Development of the RHEED apparatus for *in situ* structural analysis of water ices in low-temperature and ultrahigh vacuum conditions

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Water (H_2O) ice is a ubiquitous material for all of us, which has been also found to exist in cold regions of the Universe. In interstellar molecular clouds, the birth places for stars and planets, water ice is the dominant solid component, and chemical reactions occurring on the ice surface are expected to contribute greatly to the evolution of interstellar molecules [1].

Due to its cryogenic environment in interstellar molecular clouds, it has been regarded that interstellar water ice is mostly in amorphous forms. However, Hama et al. recently reported for the first time that ice with a long-range ordered crystalline structure can be formed even at cryogenic temperatures by preparing a H_2O/Ne matrix at 6 K in a vacuum environment and heating it to 11~12 K to sublimate Ne [2]. They determined the crystallinity only by infrared (IR) spectroscopy, whereas IR spectroscopy has a problem that Ice Ic (cubic) and Ice Ih (hexagonal) cannot be distinguished. Therefore, further structural analysis by diffraction is crucial.

In this research, we report on the development of the experimental apparatus necessary to identify the crystal structure of ice surfaces. Specifically, an Al vacuum chamber is evacuated at the base pressure of 10^{-7} Pa. An Al substrate is mounted on the cold head of a closed-cycle He refrigerator, which is cooled down to 6 K for water vapor deposition. The structure of vapor-deposited ice is then analyzed by RHEED (Reflection High Energy Electron Diffraction). The RHEED patterns are projected onto a fluorescent screen. Figure 1 shows the present view of the RHEED apparatus in the laboratory. We will report more details of the experimental setup and present some preliminary RHEED data.

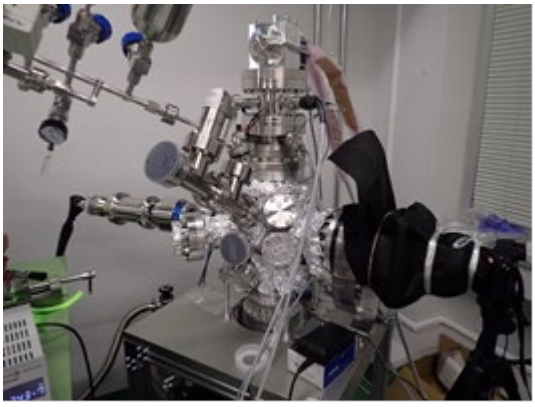

Figure 1: The present view of the RHEED apparatus

References

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[2] T. Hama, S. Ishizuka, T. Yamazaki, Y. Kimura, A. Kouchi, N. Watanabe, T. Sugimoto, & V. Pirronello, 2017, Phys. Chem. Chem. Phys. **19**, 17677−17684