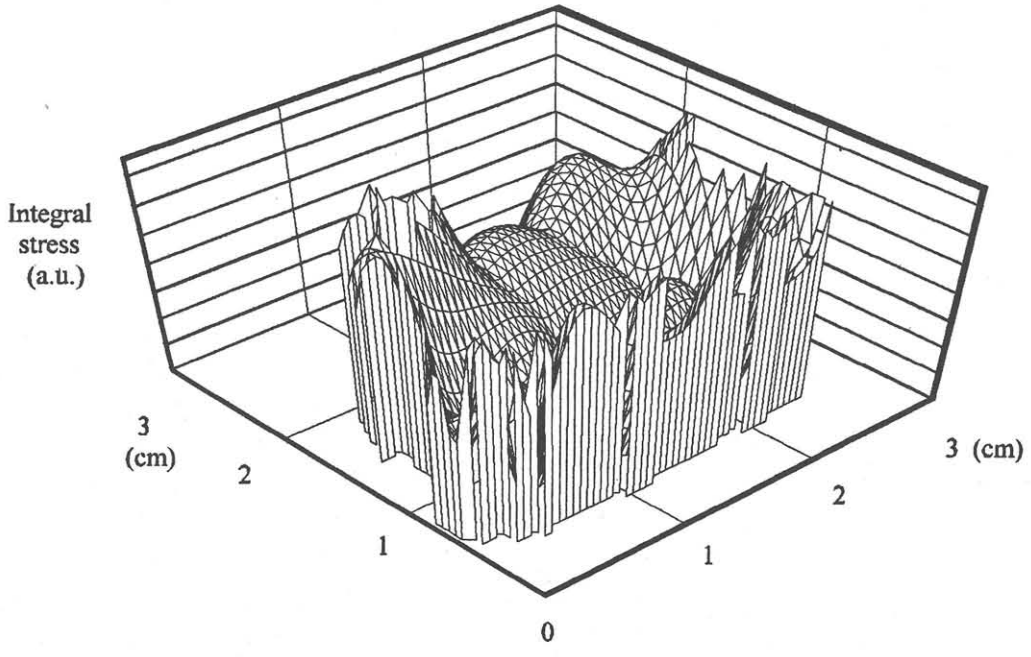

Fig.2