Electronic configuration and magnetism in FeO at extreme pressure and temperature

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Abstract

Iron monoxide is a fundamental component in the Earth's interior as the iron endmember of ferropericlase (Mg,Fe)O – the second most abundant mineral in the lower mantle. Moreover, iron monoxide is likely to be the final constituent of the evolution of subducted banded iron formations and might be a source of the low-velocity zones at the Earth's core-mantle boundary (Dobson and Brodholt, 2005). The stability and high-pressure properties of FeO could, thus, determine the fate of banded iron formations and their potential role in processes in Earth and planetary interiors, including controls on redox cycles.
At ambient conditions, FeO crystallizes in the B1 structure and undergoes a phase transition into rhombohedrally distorted B1 (rB1) above 16 GPa (Yagi et al., 1985). The transition is accompanied by the appearance of antiferromagnetic ordering. Although numerous studies were focused on investigation of the electronic and magnetic properties of FeO at high pressures and moderate temperatures, information on the properties at relevant high temperatures is very limited. For instance, the pressure dependence of the Néel temperature – one of the fundamental characteristics of antiferromagnetic materials – was determined only up to 40 GPa under non-hydrostatic conditions (Kantor et al., 2007).

We will present our investigation on the pressure dependence of the electronic and magnetic properties of iron monoxide by means of Synchrotron M'́ossbauer Source spectroscopy in resistively- and laser-heated diamond anvil cells. We employed Single-Crystal X-ray diffraction in order to identify further distortions of the FeO structure at higher pressures. We will discuss the influence of the distortions on the electronic and magnetic properties of FeO and their potential role in the mineralogy, chemistry, and physics of the Earth's deep interior.

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Yagi, T., Suzuki, T., Akimoto, S.-I., 1985. Static Compression of W´ustite (Fe0.98O) to 120 GPa. J. Geophys. Res. 90, 8784.