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固体表面における C_2H_2 分子水素付加反応：彗星 C_2H_6 生成の解明に向けて
Hydrogen addition reactions of C_2H_2 on cold grains; clue to the formation mechanism of cometary C_2H_6

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Volatiles incorporated into comets were formed in the pre-solar molecular cloud and probably chemically altered in the proto-planetary disk of the Sun. Although physico-chemical evolution from a molecular cloud to the disk is basically understood, detailed evolutional processes are still in debate; e.g., the fraction of the materials originated in the molecular cloud incorporated into the disk without physico-chemical alterations (some fraction of materials might sublimate via accretion shock) and physical conditions (temperature, densities of materials, etc.). To reveal those links, we focused on the molecules formed through grain surface reactions, which occurred under quite low temperature conditions like 10K. We discuss the origin of such molecules in comets (icy small body of the Solar system), which might preserve the information about chemical and physical conditions of proto-planetary disk. Cometary ethane (C_2H_6) and acetylene (C_2H_2) have been observed in multiple comets since 1996 and their abundances relative to H2O (the major component of cometary ices) is ˜10^{-3} but with variations. This variation might be caused by the difference in the mixing ratios between the materials originated in the molecular cloud and the disk-processed materials. C_2H_6 has never been detected in the molecular cloud and the formation mechanism of C_2H_6 detected in comets is still in debate. One of the candidates of formation reactions of C_2H_6 is the hydrogen addition reaction of C_2H_2 on the cold grain surface (C_2H_2 ->C_2H_3 ->C_2H_4 ->C_2H_5 ->C_2H_6). In the previous experimental studies, those reactions were evaluated qualitatively and it was concluded that the reaction from C_2H_4 to C_2H_6 occurred more rapidly than the reactions from C_2H_2 to C_2H_4 and it would be a reason for the nondetection of C_2H_4. To investigate these reactions more quantitatively in realistic conditions for molecular clouds, we performed the laboratory measurements of hydrogen addition reactions of C_2H_2 and C_2H_4 on the amorphous solid water (ASW), respectively.

The experiments were conducted by using laboratory setup for surface reaction in interstellar environment (LASSIE) at the institute of low temperature science, Hokkaido University3. A cryogenic aluminum substrate is located in the center of the main chamber and surrounded by a large copper shroud connected to a liquid-nitrogen reservoir. Atomic hydrogen used for the reactions were produced by the dissociation of H2 molecules in microwave-induced plasma. The kinetic temperature of hydrogen atoms were ˜120 K and the H-atom flux was ˜10^{13} cm^{-2} s^{-1}. The samples of pure solid C_2H_2, C_2H_4, and those on ASW were produced on the substrate at 10, 15 and 20K. Infrared absorption spectra of the ices were measured by FTIR before and during the exposure of H-atom.

Our measurements show basically the same trend as shown in the previous studies. We will discuss the temperature and thickness dependence of the time constant for the sample ices in the poster.

キーワード: 分子生成, 固体表面反応, 星間物質
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