

Numerical simulations of induced wrinkling by patterned defects in metal thin films

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Abstract

Finite-element simulations are employed to study the induced wrinkling in freestanding metal films with patterned defects under tensile loading. Evolution of the spatial wrinkling pattern over different loading stages is predicted. In the numerical simulations, we focus on the size, number and distribution of the patterned defects that control the extent of interaction between wrinkle branches generated by the defects. For Al thin films, as an example, the numerical predictions show that plasticity plays an important role in the evolution of the wrinkling patterns. It is revealed by parametric study that the spacing and dimensions of the patterned defects have important effect on the wrinkling configuration: when the defects are close to each other, strong interactions between different wrinkle branches can result in the merging of these branches into one single wrinkle with a large displacement amplitude and a well-defined profile in the out-of-plane direction. The numerical simulations of wrinkling patterns presented here can be applied for designing films with desired wrinkling pattern to obtain specific microstructural geometries for engineering applications.

Keywords: Metal thin film, Patterned defects, Wrinkling patterns, Finite-element simulations