Diffusion-mechanical instability of a spherical gel

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When a sphere made of hydrophilic polymer is immersed in water, it experiences a volume phase transition and swells. In the case of polyacrylamide gels, the volume ratio can increase by a factor of the order of one thousand and this swelling process is nonlinear. We present an experimental study of the swelling of polyacrylamide spheres in water. During the growth, a diffusion-mechanical instability is observed and analyzed. The patterns on the surface of a sphere are first random and homogeneous. Then, wrinkles appear and their wavelength and amplitude increase as a function of time (solvent absorption). The wrinkles were first well defined hemispherical lobes and then deformed. As time proceeds, the number of lobes decreases. Finally, the final sphere is smooth and well rounded. The wavelength of these patterns are compared to patterns found in reaction-diffusion systems (Turing model) [1] and recent developments in the mechanics of soft solids (core/shell model) [2].

Recently hydrogel spheres systems have been used to study the so called 'jammed' state transition of matter, taking advantage of their deformability, friction and optical properties to image and analyze the rheology of soft particles [3]. Hence spherical gels are promising and interesting to study. Morphological instabilities of such soft swelling spheres may have important implications on tumor growth.

Références

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