COX BG63 0713

NEW MATERIALS FROM HIGH TEMPERATURE AND HIGH PRESSURE PROCESSES

Transformations in materials occurring as the result of high temperature and high pressure reactions are intimately related to the performance of military materiel, and studies of the transitory and final effects produced under these conditions should lead to materials with useful new properties. Recent research has demonstrated that high pressures can have a decided effect on the rates of chemical reactions which proceed through ionic transition states. Little is known of constitutional diagrams in which pressure is a parameter, because of experimental difficulties on obtaining data on phase boundaries, solubilities, etc., at high pressure. Studies in this area will provide basic information useful in the production and performance of military materiel. This report summarizes information obtained to date in this AROD-supported Military Theme.

I. NEW APPARATUS

Tetrahedral Ram

A tetrahedral anvil high pressure apparatus has been constructed, with modifications and adaptations to allow *X-ray diffractometry analysis* of samples subjected to pressures up to 98,000 atm. The X-ray tube is mounted in a cylindrical cross-axis hole in one of the hydraulic rams. The tetrahedral sample chamber is made of solid LiH to reduce X-ray absorption, and is formed by pressing polycrystalline LiH in a suitable die. The system has been tested by measuring X-ray diffraction patterns from KCl at various pressures; the KCl *volume transition* reported by Bridgman at approximately 20,000 atm. has been observed. [1]

II. INORGANIC REACTIONS AND MATERIALS

1. Aluminum Oxide

Application of pressure induces *thermoluminescence* in γ-irradiated Al_2O_3 single crystals, indicating geological age-dating by measuring thermoluminescence should take *pressure effects* into consideration.[5]

2. Boron

A non-equilibrium *transformation boundary* between α and β rhombohedral boron has been determined between 20,000 - 40,000 atm.

3. Boron-Phosphorus System

Three new *high temperature phases* have been detected in addition to cubic BP and hexagonal $B_{13}P_2$; a fcc phase with lattice constants of 5.71-5.76A, and two primitive cubic phases with lattice constants of 5.53 and 5.70A.[4]