Dual scale controlled surface roughness by wrinkling of polymer imprints

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Recently we reported an innovative way to create nanoscale patterns with a hierarchy of length scale at the nanoscale.[1] By combining surface wrinkling and nanopatterned polymer films, we create anisotropic, hierarchical surfaces whose larger length-scale (wrinkling wavelength) depends intimately on the geometry and orientation of the smaller length-scale (nanopattern). As shown in Figure 1, these patterns are created by applying a compressive strain to a pre-patterned polymer film. Depending on the orientation of the strain relative to the direction of the patterns, a broad range of hierarchical patterns can be created. We systematically vary the pattern pitch, pattern height, and residual layer thickness to ascertain the dependence of the wrinkling wavelength on the nanopattern geometry. Furthermore, we apply a composite mechanics model to gain a quantitative understanding of the relationship between the geometric parameters and the anisotropy in wrinkling wavelength.

The precise control of the characteristics of the dual length scale patterns and a quantitative description of the observed wrinkling behavior using a composite model will be presented in a great detail.

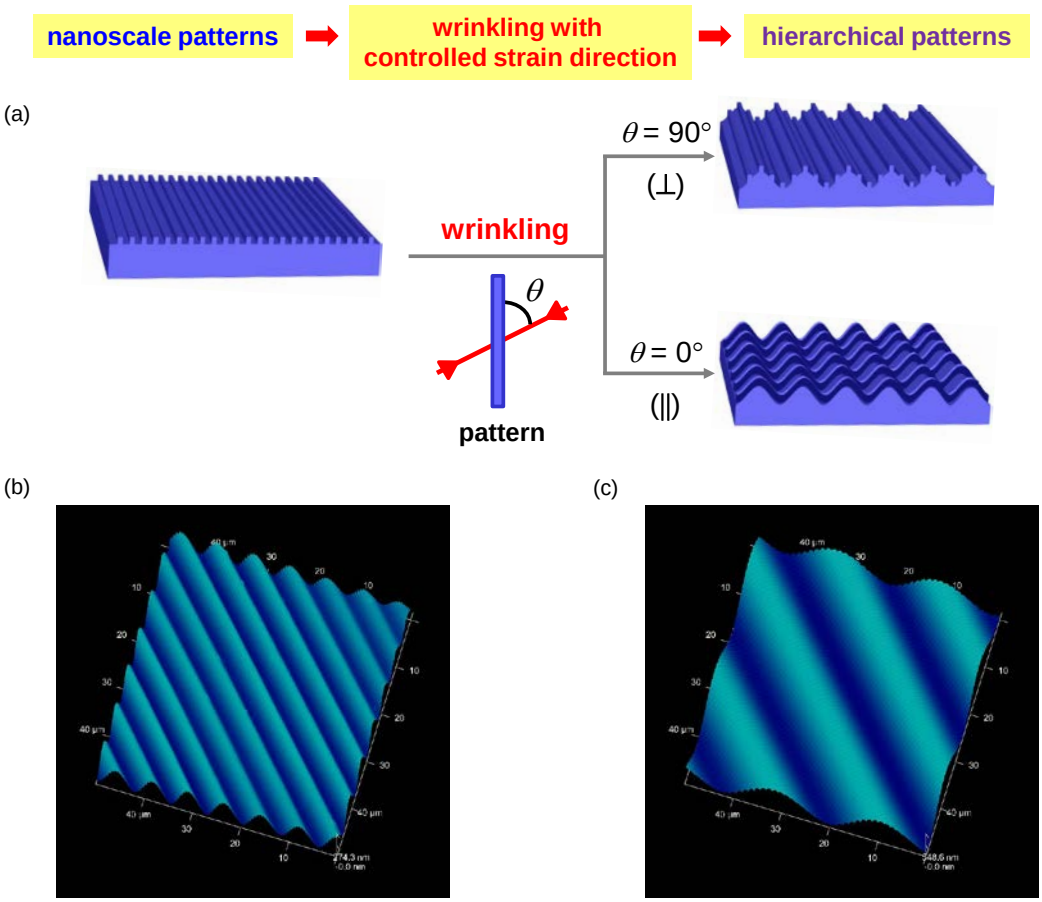

Figure 1. (a) Schematic of creating dual length scale hierarchical surface through the combination of nanoimprint lithography and wrinkling. Examples of dual length scale controlled roughness by varying the applied strain field during wrinkling where the nanoscale roughness and the micronscale roughness are (b) parallel and (c) perpendicular.

1. J. H. Lee, H. W. Ro, R. Huang, P. Lemaillet, T. A. Germer, C. L. Soles, C. M. Stafford, *Nano Letters* **2012,** *12*, 5995.