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MEASUREMENT OF DIFFUSION COEFFICIENTS OF GAS MOLECULES IN ICE (ABSTRACT)

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Measurements of diffusion coefficients of He gas and N_2 gas in ice crystals were carried out under the high pressure and atmosphere pressure.

The understanding of diffusion phenomena of air molecules in ice is important on studying palaeo-environments by polar ice core analysis. But the measurements of gas molecules diffusion in ice have been done only for He and Ne. Thus we developed an apparatus to measure the diffusion coefficient of gas molecules in ice. In order to estimate the accuracy of this apparatus, the diffusion coefficient of He gas is measured. Measurements of N_2 gas, which is the main constituent of air, were carried out.

The diffusion coefficients were measured by the change of gas pressure in the sample cell. In this study a precise differential pressure transducer was used for measuring the small pressure change under high pressure caused by the diffusion of gas molecules in ice samples. All measurements were carried out at 263 (±0.1) K.

The diffusion coefficients of He gas molecules in an ice single crystal are 1.5 $(\pm 0.6)\times 10^{-5}$ and 1.6 $(\pm 1.0)\times 10^{-5}$ cm^2/s at 47.5 and 69.5 atm, respectively. Under atmosphere pressure, it is 1.9 $(\pm 0.6)\times 10^{-5}$ cm^2/s. These results agree with the results obtained by J HAAS *et al.* (Solid State Commun., **9**, 2033, 1971). Therefore it is estimated that this apparatus can measure diffusion coefficients of more than about 10^{-6} cm^2/s.

The diffusion coefficient of N_2 gas molecules in an ice polycrystal is 1 $(\pm 1)\times 10^{-6}$ cm^2/s, at atmosphere pressure. In a single crystal of ice it cannot be measured. N_2 gas molecules can be considered to diffuse with less than 10^{-6} cm^2/s of diffusion coefficient in a ice single crystal. These results indicate that N_2 gas molecules in ice diffuse along grain boundaries faster than in the lattice. The obtained diffusion coefficient of N_2 gas also indicates that air molecules in a deep ice sheet can be estimate to diffuse about 20 m during 100 kyr if they diffuse only along grain boundaries.

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