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Freezing Bubbles CHRISTIAN KINGETT, FARZAD AHMADI, SAURABH NATH, JONATHAN BOREYKO, Virginia Tech — The two-stage freezing process of a liquid droplet on a substrate is well known; however, how bubbles freeze has not yet been studied. We first deposited bubbles on a silicon substrate that was chilled at temperatures ranging from –10 C to –40 C, while the air was at room temperature. We observed that the freeze front moved very slowly up the bubble, and in some cases, even came to a complete halt at a critical height. This slow freezing front propagation can be explained by the low thermal conductivity of the thin soap film, and can be observed more clearly when the bubble size or the surface temperature is increased. This delayed freezing allows the frozen portion of the bubble to cool the air within the bubble while the top part is still liquid, which induces a vapor pressure mismatch that either collapses the top or causes the top to pop. In cases where the freeze front reaches the top of the bubble, a portion of the top may melt and slowly refreeze; this can happen more than just once for a single bubble. We also investigated freezing bubbles inside of a freezer where the air was held at –20 C. In this case, the bubbles freeze quickly and the ice grows radially from nucleation sites instead of perpendicular to the surface, which provides a clear contrast with the conduction limited room temperature bubbles.

Christian Kingett
Virginia Tech

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