The enhanced iodide oxidation in frozen environment and the following release of gaseous iodine molecules (I_2) to the atmosphere

Kitae Kim[1,2], Ho-Il Yoon[1], Akihiro Yabushita[3], Wonyong Choi[2]

[1] Korea Polar Research Institute(KOPRI), Incheon 406-840, Korea

[2] School of Environmental Science and Engineering, Pohang University of Science and Technology (POSTECH), Pohang 790-784, Korea

[3] Department of Molecular and Material Sciences, Interdisciplinary Graduate School of Engineering Sciences, Kyushu University, Fukuoka 816-8580 Japan

Active halogens play a significant role in Earth's environmental systems. Especially, iodine species are known to related to perturbation of HOx/NOx cycles, ozone depletion event, formation of CCN(cloud condensation nuclei), controlling the atmospheric oxidizing capacity. However, the mechanism for abiotic generation of iodine compounds is still not clear. Although the reaction processes taking place in ice matrix are greatly different from those in aqueous solution, chemical reactions of halogens in frozen condition have rarely investigated compared to those in water. In this work, we investigated the formation of tri-iodide (I_3^-) through iodide oxidation in ice phase under UV irradiation ($\lambda > 300$ nm) and dark condition. The oxidative formation of I_3^- through iodide oxidation, which is very slow in aqueous solution, was significantly accelerated in polycrystalline ice even in the absence of UV irradiation. The following release of gaseous iodine molecule (I_2) to the atmosphere was also monitored by CRDS (cavity ring-down spectroscopy). We suspect that the highly enhanced oxidation of iodide in ice is owing to the freeze concentration of iodides, protons, and dissolved oxygen in the ice crystal grain boundaries. The outdoor experiments carried out under ambient solar radiation of the Antarctic region (King George Island, 62°13′S 58°47′W, sea level) also confirmed that the generation of I_3^- via photooxidative process is enhanced when iodide is trapped in ice. The observed authentic redox transformation of iodide in ice phase suggests a previously unknown generation pathway for the considerable release of reactive halogen compounds to the atmosphere consequently influencing O_3 and Hg depletion event, perturbation of OHx/NOx cycles, and DMS oxidation to form CCN.