Report HC1104

Density and compressibility of liquid iron alloys under Earth's outer 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. We continue the investigation of Fe-O and Fe-C systems performed in previous proposal (HS4752) by studying different sample composition and preparation. In addition to previous sample preparation (homogeneous Fe-C alloys (~100 nm grain size) synthetised by electromagnetic levitation melting techniques), Fe-10wt%O samples of homogeneous composition have been manufactured by deposition under vacuum of Fe under O_2 atmosphere (DEPHIS company). This method allows us to obtain alloys, homogeneous at the nanometer scale.

Melting properties have been investigated up to 150 GPa for these different O and C compositions: Fe-10 %wtO; Fe-1.5wt%C and Fe-4wt%C. 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, HS4488), which gave accurate melting temperature and density for Fe-S and Fe-Si alloys up to 100 GPa. These results are described in recent publications [1–5].

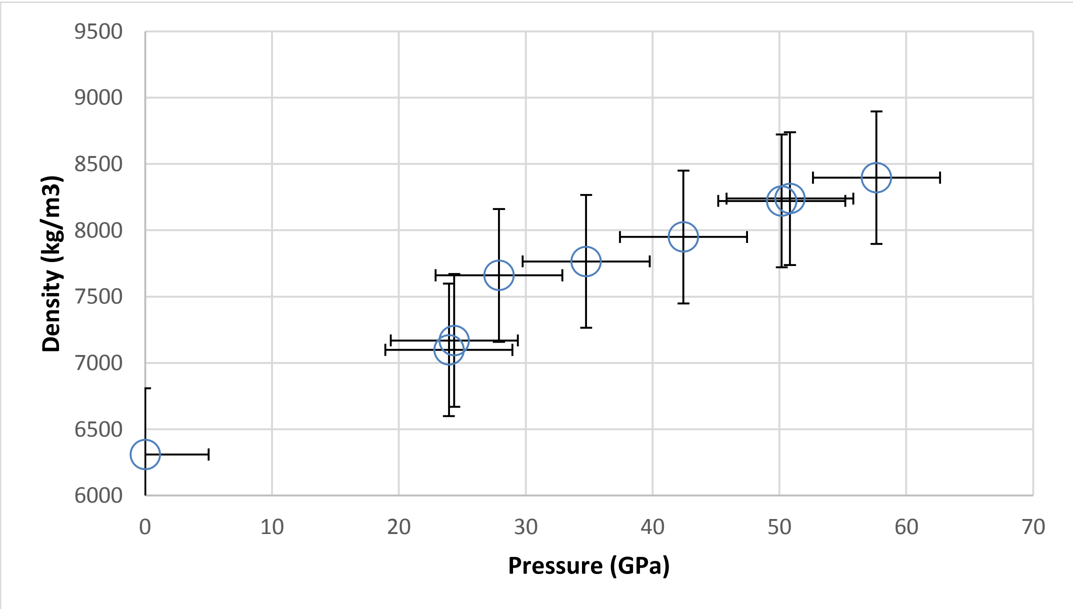

Figure 1: *Density of Fe-1.5wt%C liquid alloys at an average temperature of 2800K. Analysis of the diffuse scattering was performed following the method established in* [2]. *Room pressure density is coming from a model from* [6] *at 2600K.*

Density of Fe-C liquid alloys were obtained up to 57 GPa and will be used to derive the effect of carbon under Earth's core conditions after fitting the data with a third order Birch Murnaghan Equation of State. Furthermore, we were able to determine the solid phase before melting and we found results in strong disagreement with previous work [7], claiming that Fe_7C_3 would be the solid phase at eutectic above 100 GPa. Here we clearly saw only Fe_3C at equilibrium before melting. Also, the solubility of C in Fe seems to strongly decrease with increasing pressure. Therefore, Fe_3C could crystallize under core conditions, and C could contribute to density jump at Earth's core inner core conditions.

Concerning Fe-O alloys, we were able to acquire only two density points, under pressure of 80 GPa. All the other resulting melts were contaminated in C after melting upon quenching. However, we obtained information on the melting curve up to 150 GPa.

References

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