

The melting curve of Fe₃C to 73 GPa

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Seismic data indicate the Earth's outer core is about 10% less dense than pure Fe-Ni at the prevailing P-T conditions, whereas the inner core is some 4% less dense. Possible candidates for the light element component required to satisfy this discrepancy include H, C, O, S and Si. Constraints on core composition, phase relations and temperature are derived from knowledge of the melting relations in relevant iron-light element systems. In this study we have determined the melting curve of Fe₃C up to 73 GPa using the Laser Heated Diamond Anvil Cell (LH-DAC).

Foils made from powdered Fe₃C (synthesised by R. Dasgupta at LDGO) were loaded into ~100 µm holes in preindented Re gaskets. NaCl, ruby and sapphire were used as pressure media and thermal insulators. Samples were compressed to experimental pressure and then heated using a 60W Nd:YLF laser and a double sided heating geometry. Pressure was measured before and after each melting experiment by ruby fluorescence. Temperatures were determined by spectroradiometry. Congruent melting in a one-component system causes 1st order discontinuities in physical properties. Here, melting is deduced primarily from discontinuities in the temperature and emissivity vs. laser power function, and in some cases by visual observation of melt convection. When these observations occur together they give a consistent melting temperature. The results of our data are shown in figure 1, the solid line being our preferred melting curve from a fit of the data to a Simon equation. An extrapolation of this curve predicts a melting temperature of ~3250±50 K at the core-mantle boundary and ~3800±100 K at the inner core boundary.

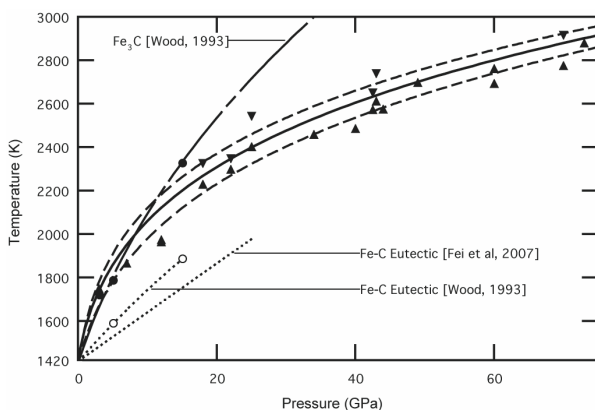


Figure 1: The melting curve for Fe₃C. Triangles are minima and inverted triangles are maxima.

References

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Molecular scale study of the synergism between oxalate and desferrioxamine-B on goethite dissolution

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Oxalate significantly increases the rate of dissolution of goethite in the presence of siderophores. This is especially true if the goethite is preequilibrated with oxalate before siderophore exposure. It has been suggested that this phenomenon is due to an oxalate-goethite surface complex that is kinetically labile with respect to iron. In this way, oxalate acts as an efficient shuttle for Fe(III) from the goethite surface to the bulk solution. Once in solution, the strongly complexing siderophore seizes the Fe(III), and oxalate is free to go back to the surface for more iron [1-3].

In this study, we use quantitative *in situ* infrared spectroscopy to further the mechanistic understanding of the role of oxalate in the dissolution of goethite in the presence of the siderophore, desferrioxamine-B (des-B). All experiments were performed at 25 °C in 0.1 M NaCl ionic medium and in the absence of light, and the pH was held at 6 using pH-Stat titration methods. The total concentration of oxalate was 1 µmol/m², and this concentration causes no significant dissolution of goethite in the absence of des-B. First, infrared spectra at the aqueous-goethite interface were collected as a function of time for one week to follow the adsorption and surface speciation of oxalate and des-B individually. Then, spectroscopic desorption experiments were performed in order to determine the relative labilities of the ligands in the different types of surface complexes. Next, spectra were collected for several days after the simultaneous addition of 1 µmol/m² concentrations of both oxalate and des-B. Finally, oxalate was reacted with goethite for one week, and then spectra were collected as a function of time after repeated 0.1 µmol/m² additions of des-B every 24 hours. We identify an oxalate-goethite surface complex that increases the mobility of Fe(III) but is otherwise thermodynamically stable in the absence of des-B. These results are discussed with respect to their broader implications toward mechanisms for ligand-promoted mineral dissolution.

References

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