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Wrinkling, Crumpling and Snapping for Surface Property Control

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Upon the development of a critical stress, many materials and geometries experience a mechanical instability, which produces significant changes in geometry with very small changes in stress. In nature, mechanical instabilities are ubiquitous with the definition of shape, morphology, and function. Examples range from wrinkles on human skin to the snapping of Venus Flytrap leaflets. Inspired by these examples and others, we use elastic instabilities to control the morphology and function of soft polymer surfaces. We present three strategies. The first is a novel approach for the development of surface wrinkles on a top-constrained elastomer surface. We demonstrate and understand the control of kinetically-trapped and equilibrium wrinkle morphologies associated with changes in the materials properties and geometric constraint. These structures are stabilized to create surfaces with enhanced adhesion and advantageous optical properties. A second strategy is based on the controlled buckling of surface attached sheets. This method allows the fabrication of responsive surface structures that are prone to snap-through instabilities and the fabrication of pattern features that are difficult, if not impossible, to achieve with any other method. The third strategy brings the bio-inspired surface control full circle with the use of mechanical instabilities to control and characterize monolayer sheets of biological cells.