Frost propagation on breath figures

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We investigate the process of condensation frosting on flat surfaces using thermal imaging microscopy. This method is particularly well-suited to characterize the frosting of polydisperse assemblies of dew droplets, also called breath figures, that transform into ice droplets by the propagation of frost fronts. The front propagation speed is found to be a nonmonotonous function of the characteristic droplet size of the breath figure. In our experimental conditions, the propagation speed is maximum around 70 μm.s^{-1} for a characteristic droplet radius of around 300 μm. We mainly show that the frost propagation speed is governed by the competition between two characteristic time scales. The first one is the freezing time of individual droplets, and the other one is the formation time of interdroplet ice bridges that grow from frozen to liquid droplets. In addition, the experiments reveal that the mean ice bridge speed is constant regardless of the characteristic radius of the liquid droplets in the breath figure. A theoretical mean-field analysis without any adjustable parameters recovers all of the features of the front propagation observed in experiments.

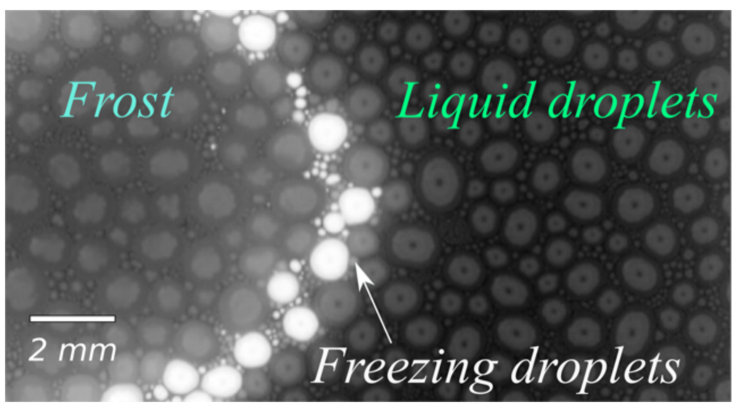

Figure 1. Frost front propagating inside an assembly of polydisperse liquid droplets. Image obtained using thermal imaging microcopy.

Références

1. D. Paulovics, C. Raufaste, T. Frisch, C. Claudet & F. Celestini, Dynamics of Frost Propagation on Breath Figures, *Langmuir* (2022).