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Mathematical modelling of swelling-induced surface instabilities in deformable porous media[1] MATTHEW HENNESSY, ALESSANDRA VITALE, JOAO CABRAL, OMAR MATAR, Imperial College London — The swelling of a deformable porous medium as it absorbs liquid can generate large compressive stresses which, in turn, can induce a rich variety of surface instabilities. When controlled, these instabilities can be used to drive the self-assembly of microscale structures that find practical applications in fields such as surface patterning, imprint lithography, optically-active surfaces, and flexible electronics. Recent experiments by our group have suggested that a swelling-induced instability can occur at a surface of crosslinked polymer gels exposed to a good solvent. In this talk, we present a mathematical model for a swelling porous medium and use it to describe spontaneous pattern formation on gel surfaces. The model is based on nonlinear poroelasticity and the flow of liquid is described by a generalisation of Darcy's law that accounts for the thermodynamics of mixing. A combination of linear stability theory and finite-element simulations is used to explore the surface morphologies in the linear and nonlinear regimes. We show that the model is able to accurately reproduce experimental observations.

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