EFFECT OF FLASH HEATING ON MELILITE SOLID SOLUTION. H. Nagasawa and H. Koujitanii, Dept. Chemistry, Gakushuin Univ. Mejiro, Toshimaku, Tokyo 171-8588, Japan. 620084@gakushuin.ac.jp

Introduction: We have reported kinetics of partial melting of melilite solid solution (ss) system when heated at a constant temperature within the range between solidus and liquidus [1]. Rapid heating and cooling of melilite ss produces mosaic structure composed of gehlenite(Ge)-rich crystals and åkermanit(Åk)-rich glasses or crystals. The mosaic structure once produced can be retained under a prolonged heating under subsolidus temperatures since inter-diffusion of Al+Al vs Mg+Si or Ge and Åk components is very slow in the solid state[2].

The mosaic structure, if found in a meteoritic melilite, may provide a marker for the thermal history of the sample; in principle, the composition and the average size of the crystals indicate maximum temperature and the time of heating interval, respectively[1].

For the purpose of possible implication for meteoritic melilite samples, we examined the possibility of determining the mosaic structure in the natural samples by combination of X-ray diffraction and SEM/optical microscopy in addition to the previously used SEM/EDX. We used artificially prepared analogues for this purpose. We also examined possible effects of flash heating on the meteoritic melilite crystals.

X-ray diffraction: To determine end-member compositions we used the shift of major peaks in the powder X-ray diffraction spectra. The observed d vs composition relation showed that the shift of (211)-peak(d=2.8446 Å) is about 0.01Å which is large enough to resolve the difference between Ge-rich and Åk-rich crystals. Observation of peak-shift in small samples a micro-focus X-ray diffractometer (beam radius=50 µm) was used.

Discussion: Using SEM/EDX, maximum temperature attained and the time interval of heating can be estimated, if the size of the grains were larger enough for EDX measurement, e.g., a few µm or heating time interval of longer than 10 min. at 1415 °C. The mosaic structure produced by shorter heating time interval, i.e., 2-10 min., can be determined by X-ray diffraction/optical microscopy.

Retention of the mosaic structure: Under subsolidus temperature homogenization of Ge- and Åk-composition occurs through inter-diffusion of Al+Al vs. Mg+Si. Time necessary to erase the structure is calculated based on the simplified 1-dimensional alternate Ge/Åk-slab model[3] using a constant diffusion coefficient value of 1x10^13 cm^2sec^-1[2]. Annealing time which decreases the compositional difference of Ge-rich and Åk-rich crystals to a half of the original difference is calculated to be about 140 days to 8.6 years for the structure composed of crystals of 10 to 50 µm in size or produced by 1- to 100-hr of heating at 1415 °C.

Enhancement of O isotope exchange. Since self-diffusion coefficient of O in Ca, Al-rich silicate melt (1.66x10^-6cm^2sec^-1[4]) is larger than that in melilite single crystal (1.74x10^-10cm^2sec^-1[5]) by ~4 orders of magnitude, exchange of O isotope with environmental gas phase is enhanced considerably by partial melting, provided partial pressure of O in the gas phase and the exchange rate of O at the surface are reasonably high. A simplified isotropic sphere (r=1mm) model indicates time necessary to decrease the difference between O isotope ratios in and out of the sphere to 1/10 to be about 20 min at 1415 °C.