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Studies of the carbonaceous materials in ureilites by micro Raman spectroscopy

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Ureilite is one of the achondrite group and consists of silicate minerals of which grain boundaries are filled with carbonaceous veins. The vein includes graphite, diamond, Fe-Ni mixed metal and troilite. The oxygen isotope composition of the vein indicates that ureilite is more primitive and an unique achondrite. It is also likely that ureilites are related to carbonaceous chondrite. There are stimulative discussions how to include the carbonaceous materials in ureilites and make the diamond in the vein from various viewpoints; petrological characteristics, noble gas isotopic ratios, X-ray diffraction analysis, Raman spectroscopic analysis and so on.
In this study, we examined the carbonaceous materials in ureilites with micro Raman spectrometer, because Raman spectra well reflect the structure of carbonaceous material such as graphite and diamond in ureilites.
We examined three ureilite samples (Y-791538, Shisr 007, NWA 3140). For the Raman measurement, we prepared powdered bulk, acid resistant residue (treated by 3M HCl and 1M HCl-10M HF) and oxidation resistant residue (treated by H_2O_2) for each ureilite. The purpose of HCl/HF treatment is to remove silicate minerals that constitute large part of ureilite and to make the measurement of the carbonaceous material easily. We obtained Raman spectra of diamond (the typical diamond peak appears at 1332 cm^{-1}) and graphite (the typical graphite peak appears at 1580 cm^{-1}: G-band and 1350 cm^{-1}: D-band). Peak positions, FWHMs and the intensity ratio of peaks of them were examined as spectra parameters. The diamond spectra show a similar trend for Y-791538 and NWA 3140, indicating that diamonds in these two ureilites are formed in a similar way. Compared to the spectra of shock synthesis and CVD diamonds in Miyamoto et al. (1993), our data could not show the clear evidence for the origin of ureilites. The graphite spectra of ureilite were compared to the Raman spectra of the primitive carbonaceous chondrite obtained by Busemann et al. (2007). Although it is supposed that ureilites are rather primitive and are related to carbonaceous chondrites, our results show that carbon materials in ureilites have experienced high thermal alteration in comparison with those in carbonaceous chondrites.