Equations of state of Fe-10Ni and Fe-10Ni-5Si at high pressure

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Earth's core is composed primarily of iron with ~5 wt% nickel alloyed with some fraction of light elements [McDonough, 2003]. Accurate equations of state for iron-nickel alloys are necessary to further constrain core composition. High temperature equations of state are typically anchored with ambient temperature isothermal equations of state. Lattice parameters of elastically anisotropic minerals can be highly sensitive to stress conditions in the surrounding environment [e.g. Zhao and Ross, 2015], particularly in ambient temperature experiments, and helium is quasi-hydrostatic to much higher pressures than neon and other commonly selected pressure media [Klotz et al., 2009]. We present high-quality powder x-ray diffraction data on bcc- and hcp-structured Fe-10wt%Ni and Fe-10wt%Ni-5wt%Si up to high pressures above 1 Mbar at ambient temperature. By using diamond anvil cells loaded with tungsten powder as a pressure calibrant and helium as a pressure transmitting medium, the isothermal equations of state of hcp Fe-10Ni and Fe-10Ni-5Si were measured with extremely high statistical quality. We systematically compare our study to a similar equation of state study on pure iron also conducted in helium with a tungsten pressure calibrant [Dewaele et al., 2006], thereby constraining the effect of nickel and silicon on the isothermal equation of state of iron alloys.

Dewaele, A., P. Loubeyre, F. Occelli, M. Mezouar, P. Dorogokupets, and M. Torrent (2006), Quasihydrostatic equation of state of iron above 2 Mbar, *Physical Review Letters*, 97, 215504.

Klotz, S., J.-C. Chervin, P. Munsch, and G. Le Marchand (2009), Hydrostatic limits of 11 pressure transmitting media, *Journal of Physics: Applied Physics*, 42 (7), 075413.

McDonough, W. F. (2003), Compositional model for the Earth's core, in *Treatise on Geochemistry Vol. 2*, edited by R. W. Carlson, chap. 2.15, pp. 547–568, Elsevier Ltd, Oxford, UK.

Zhao, J., and N. L. Ross (2015), Non-hydrostatic behavior of KBr as a pressure medium in diamond anvil cells up to 5.63 GPa, *Journal of Physics: Condensed Matter*, 27 (18), 185402.