In situ density measurement of basaltic glass at high pressure

R. ANDO[1], E. OHTANI[2], S. URAKAWA[3], Y. KATAYAMA[4],

[1]Inst. Mineral. Petrol. and Econ.Geol., Tohoku Univ. (andou_rt@ganko.tohoku.ac.jp)
[2]Inst. Mineral. Petrol. and Econ.Geol., Tohoku Univ.
[3]Dept. of Earth Sci., Okayama Univ.
[4]JAERI

Density of silicate melt at high pressure is one of the most important properties to understand magma migration in the planetary interior. Becasue of experimental difficulties, the density of magma at high pressure is poorly known. Katayama (1996) recently developed a new in situ density measurement method based on the density dependency of X-ray absorption in the sample. In this study we made, as a first step, preliminary measurements of the density of basaltic glass by the absorption method.

Starting material is a glass with the MORB composition (SiO_2-Al_2O_3-FeO-MgO-CaO-Na_2O). The glass was prepeared by heating at 1603K in the Pt crucible under the controlling oxygen fugacity around QFM buffer, and by quenching into water.

When X-ray is transmitted to the sample, the intensity of the transmitted X-ray beam (I) is expressed as follows;

$I = I_0 \exp(-\mu\rho t)$, where I_0 is the intensity of incident X-ray beam, μ is the mass absorption coefficient, ρ is the density of the sample, and t is the thickness of the sample. If t and μ are known, we can determine the density of the sample by mesuring I and I_0. In order to determine t, we used a single crystalline diamond cyrinder as a sample capsule, which shows less absorbed and less deformed. So t (thickness of the sample at the point x) is expressed as follows; $t = 2*(R^2-x^2)^{1/2}$, R is the inner radius of cylinder, and x is distance from center of the capsule.

For generation of high pressure and high temprature, We used DIA-type cubic anvil apparatus (SMAP180) installed in the beamline (BL22XU) of Spring-8. We used tungsten carbide anvils with the edge-length of 6 mm. The energy of monochromatic X-ray beam was 25 keV and the beam size was reduced to 0.1*0.1 mm^2 by 2 slits.

We measured the density from 1 atm to 5 GPa at 300 K first, and then we heated to 773 K. At same temprature we also measured the density at this temperature along the path of the pressure release from 5 GPa to 1atm The density of the glass increased by 25 % during compression from 1 atm to 5 GPa at 300K. When the sample was heated to 773 K at 5GPa, the density increased by 20 %, which may be due to the structural relaxation of the glass. The density decreased by 10 % along the path from 5 GPa to 1 atm. In order to calculate the bulk modulus of the glass (K), we used the density data from 1 to 5 GPa along the path of the pressure increase, and obtained K (at 273 K)= 22(5) GPa. The bulk modulus of the glass at 773 K was K=46(4) GPa, when K'=4. This method an be applied to detemine the density of silicate melts at high pressure.

Extraction of nano-scale carbon minerals for HRTEM from tiny meteorite samples and its application to chondrite type discrimination

T. AOKI [1] AND J. AKAI[1]

[1]Deptm. Geology, Fac. Sci.,Niigata Univ. Ikarashi, 8050 Niigata 950-2181,Japan akai@sc.niigata-u.ac.jp

Introduction : Many small mineral grains are contained in carbonaceous chondrite (CC). Presence of unique or characteristic mineral is a strong indicator for formation conditions of the meteorite. Carbon minerals, diamond, graphite (Amari et al., 1990) etc. are such examples. Diamond in CC was first found by by Lewis et al.(1987). Daulton et al. (1996) examined nano-diamond in Allende and Murchison CC by HRTEM, which may be formed by CVD processes. Antarctic CC sometimes have unique types of meteorites. Previous studies required considerable amounts of CC samples. We extracted carbon minerals from tiny meteorites.

Materials and Methods: Antarctic and non-Antaractic CCs were prepared. Ten Antarctic CCs were mainly used. We processed a sample by hydrofluoric acid (48%) , nitric acid (30%, 75 C, 30min.) , and aqua regia (75 C, 60 min.). Washing and centrifugations were also carried out. CC samples less than 0.2 ~ 0.3g were used. So, this procedure is an effective method to extract carbon minerals for HRTEM observation even from tiny CC samples.

Application and its Resutls: Varieties of carbon minerals were found; e.g., nano-ball graphite, concentric type graphite, ribbon-like graphite. A "nano ball" shaped graphite had a diameter of ~ 10nm. Graphite from Murchison was in low crystallinity. Graphite in Allende is relatively well crystallized Ten Antarctic CCs were classified into two types, as follows:[CC-name, class, type]

[Asuka-881551, C6, nd.]
[Yamato-82102, C5, nd.].
[Asuka-882094, CO3, Allende-type]
[Yamato-790992, CO3, Allende-type<intermediate>]
[Yamato-86751, CV3, Murchison-type<intermediate>]
[Yamato-81020, CO3, Murchison-type]
[Yamato-74662, CM2, Murchison-type]
[Yamato- 86720, CM2, Murchison-type]
[Yamato-793321, CM2, Murchison-type]
[Belgica7904, "CI", Murchison-type]

References

[1] Amari, et al.,(1990) *Nature* 345,238;
[2] Daulton et al. (1996),*GCA*,60,4853;
[3] Lewis et al. (1987) *Nature* 339, 117.