Oral | Symbol P (Space and Planetary Sciences) | P-PS Planetary Sciences

[P-PS24_1PM2]Origin and evolution of materials in space

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Recent progresses of astronomical observations, laboratory experiments, solar-system exploration, and theoretical work have enabled us to attempt to understand the origin and evolution of materials (dust and gas) in space in the context of material science. It is thus important to link further planetary material science and astronomy for comprehensive understanding of dust and gas in space and their role in evolution of galaxies, stars, and planetary systems. In this session, based on latest results on observations, experiments, planetary missions, and theoretical studies on materials in space, we discuss next steps in science for materials in space.

5:45 PM - 6:00 PM

[PPS24-P04_PG]Condensation of forsterite under protoplanetary disk conditions

3-min talk in an oral session

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Keywords:forsterite, condensation, protoplanetay disk

Meteoritic evidence indicates that dust condensation occurred in the early stage of solar system evolution. In this study, we succeeded in performing condensation experiments of forsterite under controlled protoplanetary-disk conditions, which will make significant contribution to understanding silicate formation and chemical fractionation in protoplanetary disks.Condensation experiments were carried out in the system of Mg_2SiO_4-H_2-H_2O. A mixed gas of H_2 and H_2O was flowed into a continuously evacuated infrared vacuum furnace at a controlled rate to keep a pressure constant. Synthetic forsterite powder in an It crucible was heated as a gas source. A part of evaporated gases were condensed on a Pt mesh located at a cooler region in the chamber. The pressure and temperature conditions were close to those of protoplanetary disks. The total pressure of the system was 5.5 Pa, and the substrate temperature ranged from 1320 to 1160 K. The H_2O/H_2 ratio was set at 0.015, which was about 15 times larger than the solar ratio. The SiO/H_2 ratio was evaluated to be about 0.7-2 % of the solar ratio from the weight loss rate of the gas-source forsterite. Experimental duration ranged from 6 to 237 hours.Sub-micron to micron-sized condensates covered with Pt substrates at 1160 and 1275 K, but no condensates were found at 1320 K. The typical size of condensates at 1160 K was less than 1 micron irrespective of experimental duration and no effective growth of each condensed grain was observed. Condensates at 1275 K for >40 hours partly had several micron-sized flat regions. EDS analyses showed that chemical compositions of condensates were consistent with the stoichiometry of forsterite, and their EBSD patterns were well fitted with the patterns from crystalline forsterite. Coincident EBSD patterns were obtained from the flat region of condensates at 1275 K, suggesting that the area was covered with a single crystal. TEM observation of condensates at 1160 K also found that

the condensates were polycrystalline forsterite with a thickness of 30-150 nm, and infrared absorption spectra of condensates show clear 10-micron absorption features resembling those of crystalline forsterite. These evidence indicates that polycrystalline forsterite condensed at 1275 and 1160 K.The mean free path of gas molecules under the present experimental conditions is less than 1 mm, and the evaporated forsteritic gas and the ambient H_2-H_2O gas are expected to be well mixed. Supersaturation ratios (*S*) for experiments at 1320, 1275, and 1160 K are thus estimated to be S1000, while aggregates of micron-sized grains would form with *S* of 10 that could be an analogue of amoeboid olivine aggregates in chondrites.