

## H<sub>2</sub>S, why you no solid at 10 K? -Nonthermal desorption from interstellar icy grains

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Hydrogen sulfide (H<sub>2</sub>S) is one of the most abundant sulfur-bearing species in interstellar molecular clouds, which are the birthplaces of stars and planets. Since H<sub>2</sub>S cannot be efficiently produced by reactions in the gas phase, it is widely accepted that grain-surface reactions are necessary for the synthesis of H<sub>2</sub>S in those environments. Nonetheless, H<sub>2</sub>S has been identified in the gas phase only, indicating that desorption processes for H<sub>2</sub>S from the grain are required. Since the typical temperature of interstellar grains (10 K) is far below the desorption temperature of H<sub>2</sub>S (>90 K), some non-thermal desorption mechanism(s) should work well at such low temperatures. In the present study, we performed laboratory experiments on the non-thermal desorption of H<sub>2</sub>S from the surface of interstellar ice analogues at 10 K. We focus on the so-called chemical desorption, which is proposed to be one of the non-thermal desorption mechanisms induced by the heat of reaction, through the reaction of H<sub>2</sub>S with atomic hydrogen (H) on amorphous solid water (ASW) as follows: H<sub>2</sub>S + H → HS + H<sub>2</sub> (1), HS + H → H<sub>2</sub>S (2). We observed a clear decrease of H<sub>2</sub>S after reactions with H by infrared spectroscopy; the desorption efficiency far exceeded that for other non-thermal desorption mechanisms such as photon and cosmic-ray induced desorption in molecular clouds. Since the heat of reactions (1) and (2) exceeds the binding energy of physisorbed H<sub>2</sub>S and HS on ASW, chemical desorption in principle may occur in both reactions. Nevertheless, we expect that reaction (2) is the dominant process for the chemical desorption of H<sub>2</sub>S because the heat of reaction (2) is significantly larger than that of reaction (1). Since reaction (2) is the final step for H<sub>2</sub>S formation interstellar grains, a large fraction of H<sub>2</sub>S is likely to desorb upon the formation, which does not contradict with the non-detection of H<sub>2</sub>S in the solid state so far and the detection of abundant H<sub>2</sub>S in the gas phase. Moreover, the present results have a potential to improve the current chemical modeling studies which typically incorporate the H<sub>2</sub>S desorption efficiency of 0 to 1%.

Keywords: Astrochemistry, Hydrogen sulfide, Chemical desorption, Molecular cloud

