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Dynamics of swelling and drying in a spherical gel THIBAULT BERTRAND, Yale University, CHRISTOPHER W. MACMINN, Oxford University, SHOMEEK MUKHOPADHYAY, Yale University, JORGE PEIXINHO, CNRS & Université de Normandie — Swelling is a fundamental process in biology, engineering, and the earth sciences. Macroscopically, swelling is a volumetric-growth process in which a porous material expands due to the spontaneous imbibition of additional pore fluid. However, swelling is distinct from other growth processes because it is inherently poromechanical: Local expansion of the pore structure requires that additional fluid be drawn from elsewhere in the material, or into the material from across the boundaries. Here, we study the swelling and subsequent drying of a sphere of hydrogel. Despite the apparent simplicity of this problem, no model has yet shown satisfying quantitative agreement with experiments in terms of the dynamics of swelling and drying. We develop a dynamic model based on large-deformation poromechanics and we compare the predictions of the model with a series of experiments performed with polyacrylamide spheres. We use the model and the experiments to study the dynamics of swelling and drying, and to highlight the fundamental differences between these two processes. Although we assume spherical symmetry, the model also provides insight into the transient patterns that form and then vanish during swelling, as well as the tendency of large spheres to fracture during drying.

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