High-pressure phase equilibria in the system Fe-C

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Earth's outer core may contain up to 10 wt% of light element(s) according to comparison of seismological data with estimated density of pure Fe melt at high pressures. Carbon is considered to be one of the possible light elements in the core (Wood, 1993). The eutectic melting temperature in the Fe-C system is sufficiently lower than that for silicate mantle (Hirayama et al., 1993), thus it is likely that significant amount of carbon was dissolved in the molten iron in the proto-earth at the depth where iron and silicate was separated.

In order to study the high-pressure phase relations in the Fe-C system, we have carried out experiments up to 10GPa and 2200deg C. Experiments were carried out in a graphite capsule installed in LaCrO3 heater with 14M MgO octahedral pressure medium. Experimental run products were polished and analyzed by EPMA. In order to analyze precise carbon concentration, the sample was analyzed without carbon coating and experimentally synthesized Fe3C (cementite) crystal was used as the standard for Fe and C.

At 5GPa, melts in the Fe-C system coexist with graphite and they are crystallized Into small dendrites of Fe3C and Fe. The melts coexisting with graphite contain 7 to 8 wt% C in the temperature range 1600 to 1800deg C. At 10 GPa, melts in the Fe-C system coexist with Fe7C3 at low temperatures (ca. 1600C) as reported by Shterenberg et al, (1975). Diamond becomes the coexisting carbon rich phase at higher temperatures. The EPMA analysis of the Fe7C3 phase, however, gives nonstoichiometric carbon concentration, which remains as one of the unsolved problems.