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TEM study on Iron Oxide Nanoparticles and Precipitates in Feldspars

U. Golla-Schindler (1), R. Hinrichs (2), and A. Putnis(1)

(1) Institut für Mineralogie, University of Muenster, Germany (2) Instituto de Geociências, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil(golla@nwz.uni-muenster.de / Fax: +49(0)251/83-38397 / Phone: +49(0)251/83-33460)

TEM studies in the field of geociences opens an avenue of new applications, which essentially help to answer unsolved questions. One excellent technique to determine the oxidation states of different mineral phases is to study the ELNES (Electron Loss Near Edge Structure). This was done using conventional EELS (Electron Energy Loss Spectroscopy) as well as the technique of spatial resolved EELS, which enables the precise study of the energy shift.

Especially for iron oxide minerals the near edge structure of the O-K edge [1] and the Fe L-edge can be used to determine the oxidation state, the iron oxide phase, and additionally the chemical composition qualitatively as well as quantitatively [2,3]. This work deals with the identification of iron bearing minerals in two systems. The possible candidates for the iron-oxide phases are FeO, α-Fe_2O_3 (hematite), γ-Fe_2O_3 (maghemite), Fe_3O_4 (magnetite), α-FeO(OH) (goethite).

The first studied materials were colloidal magnetic iron-based nanoparticles. Their structure is supposed to consist of an oxidized rim and iron core [5]. Fingerprinting the ELNES of the O K-edge two possible candidates for the iron oxide phase of the rim are Maghemite and Magnetite. Quantitative analysis of the EELS spectrum yields a chemical composition consistent with maghemite. High resolution TEM studies confirm the crystalline structure of the rim and core. Additionally the lattice fringes of the rim fits the maghemite structure.

In the second analysis examined small iron oxide needles in alkali feldspars of granitic rocks. It has long been supposed, that the clouded pink-red feldspars in granites owe their colour to hematite inclusions [4], but optical petrography and microprobe anal-

ysis can't resolve the fine structure. TEM and EELS now enables to analyse these precipitates. Fingerprinting the ELNES of the O K-edge yields that the iron oxide phase of the small precipitates consists of hematite. This can be confirmed by the comparison of experimentally taken and calculated diffraction patterns.

The investigations were performed using two different TEM's. A conventional JEOL 3010 operating at 297 kV equipped with a LaB_6 cathode, postcolumn Gatan Imaging Filter and a 1 K slow-scan CCD camera and a LIBRA 200FE operating at 200 kV, equipped with a field emission gun, a 4 K slow-scan CCD Camera and a corrected 90˚ in-column Omega energy filter.

References

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