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Fluid infiltration-driven morphological transition during prograde olivine growth formed by high-pressure Atg-serpentinite dehydration

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Crystal morphologies are essential for deciphering the reaction history of igneous and metamorphic rocks because they often record the interplay between nucleation and growth rates controlled by the departure from equilibrium (i.e., the reaction affinity). We report a unique record of morphological transition in olivine from a chlorite harzburgite formed by high-pressure dehydration of antigorite serpentinite from the Almirez Massif (Betic Belt, Nevado-Filábride Complex, S. Spain). Correlative X-ray μ-CT and EBSD in a varied-textured Chl-harzburgite unveils the presence of composite olivine grains made up of large equant cores mantled by epitaxially grown coronas of tabular olivines with a spinifex-like morphology. Olivine in overgrown coronas is tabular on (100) with $c > b >> a$, which strongly differs from anisotropic olivines in igneous and metamorphic systems, where reported morphologies are tabular on (010) with either $a > c >> b$, or $a \approx c >> b$. Coronas of tabular olivine on equant grain substrate record a shift from isotropic to strongly anisotropic growth due to inhibited growth on the (100) and, to a lesser extent, (010) olivine interfaces. Inhibited growth along these interfaces is predicted in crystals that grow from highly polymerized fluids due to the dissociative and molecular adsorption of water monolayers on (100) and (010) olivine interfaces, respectively. This morphological transition likely records the open-system arrival of highly polymerized aqueous fluids during the late stages of Atg-serpentinite dehydration in a subduction setting. These results show that, besides reaction affinity, surfactants may play an important role in shaping the morphology of growing crystals during metamorphism.

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