Chemistry of NO₂ and SO₂ on Ice: Photoemission Studies on the Formation of Acid Water

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Introduction: Low concentrations of ozone have been systematically observed in Antarctic areas for the last few decades. Ozone depletion has been considered a result of heterogeneous catalytic reactions on polar stratospheric clouds (PSCs) and photochemical reactions. An understanding of the chemistry of PSCs or ice surfaces as models could greatly help to explain the phenomena of the ozone holes. Nitric and sulfur dioxides (NO₂ and SO₂) are one of the most dangerous atmospheric pollutants. When released into the air, NO₂ and SO₂ undergo oxidation processes and react with water to form acid particles or droplets.

Methods and Materials: Synchrotron-based high-resolution photoemission (PE) was used to study the interaction of NO₂ and SO₂ with ice surfaces.

Results: On ice films, SO₂ is more reactive than NO₂ [1]. Small amounts of dosed SO₂ react with surfaces of ice at 100 K producing sulfuric acid-like species (H₄SO₄). Extensive dosing leads to a condensed SO₂ multilayer that is thermally unstable and desorbs from the ice substrate upon mild heating to 130-150 K. The acid water produced in this way was able to corrode metals like zinc or iron [1]. At 100 K, the initial stage of NO₂ adsorption on ice is nonreactive. The formation of a weakly bonded {ONO−−NO₂} dimers takes place. NO₂ reacts with ice only at high exposures producing a small amount of nitric acid-like species (H₄NO₃) [1]; followed by condensation of an O₂N-NO₂ multilayer. The N₂O₄ multilayer partially desorbs at temperatures around 150 K and partially reacts with ice producing more H₄NO₃.

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References: