# Development of ambient-controlled gas levitation system embedded in tube furnace and its application to chondrule formation

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Chondrules are the most abundant component in chondrites. They are mm-sized round (or irregularly) shaped particles mainly composed of silicates, which formed by the rapid cooling of droplets of molten or partially molten rock in space before they accreted. They show unique and diverse internal micro-textures (e.g., porphyritic olivine, barred olivine, radial pyroxene, etc.), even if they have same bulk compositions. These internal textures, therefore, should reflect not only stating material compositions, but also nebular conditions, such as gas species and their partial pressures, heating and cooling rate. The conditions of chondrule formation, however, remain poorly constrained, because the reproduction of the chondrule formation processes in a laboratory is experimentally difficult, especially in terms of container-less arrangement and reducing (low-fO2) ambient. In the present study, we developed gas-levitation system embedded in ambient-controlled tube furnace in order to reproduce micro-textures of chondrules, and to constrain their formation conditions.
The following is a summary of the newly developed equipment. A vertical tube furnace with a double-helical silicon carbide heating element and an alumina core tube (OD 50 mm, ID 42 mm) is used as a heating source device. An alumina inner core tube (OD 32 mm, ID 26 mm) with a carbon nozzle (blowout hole diameter of 1 mm) at the top is inserted into the outer tube. H2+CO2+Ar mixed gas are separately introduced into the both inner and outer core tubes from a gas port at the bottom, and gas flow rates can be controlled by digital mass flow controllers. The inner tube with the nozzle can move up and down by motor-controlled pantograph, and thereby the seamless switching from a sample exchange positon to a maximum temperature position becomes possible. A levitated sample can be in situ observed by a long focal CCD camera thorough a mirror from the top of furnace. Because thermal radiation light around the heating sample prevents the observation at high temperatures, a dichroic filter that cut >500 nm wavelength light and high power blue (460 nm) LED illumination are installed into the observation optics. Currently, using this system, quenched NaAlSi3O8 glass were successfully collected from 1280 degree Celsius. The developed gas levitation system of the present study show that reducing-gas levitation experiments is a powerful technique to simulate the molten-quenched texture of early solar materials.

Keywords: Chondrule, Gas levitation technique, Crystal growth

 