Growth kinetics of NaCl crystals in a drying drop of gelatin: transition from faceted to dendritic growth

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The study of droplets of complex fluids, dried through evaporation, reviewed recently by Sefiane [1, 2] is becoming a rapidly growing field of research. The widespread interest is due to the basic physics aspect as well as promising applications in technology [3], quality control and medical diagnostics [4]. A drying droplet may exhibit a host of features, concentric ring patterns [5, 6], cracks[7, 8], and other interesting morphologies. A fact well known since many years is that gels provide a good medium for the growth of crystals [9].

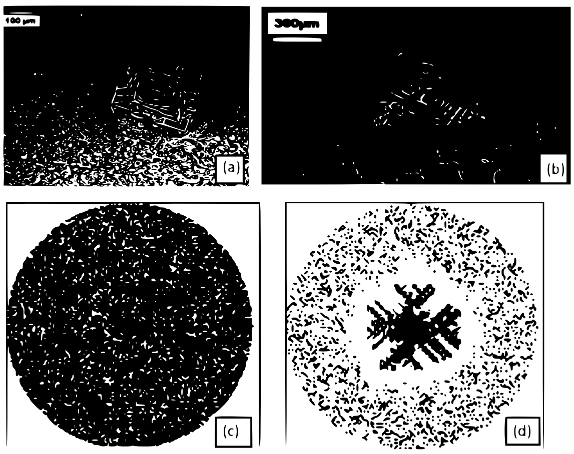

FIG. 1. (a) shows homothetic growth of the larger crystals, at times measured from the time of deposition at (a) 1 h 30 min 14 s. In the gel, which contains many air bubbles surrounds the rectangular seed crystal. A depressed region, due to depletion of the gel, is seen to develop around the crystal. (b) Dendrite growth is shown after the percolation transition from connected fluid to connected voids at time 2 h 17 min 54 s. Isolated blobs of fluid appear lighter in the snapshots. Larger blobs are incorporated into the dendrite as a whole and form a diamond shaped node in the dendrite branch. (c)Simulated structure showing uniform, faceted growth, new growth sites are shown in red. White spots in the blue fluid are voids, i.e. sites where the fluid has evaporated. (d) Simulated showing dendritic growth, the voids now span the system, with the fluid blobs isolated.

We report a study on the kinetics of drying of a droplet of aqueous gelatin containing sodium chloride. The process of drying recorded as a video clearly shows different regimes of growth leading to a variety of crystalline patterns. Large faceted crystals of mm size form in the early stages of evaporation Fig. 1(a), followed by highly branched multi- fractal patterns with micron sized features Fig. 1(b). We simulate the growth using a simple algorithm incorporating aggregation and evaporation, which reproduces the crossover between the two growth regimes Fig. 1(c - d). As evaporation proceeds, voids form in the gel film. The time development of the fluidvoid system can be characterized by the Euler number. A minimum in the Euler number marks the transition between the two regimes of growth Fig. 2 .

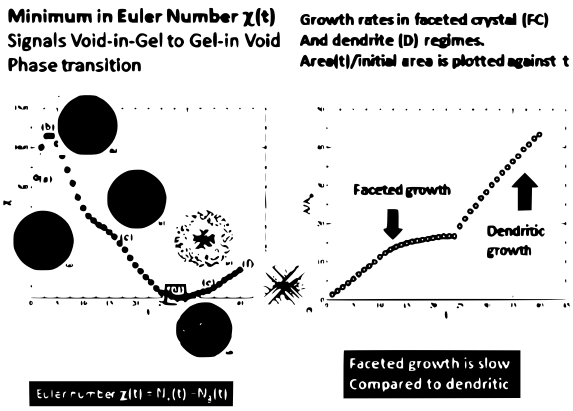

FIG. 2. Variation of Euler Number with time spent. Minimum of Euler Number shows the transition of void-in-gel phase to gel-in-void phase

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