High–pressure Mössbauer study of FeS with nuclear forward scattering of synchrotron radiation

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For ambient conditions, stoichiometric FeS has a troilite crystal structure which is closely related to a NiAs–type, and is an antiferromagnetic semiconductor with T_N = 593 K. FeS is believed to belong to the intermediate regime between the Mott–Hubbard and the charge–transfer insulators. As indicated by high–pressure X–ray diffraction measurements, it undergoes two first order phase transitions with increasing pressure at room temperature. The first transition occurs at 3.5 GPa and the structure transforms to a MnP–type. The second transition takes place to an orthorhombic structure at 6.5 GPa. We carried out the measurement of ^{57}Fe Mössbauer absorption spectra with pressure up to 16 GPa. At low pressure the spectra consist of six peaks whereas at high pressure the spectrum is typical of paramagnetic irons. We have examined the magnetic properties of FeS using ^{57}Fe Mössbauer spectroscopy with nuclear forward scattering of synchrotron radiation under pressure.

Samples with enriched 10 *at.*% ^{57}Fe were synthesized by a sintering method in an evacuated quartz tube. The sample has the composition $Fe_{0.997}S$ determined by the X–ray diffraction measurement using the empirical relation of the lattice parameter vs. the concentration of Fe in Fe–S system. The time spectra of nuclear resonant forward scattering were measured at BL09XU in SPring–8 under high pressure using a clamp–type diamond anvil cell (DAC). Fluorinert was used as the pressure medium which can ensure a almost hydrostatic pressure. Pressure was calibrated by measuring the wavelength shift of R_1 luminescence line of the ruby crystal irradiated by Ar^+–ion laser.

Three time spectra of nuclear resonant forward scattering from FeS in DAC are shown in fig. 1. We have observed three different quantum beat patterns which probably correspond to the three phases. The quantum beat pattern of the time spectrum at 2 GPa is almost similar to that at ambient conditions where the spectrum of satisfactory quality was obtained from the not–enriched sample. This result consists with that of Mössbauer absorption spectra in which the hyperfine interaction parameters except for the isomer shift hardly depend on pressure in troilite phase.

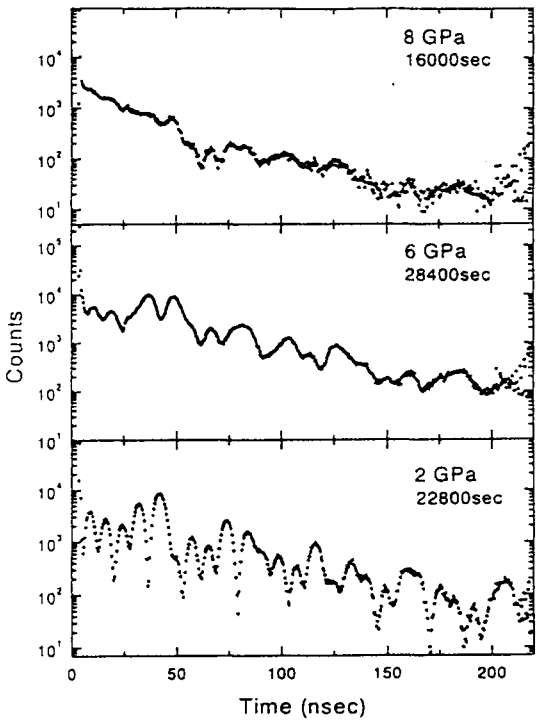

Figure 1: Time dependences of nuclear resonant forward scattering from FeS in DAC. Three different quantum beat patterns are observed.

Detailed analysis of the time dependences of nuclear resonant forward scattering is now in progress.