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Buckling, driven by constrained phase separation, of toroid-shaped hydrogels MICHAEL S. DIMITRIYEV, YA-WEN CHANG, Georgia Institute of Technology, ANTON SOUSLOV, Universiteit Leiden, ALBERTO FERNANDEZ-NIEVES, PAUL M. GOLDBART, Georgia Institute of Technology
— We investigate the buckling process observed in connection with the temperature-induced shrinking of an elastic toroid composed of hydrogel. Hydrogels are polymeric network media that become swollen when mixed with water, provided the temperature is low enough. As the temperature is increased beyond a certain point, such gels undergo a first-order de-swelling transition to a de-mixed state, in which the network segregates from the water, resulting in a shrunken phase. It is known that the rapid heating of swollen hydrogels beyond the de-swelling transition results in the formation of a shrunken-phase boundary region, or shell. This shell hinders the expulsion of fluid associated with the equilibration of the sample interior, and gives rise to a prolonged period of coexistence between shrunken and swollen domains in the interior of the sample. In contrast with the spherical case, toroidal samples have been observed to undergo a constrained phase separation that is accompanied by a global buckling (or "Pringling") deformation of the sample shape. We present a model of hydrogel toroid Pringling in which such deformations are driven by this phase separation process.

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