The first detection of sulfur atom behavior on the silicate surface

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In molecular clouds (MCs), there is a long-time unsolved issue called "missing sulfur", that the observed abundance of S-bearing molecules in both gas and solid phases cannot match the cosmic abundance of S (~10^{-5} relative to H) [e.g., 1, 2]. The main reservoir of S remains unknown. Several experiments on the photolysis of ice containing H_2S have been performed and have found the synthesis of S-bearing molecules, but these cannot explain the missing sulfur issue. Although atomic S^+ ion was assumed to accumulate onto dust grains, being locked on the surface to cause the S depletion [3], no one can really verify this hypothesis. To clarify the fate of sulfur on dust grains, experiments for monitoring the behavior of S atoms on the materials of dust grains are highly desirable. However, a direct measurement of the S atom is difficult through the conventional experimental methods, such as IR spectroscopy and mass spectrometry.

In this work, we focus on the S atom itself using a recently developed method, PSD-REMPI, which has been applied to detect the atoms and radicals successfully [4, 5]. We monitor the behavior of S atoms on the silicate (Mg_2SiO_4) and amorphous solid water surface during the annealing process. By comparing the ratio, how many S atoms remain can be derived. We found that the S residue can remain in atomic form and survive even at room temperature, which shows a refractory property. In addition, the sulfur dimer S_2 is also detected, which is the main contribution of the S loss during annealing activities. These results could give evidence that embedded S atoms in the dust grain surface may be the source of missing sulfur in MCs

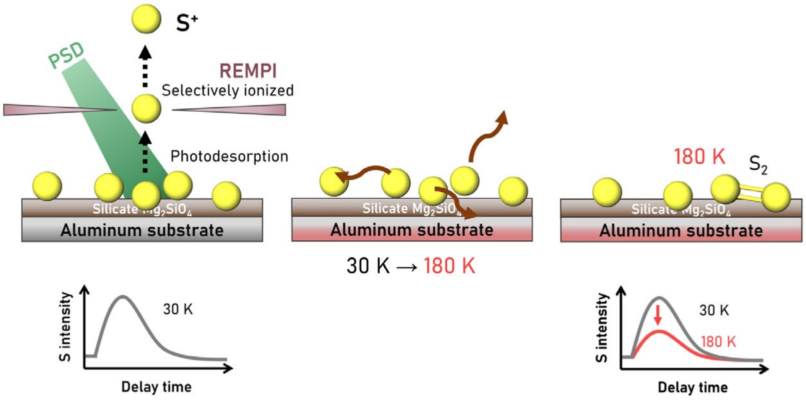

Figure 1: The cartoon figure of the PSD-REMPI method and experimental procedure.

References

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