Mechanical Engineering Doctoral Defense

Study on buckled stiff-thin-film on soft substrates as functional materials

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abstract

Mechanical instability is usually a problem that engineers try to prevent. Such instabilities can often lead to structural failures and collapses. For example, in engineering, buckling is instability of walls or columns under compression. And when a wall buckles, the collapse is usually sudden and catastrophic. Over the past decade or so, however, researchers have begun to embrace instability, in a more flexible way, thanks to the widespread availability of soft polymers and silicone materials. PDMS polymer is soft and elastic; Silicon, gold and ZnO are not. A strategy that overcomes this fundamental mismatch in mechanics and form has enabled exploration of a variety of applications. Configuring such hybrid structures into“wavy”shapes yields a film/PDMS system with large stretchability and the underlying mechanism is that the wavy shapes change to accommodate applied strain resulting in considerable strains in the PDMS only, but not in the film. The goal of this work is to deepen understanding of buckling behavior of thin films on PDMS elastic substrates and, in turn, to harness the fundamental properties of such instability for diverse applications ranging from tunable optical grating, spontaneously formed submicron optical mask for soft contact lithography, stretchable ZnO energy harvester, to Si-anode-based lithium ion battery.

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