

Ice Chromatography. A New Physicochemical Approach to Water-Ice Surface

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The molecular interactions on a water-ice surface are involved in the phenomena occurring in global environments, and thus, the elucidation of the physicochemical properties of water-ice is not only of fundamental interest but also of geological and meteorological importance. We have successfully probed the properties of a water-ice surface by "ice chromatography", in which ice particles are used as a stationary phase in liquid chromatography. In ice chromatography, solutes can be adsorbed on the ice surface via hydrogen bonds and/or dissolved into a quasi-liquid layer (QLL). The solutes having more than two polar groups are strongly adsorbed on ice by hydrogen bonds and their structural difference results in different retention times. We can thus extract the information about the solute interaction with the ice surface. When the temperature is higher than a particular point, which is determined by experimental conditions such as the composition of the mobile phase, QLL grows on the water-ice surface, and the partition of a solute into QLL becomes a dominant retention mechanism. We have estimated the thickness of QLL to be a few tens of nm from ice chromatographic measurements. Ice chromatography is thus a unique method capable of probing liquid/water-ice interfaces that are difficult to study by other methods.