

## **The transformation of andalusite to mullite and silica: Part II. Transformation mechanisms in $[100]_A$ and $[010]_A$ directions**

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### **ABSTRACT**

The transformation of an andalusite ( $\text{Al}_2\text{O}_3 \cdot \text{SiO}_2 = A$ ) single-crystal to 3:2-mullite ( $3\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 = M$ ) and non-crystalline silica ( $\text{SiO}_2$ ) was investigated at the  $(100)_A$  and  $(010)_A$  faces using electron microscopy. The transformation starts topotactically at the surfaces producing a dense layer of mullite and vitreous silica on the surface and underneath the mullite layer. Next, the reaction proceeds by dissolution of andalusite in the vitreous silica and by diffusional transport of alumina to mullite crystals occasionally nucleated at the dissolving andalusite. Transformation along  $[100]_A$  proceeds twice as fast as along  $[010]_A$ , which is explained by the higher stability of the  $(010)_A$  face against dissolution. Transformation by dissolution and precipitation is one order of magnitude slower than the topotactic transformation along  $[001]_A$ . The transformation reaction of andalusite to mullite and silica is highly anisotropic. Combining the results along the directions  $[100]_A$ ,  $[010]_A$ , and  $[001]_A$  predicts the type of transformation which will take place at an arbitrary andalusite face. Only if the  $c_A$  axis is oriented more than  $80^\circ$  off the surface normal, will the reaction proceed by the dissolution-precipitation process, whereas for all other orientations andalusite transforms by the fast topotactic reaction along the  $c_A$  axis.