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Chapter 8

High-Pressure High-Temperature (HPHT) Synthesis of Functional Materials

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Abstract

High-pressure techniques have been used extensively in effecting phase changes in materials science for decades. The use of high-pressure high temperature enables changes in material atomic arrangement or structure which in turn brings about changes in functional properties such as magnetism, optical, electrical and thermal conductivity. High-pressure technology is highly specialised and requires understanding to fully utilise its potential as a tool for the development of new and novel functional materials with improved properties. This chapter explores the various high-pressure technologies available and how they have been utilised to obtain a wide range of functional ceramic materials for a wide range of applications.

Keywords: high-pressure high-temperature sintering, functional materials, high-pressure synthesis, phase transition

1. Introduction

The discovery of novel properties and quantum states at high pressure has led to a number of new functional material categories. Pressure has long been recognised as a fundamental thermodynamic variable which can be used to manipulate electronic, magnetic, structural and vibrational properties of materials for a wide range of applications. High pressure effectively decreases the atomic volume and increases the electronic density of reactants which results in unusual and interesting properties. There are two basic approaches evident to high-pressure synthesis which involves structural transformation on the one hand and formation of new chemical bonds on the other. Particularly noticeable discoveries in high-pressure physics include metallisation of hydrogen, quantum criticality, high $T_c$ superconductors, polymorphism and exotic metals [1].
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