Structural effects of icy grain surfaces in CO hydrogenation at a low temperature

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The successive hydrogenation of CO (CO → H_2CO → CH_3OH) on the icy grain surface has been perceived as an effective process for the formation of H_2CO and CH_3OH in molecular clouds [1]. That process on amorphous sold water (ASW) has been investigated extensively from several points of view (the dependences of temperature [1,2], ice compositions [3,4]). In the present study, we focus on the structural effects of the ice surface on the hydrogenation of CO at a low temperature, while the reactivity was compared between ASW and crystalline ice (CI) surface.

The top and bottom panels in Figure1 shows the IR absorption spectra of the initial samples with the same amounts of CO deposited at 15 K and the variation in the absorption spectra of these samples during exposure to hydrogen atoms, respectively. The formation of H_2CO and CH_3OH with decreasing of CO was observed in both samples. The hydrogenation reaction on ASW was found to be much faster than that on CI. The higher reactivity on ASW is attributed to the enhancement of the number density of adsorbed hydrogen atoms due to larger surface area of ASW compared to CI.

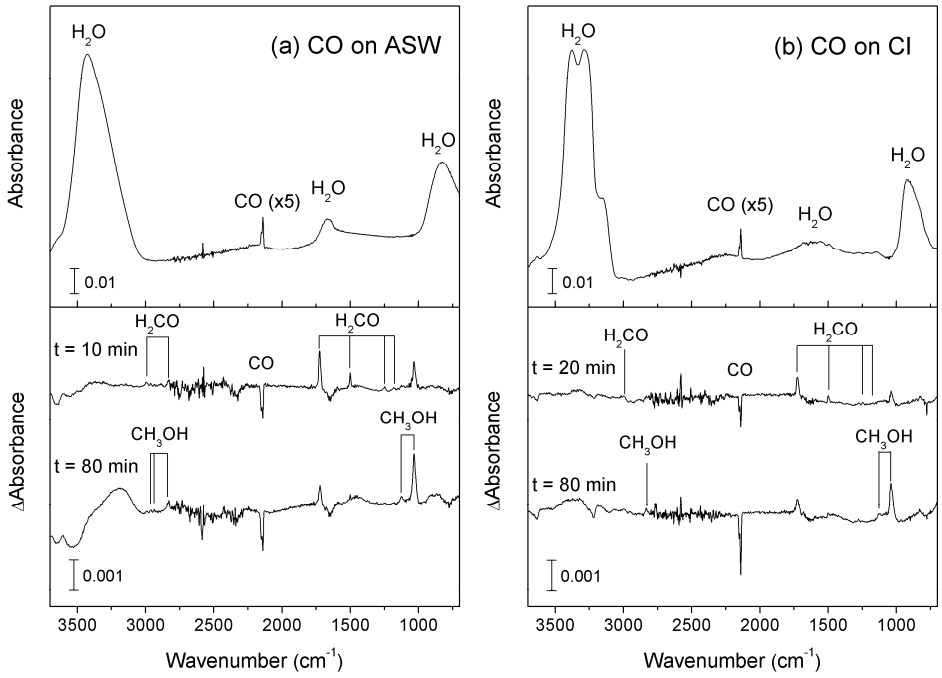

Figure 1: Initial IR adsorption spectra (top) and variations in the absorption spectra (bottom) with H atom exposure for (a) CO on ASW and (b) CO on CI at 15 K, respectively. Peaks below and above the base line represent a decrease and increase in the absorbance, respectively.

References

[1] N. Watanabe and A. Kouchi, 2002, ApJ 571, L173.
[2] N. Watanabe, T. Shiraki, & A. Kouchi, 2003, ApJ 588, L121.
[3] N. Watanabe, A. Nagaoka, T. Shiraki, & A. Kouchi, 2004, ApJ 616, 638.
[4] N. Watanabe, A. Nagaoka, H. Hidaka, T. Shiraki, T. Chigai, & A. Kouchi, 2006, Planet. Space Sci. 54, 1107.