Density measurements of crystalline Fe and amorphous materials at high pressure

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Terrestrial planets, such as Earth, Venus, Mars, and Mercury, have metallic liquid and/or solid cores. The cores consistent of mainly Fe and Ni with small amounts of light elements. Chemical compositions of solid state cores have been estimated by density measurements of crystalline core materials in a number of previous studies. On the other hand, there are a few previous studies on density measurements of liquid samples because of technical difficulties. Although Morard et al. (2008, 2013) obtained densities of liquid Fe with light elements by structure analyses from XRD patterns, accuracy of the densities was under debate because they used XRD patterns with narrow reciprocal lattice spaces. In this study, we have measured densities of crystalline Fe and amorphous materials using an X-ray absorption method in order to avoid problems of small diffraction angles due to a diamond anvil cell (DAC).
High pressure measurements were performed using a DAC with a gasket having 3 sample chambers. Fe or amorphous samples were loaded in a sample chamber for density measurements. Powders of KCl, KBr, or RbBr as references for thickness were also loaded in the other sample chambers. After XRD patterns were taken from all samples and references, absorption profiles were also measured. Experimental pressures were determined using pressure averages between KCl and KBr, or KBr and RbBr. Densities based on the X-ray absorption method were obtained using the Lambert Beer law with mass absorption coefficients from NIST data base. Densities of crystalline Fe were obtained up to 20 GPa and density differences between XRD and the absorption method were less than 2%. This technique was applied to densities of amorphous materials as well. We will report the densities based on the X-ray absorption method.

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