Contact line catch up by growing ice crystals

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The effect of freezing on contact line motion is a scientific challenge in the understanding of the solidification of capillary flows. In this presentation, we experimentally investigate the spreading and freezing of a water droplet on a cold substrate. In accordance with literature [1,2], we find that solidification and temperature do not affect the spreading of the drop until the pinning time. We demonstrate that solidification stops the spreading because the ice crystals catch up with the advancing contact line. Indeed, using polarized light, we directly observe the formation and growth of ice crystals along the substrate during the drop spreading (see Fig 1), and show that their velocity equals the contact line velocity when the drop stops. Using a simple one directional diffusion argument, we model the growth of the crystals, we predict the shape of the crystal front and show that the substrate thermal properties play a major role on the frozen drop radius. [3]

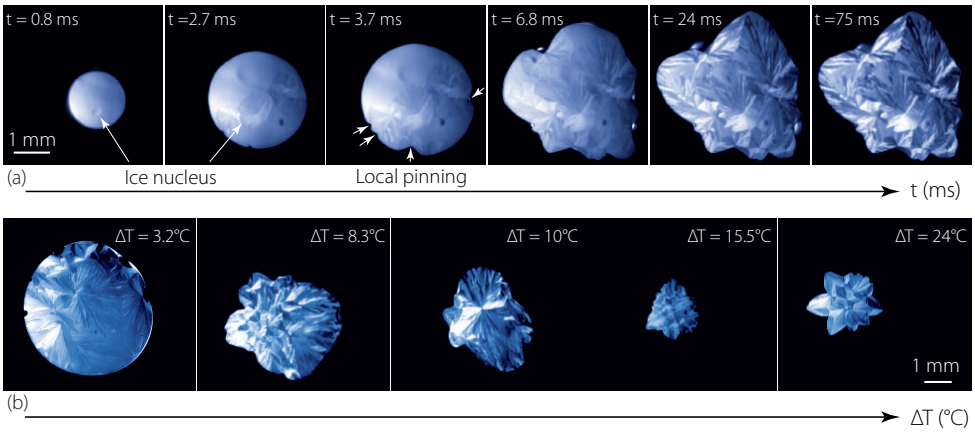

Figure 1. (a) Temporal evolution of the spreading at −13°C. Nucleation has already occurred on the first image in a small region indicated with the white arrow. (b) Final contact line shapes and ice/substrate morphologies for different temperatures.

Références

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2. R. B. Koldeweij, P. Kant, K. Harth, R. de Ruiter, H. Gelderblom, J. H. Snoeijer, D. Lohse, & M. A. van Limbeek, Initial solidification dynamics of spreading droplets, *Phys. Rev. Fluids* , **6**, L121601 (2021).
3. R. Grivet, A. Monier, A. Huerre, C. Josserand, T. Séon, Contact line catch up by growing ice crystals, *arXiv preprint*, arXiv :2005.12189 (2020).