High pressure Mössbauer spectroscopic and X-ray diffraction studies on Nathdwara meteorite.

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A meteorite which fell near Nathdwara in Rajasthan(India) on 25th December 2012 was categorized as H6 chondrite through its mineralogical compositions[1]. Ambient Mossbauer spectroscopic study on the sample confirmed 49% olivine, 30% pyroxene alongwith troilite and kamacite. High pressure Mössbauer spectroscopic measurements up to 10GPa were done on this 14% fayalite sample using Co^{57} source, Diamond anvil cell (DAC) and 4:1 methanol ethanol mixture as hydrostatic pressure medium. X-ray diffraction studies upto 15 GPa were conducted at BL11 EDXRD beam line at INDUS 2 synchrotron facility using monochromatic X-rays (λ=0.6206Å), MAR345 image plate detector. Corrections were done using LaB_6 powder inside DAC and Au as pressure marker.Within span of 0^0-40^0, error calculated was $\pm 0.0002^0$. Troilite peaks vanished below 5GPa while pyroxene did not show any effect. Prominent effect was observed on olivine with emergence of a new peak at 5 GPa whose intensity grew with pressure.Considerable broadening in peaks were observed with pressure which might be either due to structural phase transition or due to a change in electronic configuration of iron [2]. Mössbauer spectroscopic study confirmed the second possibility with the presence of a low spin Fe^{2+} configuration (isomer shift ~ 0.6mm/s) at 5GPa whose population increases continuously with pressure but decompressed from 10GPa regained the original high spin configuration. Reversible transition was observed for olivine and pyroxene in decompressed XRD pattern from 14.46GPa but troilite showed irreversible trend. The spin cross over taking place at such a low pressure (~ 5 GPa) as compared to earlier studies [2] suggst a residual stress preserved in this meteorite due to shock impact.

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