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Nonlinear dynamics of wrinkle growth and pattern formation in stressed elastic thin films on viscoelastic substrates

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A stressed thin film on a soft substrate can develop complex wrinkle patterns. The onset of wrinkling and initial growth is well described by a linear perturbation analysis, and the equilibrium wrinkle patterns can be analyzed based on an energy approach. In between, the wrinkle pattern undergoes a growth and coarsening process with a peculiar dynamics. By using a proper scaling along with numerical simulations, this paper develops a quantitative understanding of the wrinkling dynamics from initial growth through coarsening toward equilibrium. By considering generally biaxial stresses and anisotropic elastic modulus of the film, we show that a rich variety of wrinkle patterns (e.g., labyrinth, orthogonal, parallel, zigzag, and checkerboard patterns) emerge as a result of the competition between the material anisotropy and the stress anisotropy.