Abstract. Laboratory transmission IR spectra of relatively thick films (up to ~ 500 μm) of mixed H₂O and SO₂ ices were measured at several temperatures between 10 and 130 K in the range 5000-450 cm⁻¹. In addition to the strong features due to crystalline SO₂ the spectra reveal bands at ~ 3668 cm⁻¹, 3634 cm⁻¹ (with some structure) and 3300 cm⁻¹ which are identified with H₂O in SO₂ environment. Also, there is no overlap between any of the H₂O bands with the 3584 cm⁻¹ band of SO₂ at any temperature in the above range. The implication of this result is that H₂O, if present on Io, must be far less than 1 part in 10⁵ SO₂.

Introduction

Over the last 20 years, the constituents of the surface of Io have been extensively investigated (Fanale et al., 1974; Trafton, 1975; Nash and Fanale, 1977); Howell et al., 1989). Among these, SO₂ has been identified as a major component material on the surface of Io. This has been achieved by successfully matching several overtone and combination bands of SO₂ with bands in Io’s reflectance spectrum in the infrared (Cruikshank et al., 1978; Fanale et al., 1979; Smythe et al., 1979; Howell et al., 1989). A new broad band near (3590 ± 20) cm⁻¹ (FWHM, Δν = 60 cm⁻¹) has recently been detected in Io’s reflectance spectrum by Bregman et al. (1993) using the Kuiper Airborne Observatory. Its width is reported to be more than can be accounted for by instrumental resolution (40 cm⁻¹). Salama et al. (1990, 1994), through an extensive investigation of H₂O/H₂S/SO₂ mixtures in the laboratory, have concluded that this band has a contribution from both SO₂ and H₂O. Specifically, they suggested that this new band derives contribution from low order multimers of H₂O and SO₂. Nash (1994) has reported reflectance spectra of thick SO₂ frost deposits containing minor amounts of H₂O. His spectra do not show bands in the 3600 cm⁻¹ region which can be associated with lower multimers of H₂O, the broad band at 3200 cm⁻¹ is characteristic of bulk H₂O ice.

In this report we present the results of our investigations of the IR spectra of mixed SO₂/H₂O ices at H₂O concentrations ranging from ~ 10⁻³% to 1% (10 ppm to 10,000 ppm) and at temperatures up to 130 K. Several absorption features due to lower multimers of H₂O are identified in the 3 μm region. The contributions of these bands to the width of the 3584 cm⁻¹ SO₂ band for several water concentrations are also evaluated.
Experimental Procedure

Samples of SO$_2$/H$_2$O ice of various thicknesses (up to 500 $\mu$m) were deposited on KRS5 and Csl windows at temperatures between 10 and 90 K. The Csl window was used for the lowest temperatures. An Air Products Displex 202 unit was employed for the low temperature studies. A gas manifold was first evacuated and then filled with H$_2$O at about 5 Torr pressure. The system was evacuated again to reduce the water content to a desired level (10$^{-3}$ Torr or less) and filled with SO$_2$ gas (Matheson, 99.8% pure) to about 50 Torr. To obtain high quality films, suitable for transmission measurements, the gas was slowly let onto the substrate in small amounts (isolated in a 1 ml container) by a combination of two valves at the inlet port. After deposition, the films were annealed at higher temperatures (70–90 K). IR transmission spectra were taken between 5000 and 450 cm$^{-1}$ with 0.5 and 1 cm$^{-1}$ resolution using a Perkin-Elmer 1800 FTIR spectrometer.