<table>
<tr><td>ESRF</td><td>Experiment title:
Investigation of the high-P and high-T structure and equation of state of Fe alloys relevant to the Earth's core</td><td>Experiment number:
HS3411</td></tr>
<tr><td>Beamline:
ID27</td><td>Date of experiment:
from: 07 February 2008 to: 13 February 2008
and from : 19 March 2008 to : 21 March 2008</td><td rowspan="2">Date of report:
29/08/2008

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<tr><td>Shifts:
21</td><td>Local contact(s):
J.P. Perrillat / M. Mezouar</td></tr>
<tr><td colspan="3">Names and affiliations of applicants (* indicates experimentalists):
G. Fiquet*, G. Morard*, E. Boulard*, A.L. Auzende*, D. Antonangeli*, J. Badro* and J. Siebert
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</table>

Report:

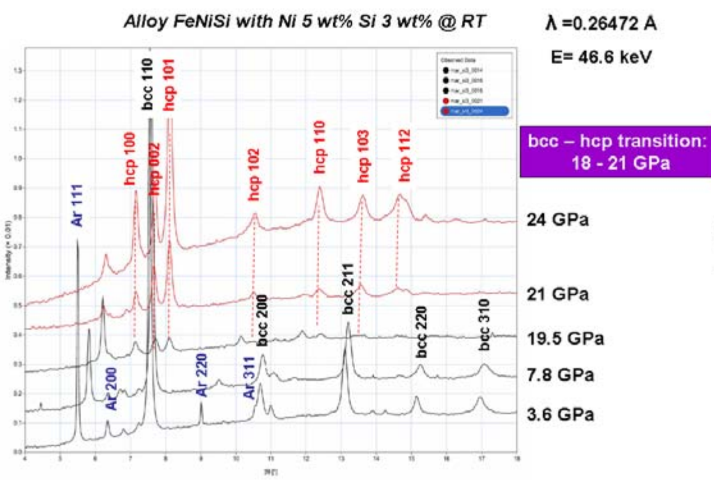
The Earth's core consists of a liquid outer core and a solid inner core [e.g. Dziewonski and Anderson, 1981], which are believed to be made predominantly of iron (Fe) [e.g. Birch, 1952]. Despite numerous studies, the structure, the melting line or the equation of state of iron at high-pressure and high-temperature are still central to a long-standing debate concerning the structure and composition of the Earth's core [see Anderson, 1995]. Among all crystallographic structures proposed, a consensus has more or less emerged with the hexagonal closed packed structure -hcp- for iron. The question of the structure of this alloy at core conditions, in particular the structure in vicinity of the melting line is however still largely debated. Among others, a possible thermal and chemical stabilization of body-centred cubic iron in the Earth's core has indeed be proposed by Vocadlo et al. [2003] after theoretical calculations. Recent X-ray experiments have shown the existence of a such bcc structure above 220 GPa at high-temperature for iron-nickel alloys [Dubrovinsky et al., 2007].

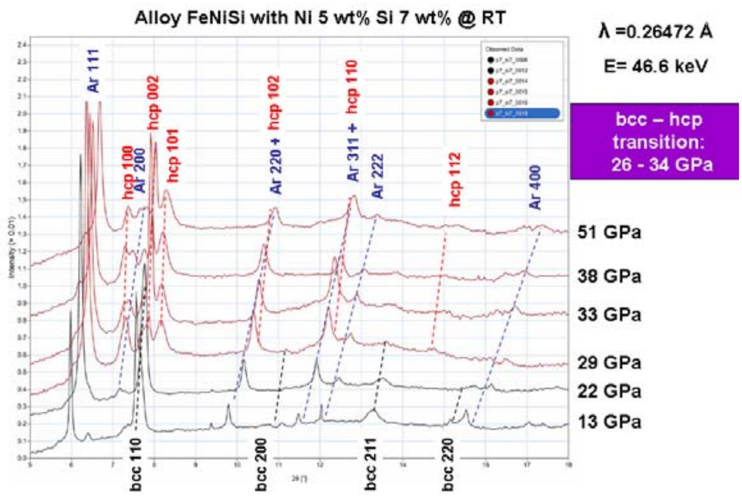
It is also known from density systematics that the Earth's core is made of iron alloyed with light elements such as O, S, H, Si or C [Poirier, 1994]. The inner core would be indeed too dense if only made by pure iron, as firmly established by Birch [1961]. We recently proposed a compositional model for the Earth's inner core and the liquid outer core, from a systematic study of the effect of light elements on sound velocities at high-pressure. The preferred core model derived from our measurements is an inner core which contains 2.3 wt.% silicon and traces of oxygen, and an outer core containing 2.8 wt.% silicon and around 5.3 wt.% oxygen. The effect of nickel on the calculated light element being negligible, the main constraint on that element comes from cosmochemical abundances, and will be around 5% [see Badro et al., 2007 for more details].

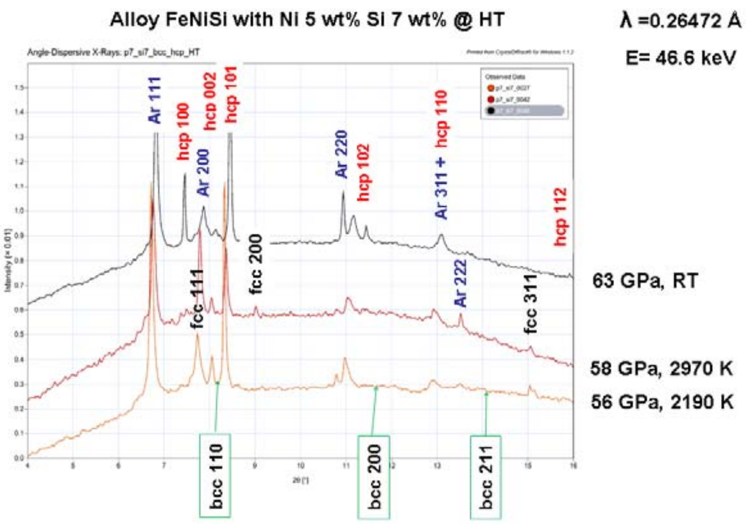
In this report, we present preliminary results from an X-ray diffraction carried out on ID27 at high-pressure and high-temperature, using the state-of-the-art double sided laser heating system available at that beamstation. We address the question of the structure of this alloy at core conditions and the available data should allow us to refine the melting temperature of such alloys up to 200 GPa.

Two different alloys have been synthesized for this experiment using a high-temperature piston-cylinder device, so as to satisfy the core preferred compositional model described in Badro et al. [2007], with alloys of compostions Fe : 92.4 wt %, Si : 3.7 wt %, Ni 3.9 wt % and Fe: 88.4 wt %, Si: 7.3 wt %, Ni: 4.3 wt %. These hot-pressed alloys were prepared under very reducing conditions so as to avoid any iron/alloy oxides, and then loaded in a diamond anvil cell with neon as pressure transmitting medium transmitting medium in a 2000-bar high-pressure vessel. Such pressure transmitting medium usually provides an optimal insulation of diamonds during sample laser-heating, and thus significantly reduce thermal gradients. Such a preparation has been shown to be very efficient during our last experiment on pure iron [see report HS2860].

Samples were subsequently analysed by diffraction collected on a CCD detector during laser-heating at pressure. Experiments were carried out between 20 and 180 GPa, and 1500-5000 K, *i.e.* covering conditions approaching those of the Earth's core. Results presented below show an increase of the pressure transition from bcc to hcp with increasing silicon content, with much more precise pressure transitions as previously published. X-ray diffraction pattern evidence only fcc and hcp at high-temperature and high-pressure and at ambient conditions, respectively. Furthermore, these preliminary results show an enlargement of the fcc stability field with increasing silicon content. Further analyses are under process to have an information on the alloy structure at 200 GPa and high-temperature.







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