Chemical reactions of Methyl Mercaptan (CH_3SH) with Hydrogen atoms on ice surface at low temperatures

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There have been about 30 sulfur (S)-bearing species identified in the interstellar medium (ISM). Given that the observed abundance of sulfur-bearing species in the gas phase is lower than the cosmic abundance of S[1], it is frequently hypothesized that there may be a reservoir of "missing sulfur" on interstellar grains. On the premise that physico-chemical processes governing S-bearing species on interstellar grains play a pivotal role in elucidating their presence on the ISM, several laboratory studies have been conducted. These studies have significantly enhanced our understanding of the surface processes of S-bearing species at low temperatures[2,3]. In the present study, we shed light on the behavior of other S-bearing species, methyl-mercaptan (CH_3SH), via chemical reactions of CH_3SH and H atoms without external energies on icy surface at low temperatures (typically 10 K) using experimental and computational methods.

Chemical reactions of CH_3SH were investigated via an apparatus system named Apparatus for Surface Reaction in Astrophysics (ASURA). We found that chemical reactions of CH_3SH with H atoms proceeded via multiple channels: $CH_3SH + H \rightarrow CH_3 + H_2S$, $CH_3S + H_2$, or $CH_2SH + H_2$. The major channel was the dissociation of C-S bond in CH_3SH with the activation barrier of 0.05 eV on amorphous solid water, eventually resulting in the formation of methane (CH_4) by further hydrogenation to CH_3[4]. The hydrogen abstraction channels lead to the formation of CH_3S and CH_2SH radicals, and further hydrogenation to these radicals would result in the formation of CH_3SH again. Chemical desorption of CH_3SH was not positively identified via these processes, implying the presence of other processes for the desorption of CH_3SH from interstellar grains at low temperatures.

References

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