

Experimental Study on Reaction Kinetics in the Systems of Mg-Si-O-H and Fe-S-H

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Chemical reactions between preexisting solids and gas are main pathways to form diverse minerals in space. Because the chemical compositions of solid and gas vary with the progress of solid-gas reactions, they could also have played critical roles in causing elemental fractionations in the early solar system. Chondrites, undifferentiated primitive meteorites, record fractionations in major rock forming elements (Mg/Si and S/Fe), and their chemical properties, by extension, may have been responsible for chemical diversities of planets.

Here we focus on formation of enstatite (MgSiO_3) via a reaction between forsterite (Mg_2SiO_4) and SiO-rich gas and formation of troilite (FeS) by sulfidation of metallic iron, which are capable of changing Mg/Si and S/Fe ratios of solids, respectively. They are ubiquitously present not only in chondrites but in interplanetary dust particles as an enstatite whisker and tiny blebs in GEMS (glass with embedded metal and sulfides). Moreover, their astronomical presence are confirmed or suggested by infrared observations.

We especially aim to determine experimentally reaction kinetics of their formation, which are key to discuss formation of dust in space as a time-dependent problem. We carried out experiments on a reaction between forsterite and Si-rich gas at temperatures close to formation temperatures of enstatite in protoplanetary disks and circumstellar environments using a molecular-beam epitaxy (MBE) type vacuum furnace. Contrary to the previous study [1] where crystalline enstatite was obtained at temperatures much higher than the plausible formation conditions, we found that no formation of enstatite occurred on forsterite but amorphous SiO condensed at 1100-1200 K. This implies that formation of enstatite is kinetically less favored under realistic temperature conditions.

Sulfidation kinetics of metallic iron has been extensively investigated at the total pressure of one atmosphere [2], but no kinetic data has been obtained under plausible pressure conditions. We are now currently working on sulfidation experiments of metallic iron under low pressures in the gold furnace. We will report kinetic of nucleation and growth of iron sulfides on metallic iron.

Keywords: dust; enstatite; troilite; solid-gas reaction; kinetics

References

- [1] N. Imae et al. 1993, *EPSL* **118**, 21.
- [2] D. Lauretta et al. 1996, *Icarus* **122**, 288.