Formation of H_2O by the H-addition to solid O_2 on amorphous D_2O ice

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INTRODUCTION

Water is the most abundant solid material in space, and has been observed in various astrophysical environments, e.g., interstellar clouds. Nevertheless, the formation mechanism(s) of water in interstellar clouds still remains understood. Since the formation of water molecules in the gas phase is revealed to be difficult to explain the observed abundance in molecular clouds, it has been suggested that they could be synthesized by atomic reactions of H and O on inorganic grains [1]. Recent studies have demonstrated that water (H_2O) and its oxygenated molecule, hydrogen peroxide (H_2O_2), were formed after hydrogen atom (H) exposure to pure solid oxygen molecules (O_2) on a metal substrate at 10-28K [2,3].

It has been reported that the presence of an amorphous water ice enhances the reaction rate and raises the reactive temperature for H-addition reaction to CO [4]. So in this study, we conducted H-addition reactions to O_2 on amorphous D_2O ice, and compare the results with those using pure solid O_2.

EXPERIMENTAL

D_2O with an ~30 monolayer (ML) was deposited onto an aluminum substrate at 10K under ultra high vacuum conditions (~10^{-10} Torr), followed by a deposition of ~3 ML O_2 onto the D_2O ice. After the deposition, the aluminum substrate was heated to up to 40K and exposed to H atoms (100K) produced by a microwave-induced plasma. Products (H_2O and H_2O_2) were monitored in situ by FTIR. As a counterpart experiment, pure ~10 ML O_2 was exposed to H atoms at 10-23K.

RESULTS AND DISCUSSION

As the time of H-exposure to solid O_2 increases, H_2O_2 and H_2O were formed (e.g. at 20K, Figure 1), being consistent with previous studies using pure O_2 [2,3]. However, it should be noted that the hydrogenation occurs even at 40K, unlike pure O_2 experiments [3]. This is probably due to the higher sticking coefficients of O_2 molecules to an amorphous D_2O ice compared to those to aluminum substrate. Both temperature dependence and effect of amorphous ice for the reaction rate will also be discussed in this presentation.

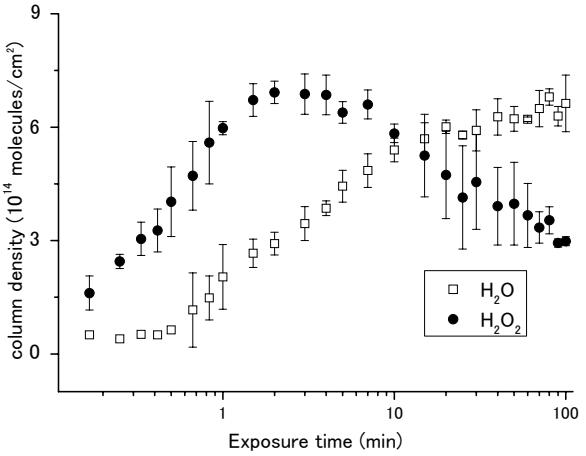

Figure 1 Variations in column density of H_2O and H_2O_2 at 20K on amorphous D_2O ice.

References

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