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Entropy-Driven Spontaneous Dissociation of Fluoroacetic Acids in Ice

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Ordinary chemical reaction is difficult to occur in ice at low temperature, where atoms and molecules are frozen in position with minimal thermal energy and entropy. Contrary to this general knowledge, fluoroacetic acids dissociate spontaneously in ice, according to studies with reflection absorption infrared spectroscopy and H/D isotopic exchange experiment. Fluoroacetic acids dissociated almost completely to ions in ice (both amorphous solid water and crystalline ice) at 8-140 K, which indicates a significant increase of the acidity as compared to that in aqueous solution at room temperature. Formic acid and acetic acid did not dissociate under the same conditions. The enhanced dissociation of fluoroacetic acids is attributed to the high mobility of excess protons in ice and its entropy-increasing effect.

Primary author(s) : Prof. KANG, Heon (Seoul National University); Mr PARK, Youngwook (Seoul National University); Dr SHIN, Sunghwan (Seoul National University)

Presenter(s) : Prof. KANG, Heon (Seoul National University)

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