# H-D Substitution Reactions of Solid Ethanol with Atomic Deuterium via Quantum Tunneling at Low Temperatures

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It has been recently revealed that surface reactions on interstellar dust play an important role in enrichment of deuterated species observed in molecular clouds as compared with the cosmic D/H ratio. Previous experimental studies demonstrated that molecules such as formaldehyde, methanol, and methylamine can be deuterated by surface reactions with deuterium (D) atoms at very low temperatures [1-3]. This process most likely consists of the radical formation through H abstraction by D atoms (e.g., $CH_3OH + D \rightarrow CH_2OH + HD$) and the following D addition to the radical to form deuterated isotopologues (e.g., $CH_2OH + D \rightarrow CDH_2OH$). In molecular clouds, there are certainly more complex organic molecules than $CH_3OH$. For example, ethanol ($CH_3CH_2OH$) has been observed toward Sgr B2 (ethanol/methanol ~ 0.02 – 0.2) [4]. The correlation between such complex organic molecules and their reactivities with D atoms is still not experimentally investigated.

Here, we studied H-D substitution reactions of $CH_3CH_2OH$ solid, which has more substituent groups than $CH_3OH$. The obtained results were compared with a previous theoretical study. The present study provides important insights into reactivity of other astronomical molecules with D atoms. Experiments were performed using the Apparatus for SUrface Reations in Astrophysics (ASURA), which mainly consists of a main chamber, and an atomic source chamber. Pure solid $CH_3CH_2OH$ (10 K) was exposed to cold D atoms (100 K). Subsequently the change in the composition of ethanol was measured using FT-IR *in situ*.

H-D substitution occurred in the ethyl group but were negligible in the hydroxyl group, which is consistent with the methanol case [2]. We also found that the D-H substitution reaction on $CD_3CD_2OD$ also occur when solid $CD_3CD_2OD$ was exposed to H atoms at 10 K. We will further discuss the temperature dependence of each reaction at 10-30 K and the difference of reactivity for each functional group.

## References

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