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Plane-strain Bulge Testing of Thin Films under Compressive Residual Stresses

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Abstract

The Bulge Test is a well-established method for the mechanical testing of freestanding thin films but is generally restricted to the investigation of membranes exhibiting tensile residual stresses. A new procedure based on successively evacuating and pressurizing the membrane from one side is suggested which provides a better estimation of the membrane initial height and extends testing possibilities to compressively stressed or buckled membranes. The robustness of the method is demonstrated by measurements on several material systems, SiO₂ and Cu/Nb sputter-deposited onto a thin SiN_x substrate. Measurements of the plane-strain modulus of the membranes show good agreement with literature and results of the residual stress levels were reasonable and coincide with the buckled state of the membranes. Moreover, Cu/Nb multilayer membranes show a consistent decrease in the compressive stress level with increasing layer thickness.

Keywords: bulge test, thin film, residual stress

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