

Quantifying the chemical desorption of H₂S and PH₃ from water ice surface

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Non-thermal desorption of molecules from icy grain surfaces is required to explain molecular line observations in the cold gas of star-forming regions [1]. Chemical desorption is one of the non-thermal desorption processes, and is caused by the energy released by chemical reactions; after an exothermic surface reaction, the part of excess energy goes into products' translational energy in perpendicular direction to the surface, leading to desorption. The desorption probability of product species, especially from water ice surfaces, is not well determined. This limits our understanding of the interplay between gas-phase and ice surface chemistry.

In this work, we constrained the desorption probability of H₂S and PH₃ per reaction event on porous amorphous solid water (ASW) by numerically simulating previous laboratory experiments of chemical desorption [2,3]. Adopting the microscopic kinetic Monte-Carlo method, we found that the desorption probability of H₂S and PH₃ from porous ASW per hydrogen addition event of the precursor species are 3 ± 1.5 % and 4 ± 2 %, respectively. These probabilities are consistent with a theoretical model of chemical desorption in the literature, if around 7 % of energy released by the reactions goes into the translational excitation of the products. As a bi-product, we also found that around 70 % (40 %) of adsorption sites for atomic H on porous ASW should have the binding energy lower than ~ 300 K (~ 200 K).

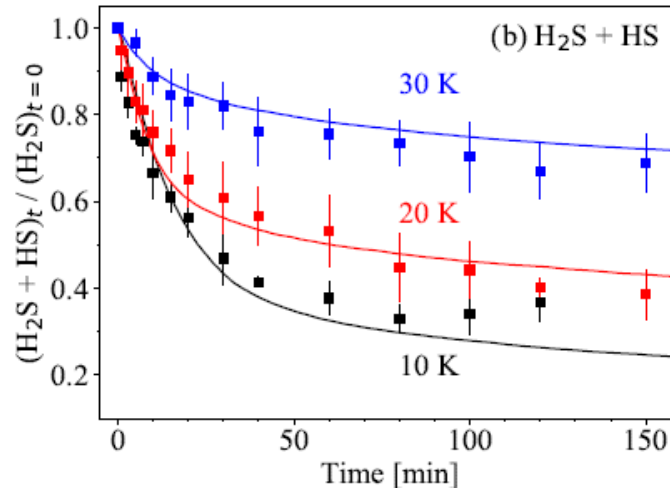


Figure 1: Total abundance of H₂S and HS on porous ASW normalized by the initial H₂S abundance as functions of the H atom exposure time in our best-fit model. Square symbols indicate the experiments by [2] and [3].

References

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