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Wrinkles or creases in a bi-layer structure LIHUA JIN, School of Engineering and Applied Sciences, Kavli Institute, Harvard University, ANESIA BURNS, RYAN HAYWARD, Department of Polymer Science & Engineering, University of Massachusetts, ZHIGANG SUO, School of Engineering and Applied Sciences, Kavli Institute, Harvard University — Wrinkles and creases are different modes of instability. In this work, we try to answer for a bi-layer structure with different modulus ratios and thickness ratios of the film and substrate whether wrinkles or creases form first when the bi-layer is under uniform compression. The onset of wrinkles corresponds to a bifurcation point, and we use the linear perturbation method to analyze the critical strain for the onset of wrinkles. Since the initiation of creases is autonomous, we directly apply the critical condition for crease initiation in a half space calculated by the finite element method in the literature to the situation of a bi-layer structure with finite thickness. By comparing the critical strains for the formation of wrinkles and creases under different modulus and thickness ratios, a phase diagram of the formation of wrinkles or creases is obtain. Although the critical strains for both wrinkle and crease initiation depend on the state of strain, remarkably the phase diagram is independent of the state of strain. As a result, creases tend to set in for more compliant and thicker films, while wrinkles tend to set in for stiffer and thinner films. Especially, when the modulus ratio of the film and substrate is smaller than 1.67, creases always form earlier than wrinkles, no matter what the thickness ratio is. We further verify the result experimentally by compressing a bi-layer of polymers with different modulus and thickness ratios.

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