The structural effects of H2O ice for the hydrogenation of CO on the H2O ice surface at low temperatures

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In order to clarify the effect of the ice structure on the chemical reaction at dust grain surfaces in dense clouds, we performed the comparative experiments for H atom addition reaction to CO on crystalline and amorphous ice.

The two types of sample ices were prepared by a vapor deposition of H_2O on a cold aluminum substrate in an ultra high vacuum chamber. The deposition temperatures for crystalline and amorphous ice were 150 and 15 K, respectively. After the ice preparation, CO was deposited on the ice samples and was exposed to H atom at 15K. The variations of the surface composition were observed in-situ by the infrared absorption spectrometer.

In the both types of ice, the formation of H_2CO and CH_3OH with CO depletion was observed. However, ratios of products (H_2CO and CH_3OH) to CO depletion are quite different between two types of ice. The ratio for the crystalline ice shows smaller value than that for the amorphous ice. This implies that for the crystalline ice the produced H_2CO and CH_3OH desorbs from the ice surface by the heat of reaction. On the other hand, the re-trapping of the desorbed products at the surface would occur in the case of the amorphous ice. This result demonstrates that the ice structure plays an important role in a desorption process of the product molecules. In addition, it was revealed that the effective rate of the H atom addition reaction to CO on the amorphous ice is larger than that on the crystalline ice.