H-D substitution reactions of formaldehyde on icy grain surfaces at low temperatures

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The high gas-phase abundance of deuterated molecules, H_2CO-$d_{1,2}$ and CH_3OH-$d_{1\text{-}3}$, have been observed in molecular clouds [1-3] and comet [4]. This deuterium fractionation in interstellar molecules has been an interesting topic in interstellar chemistry. Although several studies on the fractionation mechanism have been carried out by using pure gas phase models, it is difficult to explain the deuterium fractionations of formaldehyde and methanol especially in multiply deuterated molecules. Recently, our group revealed the validity of surface reactions in the formation of multiply deuterated methanol [5]. We believe that the surface reaction on interstellar ice is a key process not only for the production of H_2CO and CH_3OH but also for that of H_2CO-$d_{1,2}$ and CH_3OH-$d_{1\text{-}3}$. In this study, the formation of deuterated formaldehyde on amorphous solid water (ASW) surface was investigated experimentally.

Experiments were performed by the exposure of H_2CO and D_2CO on ASW to D and H atoms at low temperatures, respectively. Figure 1 shows the infrared (IR) absorption spectra of initial samples (*top*) and variations in IR absorption spectra (*bottom*) for (a) D atom exposure of H_2CO on ASW and (b) H atom exposure of D_2CO at 15 K, respectively. For D + H_2CO, H_2CO was converted to HDCO and D_2CO by the H-D substitution reactions. The addition reactions (formation of deuterated methanol) were minor routes. On the other hand, for H + D_2CO, the substitution reactions to produce HDCO and H_2CO as well as the addition reactions proceeded. We discuss formation processes for the deuterated formaldehyde on ASW surface in the environment of molecular clouds.

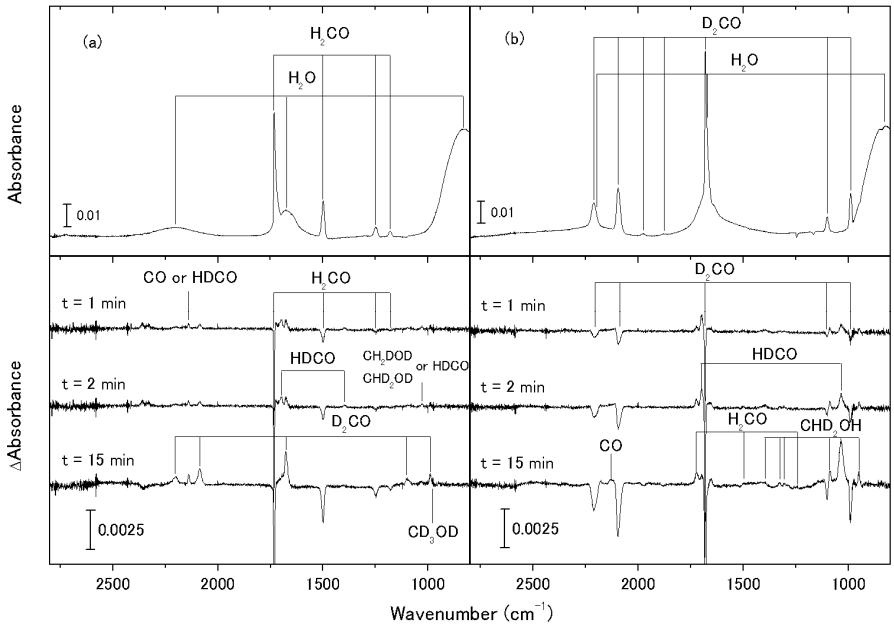

Figure 1: Initial IR spectra (*top*) and variations in the IR spectra (*bottom*) for (a) D atom exposure of H_2CO on ASW and (b) H atom exposure of D_2CO at 15 K, respectively.

References

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