

RUTILE AND HEMATITE PSEUDOMORPHS FROM MWINILUNGA (ZAMBIA)

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Samples of rutile and hematite pseudomorphs from Mwinilunga (Zambia), were investigated by optical microscopy, X-ray powder diffraction, scanning and transmission electron microscopy. The pseudomorphs retained the plate-like morphology of the original crystals. Their surfaces are covered by fresh euhedral crystals of rutile, following a semi-epitaxial orientation relationship $[001]_{\text{rut}} \parallel \langle 11\bar{2}0 \rangle_{\text{ilm}}$ where c -axes of the rutile crystals are lying parallel to the basal planes of the precursor. In-plane $\{101\}$ twins of rutile are frequent. Cross-sections cut parallel to the basal plane of the precursor were prepared from the interior of the pseudomorphs. Optical microscopy of polished thin sections shows sub-microcrystalline texture of transparent rutile areas within a matrix of opaque phase. XRD analysis confirmed the presence of rutile and hematite. Although polycrystalline, rutile grains form distinct 120° domains, induced by a topotaxial growth on the corundum-type precursor. Within nanocrystalline domains of rutile macroscopic, often twinned crystals of rutile are emerging. These crystals adopt the orientation of the originally polycrystalline matrix. In nature, twins are commonly associated with a topotactic replacement of hematite or ilmenite by rutile, due to structural similarity. They do not have a definite three-dimensional form and the transformation is governed by rearrangement of the cations across the interface, while a hexagonal stacking of the oxygen sublattice remains unaltered (FORCE *et al.*, 1996; DANEU *et al.*, 2007). On sub-micron scale we have confirmed a nanocrystalline nature of rutile and hematite precipitates by TEM. The possible

mechanism of recrystallization includes the action of acidic hydrothermal solutions (JANSSEN *et al.*, 2010). Under low pH values ilmenite rapidly alters to fine crystalline rutile following a dissolution-precipitation mechanism. First ilmenite is dissolved in acidic solution. With decreasing temperature hydrothermal solution reaches a point of supersaturation, which triggers precipitation of rutile. The volume difference between the ilmenite and rutile causes the formation of porosity, which is then filled-up by nanocrystalline hematite. Throughout the alteration process morphology of the precursor ilmenite crystal is preserved. A high degree of coherency between the precursor and precipitated rutile grains suggests a progressive recrystallization from the surface to the interior. This is indicated by finer crystallinity and higher coherency of the surface areas and coarse crystallinity in the interior as the acidity drops. In the final stage, macroscopic rutile crystals developed on the open surfaces and in the pores of ilmenite precursor. Twinning, where present, tends to follow the 120° domain texture of the fine crystalline rutile.

References

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