UDC.669.855:539.292:539.89

HIGH-PRESSURE PHASE TRANSFORMATIONS IN CERIUM*

A. P. FROLOV, K. P. RODIONOV and L. F. VERESHCHAGIN

Institute of Metal Physics, Academy of Sciences, U.S.S.R.,
Institute of High-Pressure Physics, Academy of Sciences, U.S.S.R.

(*Received* 27 *June* 1969)

compressibility

The X-ray diffraction method was used to study the volume change of the γ- and α-phases of cerium under the best equilibrium conditions and hydrostatic pressure of up to 10,000 kg/cm²: for the γ-phase $\Delta V/V_0 = 36 \times 10^{-7} p$; for the α-phase 88×10^{-7} $(p - p_0)$, where $p_0 = 1100$ kg/cm²; p is pressures ranging from 1100 to 10,000 kg/cm². In the range 1100-10,000 kg/cm² a hexagonal phase has been found and the lattice parameters, measured at $p = 6000$ kg/cm², are: $a = 3.671$ Å, $c = 11.700$ Å.

High-pressure phase change in cerium has been studied at low temperatures in [1-18]. The X-ray diffraction studies of [19-21] have shown that, like the original γ-phase, the high-pressure phase of cerium (α) has an f.c.c. lattice at high pressures and room temperature. But the lattice parameters are different in value.

Lawson and Tang [19] have found a lattice constant of $a_0 = 4.84 \pm 0.03$ Å for the α-phase at room temperature and $p = 15{,}000$ kg/cm² ($a_0 = 5.14$ Å for the γ-phase at room temperature and atmospheric pressure). The total volume change due to the γ-α transition is 16.5%. For the α-phase at room temperature and $p = 7000$ kg/cm², Adams and Davis in [20] found $a_0 = 4.824$ Å, total volume change 18%, change during transformation 14%. Yevdokimova and Genshaft in [21] found an α-phase at atmospheric pressure ($a_0 = 4.94$ Å).

X-ray diffraction analyses of cerium under high pressure [19-21] have not established the relation $\frac{\Delta V}{V_0} = f(p)$ where $\frac{\Delta V}{V_0}$ is the relative volume change of the material under a pressure p at constant temperature. Only Bridgman has found such a relation, by measuring the compressibility with the "piston displacement" method.

The problem in the present work was to study the relation between pressure and the relative volume change of cerium by means of X-ray diffraction analysis under the best equilibrium conditions.

EXPERIMENTAL PROCEDURE

The apparatus which we described in [22, 23] was used for X-ray diffraction analysis of cerium under high pressures. The size of the line focus was reduced to 12.0 × 0.2 mm by improving the focusing of the electron beam with a focusing X-ray tube [23]. Changes were made in the design of the beryllium compartment of the X-ray apparatus [22]: the special groove shown in Fig. 1, and the wall thickness of the compartment reduced from 3.3 to 1.5 mm at the groove. The groove was turned towards the collimator of the X-ray apparatus. The internal diameter of the cylindrical part of the compartment was 1.34 mm. Lithium

was u
with
of the
The X
the c
press

* *Fiz. metal. metalloved.*, 28, No. 6, 993-998, 1969.