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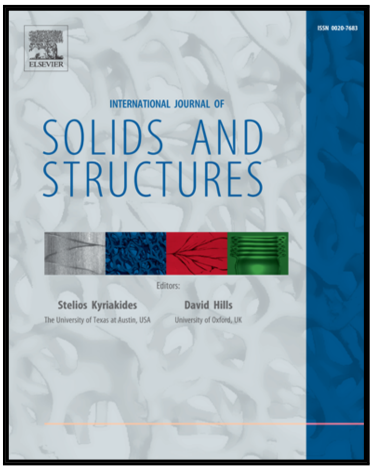

Effects of surface integrity on the mechanics of ultra-thin films

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Effects of surface integrity on the mechanics of ultra-thin films

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Abstract

A detailed formulation for the effects of the surface integrity, *i.e.* surface topography, surface metallurgy, and surface mechanical properties, on the mechanics of ultra-thin films is proposed in the framework of linear elasticity. In this formulation, the ultra-thin film is modeled as a material bulk covered with two altered layers and two rough surfaces as distinct phases. Two versions of the proposed formulation are developed. In the first version, the governing equations are obtained depending on the general form of the surface topography. In the second version, the governing equations are reformulated utilizing the average parameters of the surface topography. In the proposed formulation, measures are incorporated to account for the effects of the surface topography, *i.e.* waviness and roughness, surface metallurgy, *i.e.* altered layer, and surface excess energy on the mechanics of ultra-thin films. A case study for the static bending of clamped-clamped ultra-thin films is analytically solved. A parametric study on the effects of the surface roughness, waviness, altered layers, and film size on the static bending of ultra-thin films is presented. In this study, new size-dependent behaviors are revealed where the mechanics of ultra-thin films can be significantly altered for the small variations in the surface integrity.

Keywords: surface integrity, ultra-thin films, surface effects, surface roughness, nanomaterials.

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