Report HS4488

Melting of iron alloys at Earth's core pressures

High pressure-high temperature experiments have been performed on the ID27 beamline using the available laser heating diamond anvil cell experimental set-up. Melting properties have been investigated up to 150 GPa for different compositions: Fe-5%wtNi-15%wtSi; Fe-5%wtNi-10%wtSi. The two samples were homogeneously synthesized under inert conditions at ambient pressure and high temperature. In the diamond anvil cell pressure chamber, thin metallic sample sheets were insulated from the diamond using dry KCl as pressure medium. Then, in-situ X-ray diffraction patterns of 30s or 10s were acquired while the temperature was increased using the double-sided laser heating system.

The procedure is similar to previous experiment (HS4073 and HS3155), which gave accurate melting temperature for Fe-S and Fe-Si alloys up to 100 GPa. These results are described in a recent publication (Morard et al., 2011). In the experiment HS4488, we succeeded to reach higher P-T conditions, i.e. real conditions of the Earth's outer core (Figure 1a). However, no diffuse signal from the liquid was observed, due to imaging problems on the laser heating experimental set up on the ID27 beamline, leading to misalignment between the X-ray beam and the laser spot. Strong decrease in the diffraction signal from the sample was still observed, potentially related with the melting. Further experiments are required to confirm these measurements.

We recently applied a method to extract density from the diffuse signal of the liquid sample under HP-HT (Eggert et al., 2002) on the data set obtained during beamtime HS4073. Two publications are actually in preparation on this topic (Figure 1b) (Morard et al., 2012a; Morard et al., 2012b). Application of this density measurement method on different iron alloys could give an interesting way to discriminate between the different potential light elements present in the Earth's core.

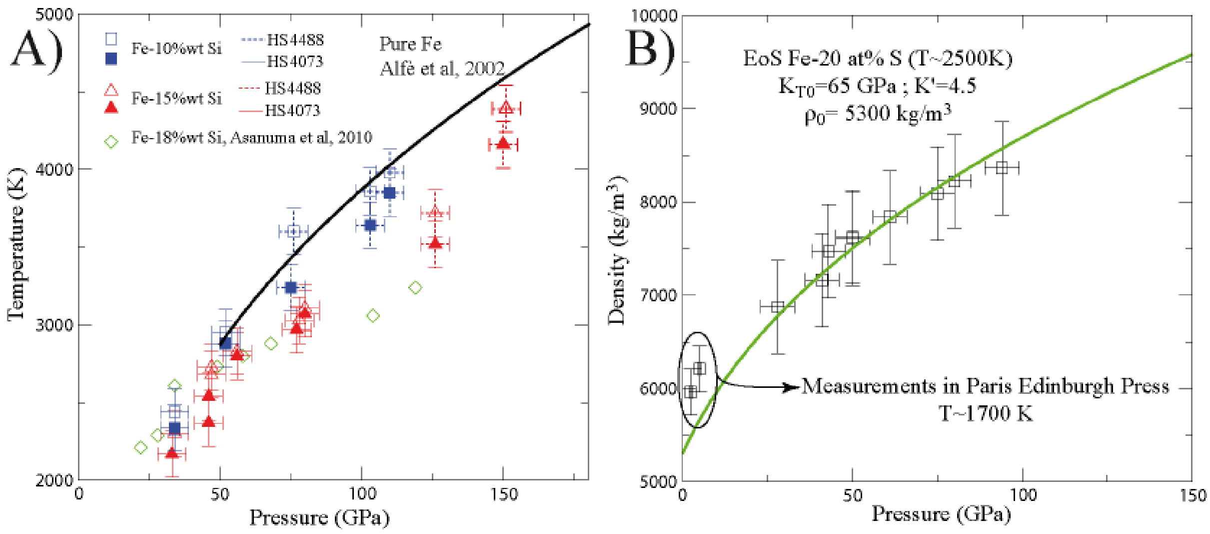

Figure 1: *A) Melting curve of Fe-Si alloys measured during experiment HS4073 and HS4488 compared with melting of pure iron fromab-initio calculations (Alfè et al., 2002). Further measurements are required to confirm melting temperature measured over 100 GPa. B) Equation of state of liquid Fe-20%at S measured up to 100 GPa, from experiment HS4073 and HS4346. Density has been calculated using the method from (Eggert et al., 2002). Further publications are in preparation on this topic(Morard et al., 2012a; Morard et al., 2012b). Discrepancy between low pressure Paris Edinburgh press and high pressure LH-DAC measurements are due to a difference in temperature.*

References

Alfè, D., Price, G. D., and Gillan, M. J., 2002. Iron under Earth's core conditions: Liquid-state thermodynamics and high-pressure melting curve from ab initio calculations. *Phys. Rev. B* **65**, 165118.

Eggert, J. H., Weck, G., Loubeyre, P., and Mezouar, M., 2002. Quantitative structure factor and density measurements of high-pressure fluids in diamond anvil cells by x-ray diffraction: argon and water. *Phys. Rev. B* **65**, 174105.

Morard, G., Andrault, D., Guignot, N., Siebert, J., Garbarino, G., and Antonangeli, D., 2011. Melting of Fe-Ni-Si and Fe-Ni-S alloys at megabar pressures: implications for the Core-Mantle Boundary temperature. *Phys. Chem. Minerals* **38**, 767-776.

Morard, G., Antonangeli, D., Andrault, D., Guignot, N., Siebert, J., and Garbarino, G., 2012a. Equation of state of liquid Fe-S alloy: implications for the maximum S content in the Earth's core *Earth Planet. Sc. Lett.*, In prep.

Morard, G., Garbarino, G., Sanloup, C., Antonangeli, D., Andrault, D., Guignot, N., Siebert, J., Roberge, M., Boulard, E., and Petitgirard, S., 2012b. Density measurements and structural properties of liquid and amorphous metals under high pressure. *Phys. Rev. B*, In prep.