Ferropericlase at high pressures: probing structural and electronic properties at synchrotron and in-house facilities

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Ferropericlase (Mg,Fe)O with ~20% of Fe is one of the main constituents of the Earth's lower mantle (second in abundance after $(Mg,Fe)SiO_3$ perovskite). Its properties and stability field are therefore important for geophysical and geochemical models of the Earth's deep interior. The MgO end member of this solid solution has no phase transitions up to at least 200 GPa [1]. In contrast, there are several structural and electronic transformations in FeO at high pressures: it transforms from the cubic NaCl structure to a rhombohedrally distorted one and further to a hexagonal NiAs-like structure [2]. Several electronic transitions are also known to occur in FeO: a magnetic ordering transition from paramagnetic to antiferromagnetic and a high- to low-spin transition [3]. If any of these transformations were to occur in ferropericlase, its physical properties would be changed significantly.

We present a combined X-ray diffraction, X-ray absorption and conventional Mössbauer spectroscopic study of $(Mg_{0.8}Fe_{0.2})O$ up to 105 GPa. Based on multiple experimental techniques we clearly established the presence of two transitions in ferropericlase: rhombohedral distortion at ~35 GPa [4] and spin transition that occurs in the 55-102 GPa pressure range. These results change our understanding of high-pressure properties of ferropericlase: the spin transition is so broad that there would be no discontinuities in any physical properties associated with spin crossover, but only smooth changes. At the same time a structural transition in ferropericlase could result in a minor seismic waves velocity discontinuities.

References

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