Ice-binding proteins (IBPs) include proteins that can stop ice crystal growth and inhibit ice recrystallization. These capabilities imply on their great potential in cryopreservation of foods, cells, tissues, and organs. It has been argued that IBPs adsorb directly onto surfaces of ice crystals, thereby depressing the freezing point below the melting point noncolligatively, a phenomenon named thermal hysteresis (TH). We investigate the interactions of various IBPs with ice to elucidate the mechanism by which these proteins promote ice growth modifications and to understand the differences between IBP types. Photo-bleaching of GFP-tagged IBP residing on ice crystal surfaces and melting hysteresis of IBP-covered crystals demonstrated direct and stable interactions between IBPs and ice crystals. In our recent work using a temperature controlled microfluidics apparatus (Celik et al, PNAS, 2013) we were able to exchange the IBP solution surrounding an IBP-bound ice crystal held in the TH gap with buffer, without losing the bound IBP or the TH activity. These results imply that IBP adsorption to the ice surface is irreversible and that TH is a function of the absorbed proteins on the surface and only indirectly a function of the concentration of IBPs in the solution. A study of ice shaping during growth and melting by a variety of IBPs (Bar Dolev et al, J. R. Soc. Interface, 2012) showed a correlation between the ice shapes, the shaping process and the basal plane affinity of the IBPs. We anticipate that better understanding the mechanism of IBP activity will contribute to their use in cryopreservation applications.

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