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Biomineralization, the control of crystal growth by biological systems, is a fascinating phenomenon. Our work on biomineralization focuses on the mechanism of action of antifreeze proteins (AFPs) which inhibit ice crystal growth. These naturally occurring proteins, and synthetic proteins modeled after them, have many potential applications in agriculture, food preservation, cryobiology, and biomedical science. The goal of this research is dedicated to understanding of the physical interactions AFPs with ice. We directly visualize fluorescently labeled AFPs on ice crystals in supercooled solutions with the help of a microfluidics device, an approach that enables direct study of the AFP-ice interaction. In our research, we have developed a novel microfluidic device that makes it possible to work with small sample volumes in the range of 1µl, and to rapidly change solutes around ice crystals. Using the microfluidics device, the solution can be cooled locally to create a temperature gradient and the content of the solution in which the ice is immersed can be changed. This device allows us to expose an ice crystal to adjustable AFP concentrations. It is also possible to exchange fluorescently labeled and unlabeled AFPs, and thus to control the background fluorescence levels. This method allows us to directly check the assumptions underlying the theories that describe AFP activity. Supported by CIHR, the Bosack and Kruger Foundation, NSF, and the Ohio University's NanoBioTechnology Initiative.

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