Melting phase relations of the system Fe-C up to 60 GPa

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The Earth's liquid outer core and solid inner core are known to be ~7 wt% and ~4 wt% less dense than pure iron, respectively. The core density deficit (cdd) is associated with the presence of light elements in the core such as carbon, oxygen, silicon, sulphur, and hydrogen. Identifying the light elements in the core is the key to understanding planetary formation process. Carbon is an important candidate for one of the light elements alloying with iron in the core as it is abundant (~3 wt%) in carbonaceous chondrites, which are thought to approximate the composition of Earth's parent material. Additionally, the mineral cohenite, Fe_3C, is present in iron meteorites.

In order to test a hypothetical carbon-bearing planetary core model, melting phase relations of the system Fe-C provide fundamental information. The high melting temperature of the iron carbides Fe_3C and Fe_7C_3, relative to iron, and the low carbon content of the eutectic at high pressure, has been invoked to suggest that carbides may be the first inner core phase to crystallize. At high pressure, Fe_3C melts incongruently to liquid + Fe_7C_3[1]. Existing measurements of the melting curve of Fe_3C do not agree within uncertainties [2],[3]. We therefore conducted simultaneous high-pressure and –temperature experiments in a laser-heated diamond anvil cell with in-situ synchrotron X-ray diffraction. We measured melting points of the system Fe_3C + Fe_7C_3 up to 60 GPa. Preliminary analysis of XRD data suggested we consistently placed constraints on the melting points under high pressures. In the presentation, we will also report ex-situ FE-SEM textural and chemical analysis.

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