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Crystal growth of pyrochlore rare-earth stannates

D. Prabhakaran*, S. Wang, A.T. Boothroyd

Department of Physics, University of Oxford, Clarendon Laboratory,

Parks Road, Oxford, OX1 3PU, United Kingdom

*Corresponding author. Tel: +44 1865 272351; fax: +44 1865 272400.

d.prabhakaran@physics.ox.ac.uk

Abstract

We report crystal growth of several rare-earth stannates $RE_2Sn_2O_7$ (RE = Pr, Tb, Ho, Dy, Yb and Lu) using the flux technique. Different combinations of flux were tried, and a $Na_2B_4O_7$-NaF (1.2:1) mixture was found to be suitable for crystal growth. X-ray diffraction and thermal characterisation data are presented, as well as some initial measurements of magnetic and thermodynamic properties of the crystals. Little effect was observed with changing oxygen content by Sc substitution for Sn.

Key Words: A2. Single crystal, A2. Growth from high temperature solutions, A2. Flux growth technique, B2. Magnetic materials, B2. Pyrochlore, B2. Stannates

1. Introduction

Geometrically frustrated magnetic pyrochlores are fascinating due to their interesting properties including spin-liquid, spin-glass and spin-ice states [1-7]. Pyrochlore oxides have the general formula $A_2B_2O_6O'$ which derives from the mineral $NaCaNb_2O_6F$ [5]. The crystal structure is described by the cubic space group Fd3m (No.227) with eight formula units (z=8). When the atoms (A, B) have valency of either (2^+, 5^+) or (3^+, 4^+) the compounds are called α-pyrochlores. AOs_2O_6 type compounds are called β pyrochlores [6], which crystallise in the non-centrosymmetric space group F43m. Many of the highly frustrated magnetic pyrochlore oxides are insulators, but others are metallic or semiconductors with different but equally interesting electronic properties, for example the giant magnetoresistance behaviour of $Tl_2Mn_2O_7$ [7], and superconductivity of $Cd_2Re_2O_7$ [8].

Rare-earth pyrochlore oxides with the B site ion Ti^{4+}, ($RE_2Ti_2O_7$) have been extensively studied, facilitated in large part by the availability of large single crystals. These compounds have congruent melting points and hence can be grown from the melt, particularly using the floating-zone technique [9, 10]. However, there has been very little investigation of the rare-earth stannate pyrochlores ($RE_2Sn_2O_7$) despite several potential applications including: catalysts and radiation