Thickness of pericline twin walls in anorthoclase: an X-ray diffraction study

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Abstract: The thickness of pericline twin walls in disordered feldspar Ab63Or30An5 has been determined by quantitative measurements of the diffuse X-ray diffraction caused by these walls. The diffuse diffraction appears as streaking between pairs of twin-related Bragg peaks. Comparison of the predictions of simple model calculations with the observed intensity profiles indicates that these walls are ~25 Å thick at room temperature.

On heating, the wall thickness increases, following the predictions of Ginzburg-Landau theory:

\[ W \propto |T_c - T|^{1/2} \]

Key-words: alkali feldspar, domain walls, Landau theory, X-ray diffraction.

Introduction

Twinning in anorthoclase is a result of the displacive \( C2/m \rightarrow C\bar{1} \) phase transition caused by the collapse of the aluminosilicate framework (Brown & Parsons, 1994; Smith & Brown, 1988). This collapse leads to domains of two types, which correspond to the two ways that the framework can collapse. If this transition is described using order parameter theory (Salje, 1985), the two domains have order parameters +Q and -Q. Thus, individual domains can be described as ordered or “+” and antierdered or “−”.

Twin walls arise at the intersection of these two types of domain. These walls will have definite crystallographic orientations (Salje et al., 1985a). These can be derived from symmetry arguments, or by minimising the mismatch between the two domains’ crystal structures.

In the case of transformation (as opposed to growth) twinning in feldspars, two principal twin laws are observed. In albite twins, the two domains meet along the (010) plane, and are related to each other by an (010) mirror plane. In pericline twins, the two domains are related by a diad rotation around [010], and meet on a plane \((h0l)\), where the values of \( h \) and \( l \) vary with the lattice parameters of the sample. In anorthoclase this composition plane is close to (001) (Smith, 1974).

The aim of this study is to examine the way that these twins affect the crystal structure of material in the vicinity of the twin. The thickness of the walls affects many properties of ferroelastic materials. For example, the distorted structure inside twin walls makes them ideal sinks for defects (Salje, 1992). In addition, twin walls affect the vibrational and hence thermal and elastic properties of materials (Horovitz et al., 1987).

The principles that determine the thickness of twin walls would be expected to apply to the relaxations around other defects as well. However,