Iron L- and M- edges of iron containing minerals measured by x-ray Raman scattering

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Concerning the composition of the Earth's core and mantle, iron is one of the most interesting elements for applications in geosciences. Investigation of its electronic structure is essential to understand the origin of physical properties of different iron containing minerals existing in the Earth's interior. E.g. Fe^{2+}/Fe^{3+} ratios, the spin state as well as the oxygen fugacity can vary significantly at relevant conditions, i.e. pressures up to 1 Mbar and temperatures up to 3000°C [1-2]. Thus, experimental determination of such parameters in situ is crucial to understand the thermodynamic properties of these minerals [3].

X-ray Raman scattering (XRS) provides a possibility to measure electronic excitations by inelastic x-ray scattering which yields similar information like measurement of x-ray absorption edges by x-ray absorption spectroscopy (XAFS) or electron energy loss spectroscopy (EELS) [4]. Because XRS is an energy loss technique and the energy of the incident radiation does not depend on the binding energy of an atom, in contrast to XAFS and EELS, measurments of absorption edges of low Z elements in soft x-ray regime are possible using hard x-rays which allows measurements even in highly absorbing sample environments like diamond anvil cells with resistive or laser heating.

In this study, Fe $L_{2/3}$ and $M_{2/3}$-edges of different iron oxides and iron containing minerals measured by x-ray Raman scattering are presented in comparison with XAFS and EELS results. Furthermore, the momentum transfer dependency of the Fe $M_{2/3}$-edge is discussed. Possible applications in geosciences are pressure induced electronic transitions in iron containing minerals.

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