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Twinning in hydrous wadsleyite: Symmetry relations, origin, and consequences

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Abstract

Twins in hydrous wadsleyite were detected by polarized-light microscopy and characterized with transmission electron microscopy techniques, including precession selected area electron diffraction and large-angle convergent beam diffraction. By inspecting diffracted intensities for high-order Laue zones, we found the symmetry of our hydrous wadsleyite samples to be reduced to monoclinic with respect to the orthorhombic symmetry of most anhydrous wadsleyite samples. Twinned domains in hydrous wadsleyite share the (122) plane as a composition plane and are related to each other by a twofold rotation around a twin axis parallel to [212] or by reflection on (122). The twin axis and twin plane in wadsleyite correspond to the <101> directions and the {101} planes of ringwoodite, respectively. The twin operations exchange the c^* and the [120]* directions of wadsleyite, both of which correspond to the directions of the cubic a axes in ringwoodite. Based on our analysis of symmetry relations and pseudo-symmetry in wadsleyite, we conclude that the twins formed during crystal growth under quasi-hydrostatic conditions in the presence of a hydrous fluid. Twinning in wadsleyite may affect the physical properties and deformation behavior of wadsleyite as well as the phase transition to ringwoodite in the Earth's mantle transition zone.

Keywords: Twinning, hydrous wadsleyite, transmission electron microscopy, Earth's mantle transition zone