Thermal histories of several carbonaceous chondrites evaluated by Raman spectroscopy

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Chondritic carbonaceous matter converts gradually to graphitic material when it suffers thermal metamorphism in parent bodies. It can be a tracer of degree of thermal metamorphism. Raman spectroscopy is a useful tool to evaluate the degree of structural order of carbonaceous matter. Typical Raman spectrum shows two Raman bands in the first order region; G-band (G for graphite) at about 1600cm^{-1}, and D-band (D for defects) at about 1350cm^{-1}. G-band is assigned to E_{2g2} in-plane vibrational mode of polyaromatic structure. D-band is not present in a perfectly stacked graphite. This band is induced by structural defects. The G/D peak area ratio corresponds to the lateral size (La) of a crystallite of the graphitic matter. However this relationship cannot be used to the carbonaceous matter of low-maturity-level, and interpretation of Raman spectra of low-maturity carbonaceous matter still remains controversial.

In this investigation, we analyzed several CM chondrites (Y791198, Cold Bokkeveld, Sayama, Boriskino, Murray, Murchison, A881334, Y86695, Y82054, B7904, Y86789, Y793321, A881458), and Ivuna (CI), Allende (CV), Ornans (CO), Tagish Lake, and Coolidge by micro-Raman Spectroscopy.

Raman spectra were obtained using JEOL JRS-SYSTEM 2000 Raman spectrometer. An excitation wavelength of 514.5nm was used on an argon ion laser. The laser beam was focused by a microscope equipped with a 50X objective, leading to a spot diameter of 2um. The power at the sample surface was 1.0 or 0.1mW. Spectra of first-order region (1000-2000cm^{-1}) were acquired.

Meteorites heated in the parent bodies (A881334, Y86695, Y82054, B7904, Y86789), weakly heated chondrite Y793321, Coolidge, Allende(CV), and Ornans(CO) show relatively strong G- and D-bands. However the unheated meteorites (Ivuna, Y791198, Cold Bokkeveld, Sayama, Boriskino, Murray, Murchison, Tagish Lake) and weakly heated chondrite A881458, showed weak G- and D-bands on the shoulder of a fluorescence peak, when the laser power was 1.0mW, and reducing the laser power to 0.1mW, the D-bands disappeared. The FWHM (Full width at half maximum) of G-band weakly correlated inversely with G-band position. For comparison, a piece of wood, not showing G- and D-bands, was heated in vacuo. After heating at 300^{o}C, it showed a similar spectrum to those of the unheated meteorites (weak G- and D-bands), and after heating at 500^{o}C, its spectrum was similar to those of the heated meteorite (well-developed G- and D-bands). Raman spectroscopy can be useful to evaluate thermal histories of carbonaceous chondrites.