Introduction

Ferromagnesian cordierite is a framework silicate with ideal formula \((\text{Mg,Fe})_2\text{Al}_4\text{Si}_5\text{O}_{18} \cdot n\text{H}_2\text{O}\). In nature, it occurs in two stable polymorphic forms, the high-temperature modification (named indialite by Miyashiro et al., 1955) with hexagonal symmetry (space group \(P6/mcc\), Meagher & Gibbs, 1977), and the low-temperature form, which is orthorhombic (space group \(Cccm\), Gibbs, 1966). The Al/Si ordering processes which relate the two polymorphs were studied extensively in the 1980’s (Putnis, 1980; Putnis & Bish, 1983; Putnis & Angel, 1985; Putnis et al., 1985, 1987; Güttler et al., 1989). It was found that synthetic anhydrous Mg-cordierite prepared from a glass starting material is at first hexagonal, with a substantial degree of Al/Si disorder. Annealing of this material at high temperatures induces an increase in Al/Si order and the transformation to orthorhombic cordierite via a metastable strain-modulated structure. Cordierites containing the tweed microstructure typical of the intermediate state have only been found twice in nature (Müller & Schreyer, 1991; Daniels et al., 1992). It appears that the stabilising factor in these modulated sam-

Strain modulation around inclusions in an annealed natural cordierite

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Abstract: A natural ferromagnesian cordierite which had been annealed at 1355°C has been found, by TEM, to contain submicroscopic cross hatched modulated microstructures (tweed) localised near \(\text{Al}_2\text{O}_3\) inclusions, while most of the sample, apart from some melting features, remained homogeneous and orthorhombic in symmetry. SAED patterns from regions with the tweed textures exhibited splitting parallel to \([31\overline{0}]^*\) and \([110]^*\) of the orthorhombic cell. Such features in cordierite have been interpreted in previous investigations as intermediate metastable states formed during the high-to-low transition associated with Al/Si ordering. Such metastable states appear to be favoured in K-bearing cordierites because the substitution \(\text{Si}^{4+} + \text{[channel]} \rightarrow \text{K}^+ + \text{Al}^{3+}\), which increases the number of the Al-O-Al bonds, hinders the development of long range Al/Si ordering and the high-to-low transition. In the present cordierite studied here, the mechanism of modulated structure formation is most probably similar but the chemical exchange involved is different and of the type \(\text{R}^{2+} + \text{Si}^{4+} \rightarrow 2\text{Al}^{3+}\) (where \(\text{R}^{2+}\) is an octahedral cation). This entails the presence of some Al in octahedral coordination. It is suggested that octahedral Al would stabilise the hexagonal form of cordierite.

Key-words: modulated structure, cordierite, TEM.


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