

## High pressure techniques at low temperatures

S RAMASESHAN, G PARTHASARATHY and E S R GOPAL\*

Raman Research Institute, Bangalore 560 080, India

Instrumentation and Services Unit, Indian Institute of Science, Bangalore 560 012, India

\*Also Department of Physics

**Abstract.** The article reviews the experimental techniques used in high pressure-low temperature investigations to study a variety of physico-chemical phenomena. The general principles of producing high pressures at low temperatures, the methods of measuring  $P$  and  $T$ , the materials used for construction and the diamond anvil cell (DAC) are briefly given first. Specific pieces of apparatus to measure the mechanical properties, phase equilibria, thermal properties, electrical properties, magnetic phenomena, optical and Raman/IR spectroscopic behaviour as well as Mössbauer spectra are then discussed. While instrumentation is the main emphasis of the article, a few illustrative examples of interesting observations are also indicated. Over 250 current papers are cited.

**Keywords.** High pressure techniques; low temperatures; diamond anvil cell; mechanical properties; phase equilibria; thermal properties; electrical properties; magnetic phenomena; Raman spectra; Mössbauer spectra; instrumentation.

PACS No. 07-35

### 1. Introduction

The study of the behaviour of materials at high pressures and low temperatures has been useful not only in understanding the properties of these materials but also in the observation of new features of the physicochemical properties. It is now believed that almost all materials will become metallic at sufficiently high pressures; therefore a combination of high pressures with low temperatures is a logical step in pursuing this phenomenon. Many superconductors have been discovered at high pressures and low temperatures. Pressure as a thermodynamic parameter and as a means of perturbing the symmetry of the system has a unique role and many of the phenomena are clearly studied only at low temperatures. For instance the study of the Fermi surface of metals at high pressures has given new insights. However progress in these directions has been hampered by the experimental difficulties in performing these measurements which combine two already difficult techniques (Swenson 1960; Stewart 1962; Brandt and Ginzburg 1965, 1969; Dugdale 1969; Paureau 1977; Chu and Woolam 1978). Nevertheless the fact that a variety of new phenomena and investigations can be performed under the simultaneous application of high pressures and low temperatures makes it desirable to review the various experimental techniques used in these studies. Inevitably some indications of the physical phenomena thrown up in these investigations have to be pointed out briefly in this review. Equally inevitable are omissions