

## 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 evolutionary 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 sublime 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  $H_2O$  (the major component of cometary ices) is  $\sim 10^{-3}$  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 ( $C_2H_2 \rightarrow C_2H_3 \rightarrow C_2H_4 \rightarrow C_2H_5 \rightarrow C_2H_6$ ). 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 University<sup>3</sup>. 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  $H_2$  molecules in microwave-induced plasma. The kinetic temperature of hydrogen atoms were  $\sim 120$  K and the H-atom flux was  $\sim 10^{13} \text{ cm}^{-2} \text{ s}^{-1}$ . 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.

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