# From epitaxy to topotaxy: the migration of reaction interfaces through crystals

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Solid state transformations create microstructures which reflect both the thermodynamics and the kinetics of the mechanism involved. Minimisation of strain results in crystallographic relationships between parent and product phases across internal interfaces between them (topotaxy). This has led to the common misconception that the existence of such topotaxy, and hence the transfer of crystallographic information from parent to product, can be used as a criterion to define a solid state transformation mechanism. For example the conversion of a single crystal of Na-feldspar to a single crystal of K-feldspar by ion exchange may imply a solid state diffusion mechanism. However, under hydrothermal conditions, this can also be accomplished by an *interface-coupled dissolution-reprecipitation* mechanism, with the dissolution of the parent phase and the epitaxial precipitation of the product. The original external interface defines the boundary of the parent phase crystal and hence the process is pseudomorphic. Differences in relative solubility of parent and product in the fluid phase, as well as differences in the solid molar volume, are accounted for by the presence of a fluid-filled porosity in the product. The fluid phase occupies pores with a crystallographically controlled microstructure and allows mass transport between the external fluid and the reaction interface, which can then move through the parent crystal. The result is that the original epitaxy defines the topotaxial relationships at the internal reaction interface. As with all microstructural evolution, the textures are transient stages in the reequilibration, and coarsen with time.

This general model of mineral-fluid reequilibration accounts for many textural observations in minerals and rocks. Just as there are various degrees of coherence at interfaces resulting from solid state processes, interface-coupled dissolution-reprecipitation mechanisms also have varying degrees of epitaxy which can lead to a single crystal being pseudomorphically replaced by a polycrystalline product. The replacement of one phase by two or more phases can lead to symplectite textures reminiscent of those formed by solid state mechanisms such as discontinuous precipitation. One striking conclusion is the parallel between the factors which control solid state mechanisms and interface-coupled dissolution-reprecipitation mechanisms, and this has important implications for the interpretation of mineral microstructures and geothermal histories.