Geophysical Research Abstracts
Vol. 21, EGU2019-17634-1, 2019
EGU General Assembly 2019

Controls on the microstructure and texture of a natural spinel reaction rim around a corundum single crystal in basalt

Roman Schuster (1), Gerlinde Habler (1), Lisa Baldwin (1), Chen Li (1,2), and Rainer Abart (1)

(1) Department of Lithospheric Research, University of Vienna, Vienna, Austria (roman.schuster@univie.ac.at), (2) Stuttgart Center for Electron Microscopy, Max Planck Institute for Solid State Research, Stuttgart, Germany

A polycrystalline spinel corona that developed by chemical reaction between a centimeter-sized corundum xenocrystal and hosting basaltic melt shows remarkable variations in the spinel microstructure and crystallographic texture when comparing particular corona segments formed along different corundum crystal facets. The comprehensive new EBSD dataset documents that the corundum lattice and/or the orientation of the reaction interface with respect to the precursor crystal control the microstructure and texture of the newly formed spinel. In addition, the morphology of the precursor crystal affects the microstructure of spinel that grew at the expense of corundum. Contrasting with the predominant control of the precursor crystal, the presence of nano-inclusions of Ti-oxides in corundum has no discernable influence on the nature of the spinel microstructure and texture.

The studied spinel corona is constituted mostly by grains of two spinel twin orientations that have a specific topotactic orientation relationship with corundum, where one spinel $\langle 111 \rangle$ direction clusters close to the corundum c-axis, and three spinel $\langle 110 \rangle$ cluster close to the three Crn $\langle 10\bar{1}0 \rangle$ directions. Still, spinel orientations deviate from perfect topotactic match, both systematically and statistically, which causes the polycrystalline nature of the spinel rim and the introduction of spinel grain boundaries (GBs) with GB misorientations of up to 20°.

Similarities and variations between different spinel corona segments are reflected by i) the characteristics of the preferred orientations of the spinel grain and twin boundary traces, ii) the characteristics of the topotactic orientation relationship between spinel and corundum, and iii) the apparent rim thicknesses. Regarding i) spinel twin boundary traces are typically straight and preferably follow the Crn (0001) plane trace but show variations in their densities for different corona segments. Low angle GB traces are curved, but for most corona segments show maxima in the GB trace orientation distribution, indicating the presence of a spinel shape preferred orientation. Both, the orientation of the low angle GB trace maxima and the asymmetry of the low angle GB trace distribution depend on the orientation of the reaction interface with respect to the precursor crystal lattice. Regarding ii) different corona segments show differing quality of the topotactic match, and varying misorientation of the spinel orientation maxima with respect to the corundum lattice. Furthermore, also the modal proportions of spinel pertaining to either of the two twin orientations vary between different corona segments. Concerning iii) two groups of corona segments with different rim thicknesses were observed, indicating that variations in the corona microstructure and texture are associated with differences in the reaction kinetics during spinel formation along different corundum facets.

The systematic variations of the parameters allow the distinction of four types of spinel rim segments that are determined by their position along the reactive corundum surface. The results have substantial implications for the petrogenetic interpretation of reaction microstructures, as they show that consideration of particular interface orientations and the crystallographic orientation of the involved phases is highly important when investigating reaction microstructures.