Melting experiments on Fe_3S under high pressure

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Keywords: diamond anvil cell, earth's core, iron-sulphur, melting

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The Earth's core is mostly composed of iron and nickel alloy but with some portion of light elements. Though there have been many attempts to define the light element in the core, there is no solid consensus as to the composition of the core. To date, there have been a number of candidate elements identified, such as silicon, oxygen, and sulphur.

Sulphur is particularly important element to consider due to its siderophilic nature. Many iron meteorites, which are believed to be the cores of destroyed planetesimals, show very high sulphur contents. The system Fe-S has therefore been of great interest as a model core system. The iron-rich compounds are important for Earth's core as the dense solid inner core is crystallised from the less dense liquid outer core. Fe_3S is the most iron-rich sulphide phase and stablised at high pressure. The thermodynamic properties of Fe_3S were less studied compared to other iron compounds mostly because the single phase of Fe_3S is difficult to synthesise from powder mixtures under high pressures. As a result, existing melting data only concerns the melting of the binary eutectic system, and not the end member Fe_3S, which limits the ability to extrapolate data to conditions of the Earth's core and thermodynamic modelling capabilities.

We have investigated the melting behavior of Fe_3S using in situ high pressure/temperature X-ray diffraction experiments in laser heated diamond anvil cells up to 100 GPa. Pressure transmitting medium of Al_2O_3, SiO_2, or KBr was used in the experiments. We used a flake-shaped amorphous alloy with a composition of Fe_3S. Melting was determined using disappearance of diffraction peaks associated with Fe_3S, and through textural analysis of recovered samples. Synchrotron X-ray in-situ experiments were performed at beamline BL10XU (SPring-8) and P02.2 (PETRA III).

We will report new experimental data and discuss the melting temperature of Fe_3S under Earth's core pressures. We will also discuss the implications of our data to the effects of sulphur on Earth's core properties.

Acknowledgments: This work was supported by the European Research Council (ERC) Consolidator Grant to TK (Earth core #647723).