Phase Transformations in Pu-Al and Pu- Ga Alloys. Effects of Pressure and Temperature on the Kinetics of the Delta-Phase Decomposition

L.F. Timofeeva

A.A.Bochvar VNIINM (All-Russian Research Institute of Inorganic Materials), Moscow, Russia

EVOLUTION OF PHASE DIAGRAMS UNDER PRESSURE

The binary phase diagram at atmospheric pressure as a section of the pressure–temperature - composition PTC diagram results from a regular variation of phase areas with space. PT diagram for Pu and earlier experimental data [1,2,3] underlie schematic phase diagrams for the Pu-Al and Pu- Ga systems over the 0 ~3 GPa pressure range (see Figure 1). As Pu phases disappear with increasing pressure, the binary phase diagram varies from complex one at atmospheric pressure to rather simple at high pressures (see Figure 1). Features of PT binary Pu-Ga (Al) diagrams was analyzed at the pressure of triple points on PT phase diagram for Pu. Our notions on the phase diagrams evolution under pressure were used for experimental constructing of phase diagrams at different pressures.

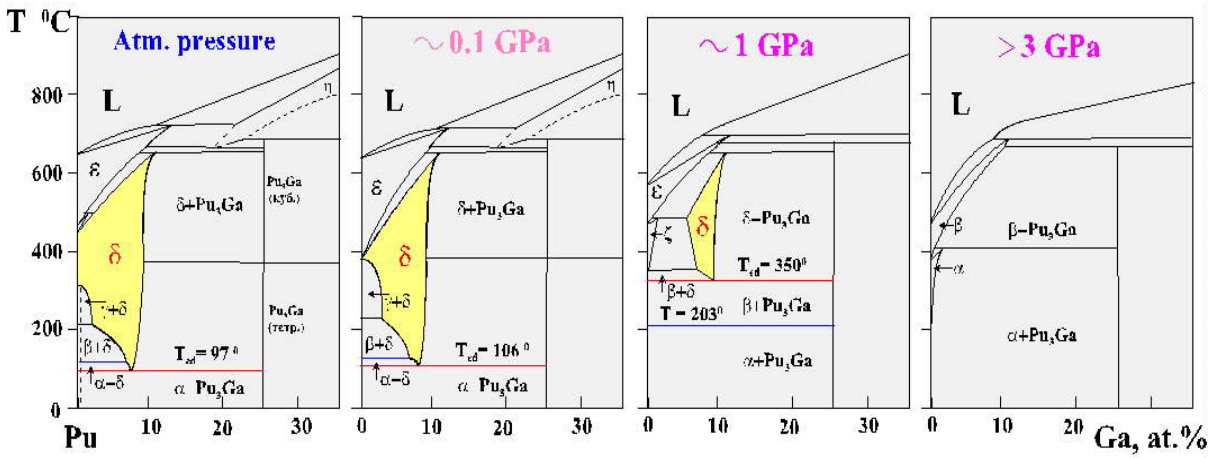

Fig1: Evolution of Pu-Ga Diagram under Pressure (scheme on a base of Experiment and Prognosis)

EXPERIMENTALLY AND THERMODYNAMICALLY DETERMINED δ-PHASE BOUNDARIES

Based on isothermal annealing results under static pressures as large as 0.6-0.8 GPa, δ-phase boundaries for the Pu-Al and Pu-Ga systems were delineated. The thermodynamic calculation of the displacement of the δ-phase boundaries to P ≅ 2-3 GPa correlates well with the experiment. The δ-phase boundary shifts to higher concentrations of Al or Ga on the Pu-side and slightly to Pu on the intermetallic compound side. The δ-region decreases to the point of disappearance. The δ-phase eutectoid decomposition temperature at different pressures was evaluated from intersection of boundaries on the $N_{моль}^{Al(Ga)}$- 1/T K coordinates. The eutectoid decomposition temperature (T_{ed}) versus pressure was plotted (see Figure 2). Parameters of the four-phase equilibrium (δ,α,β, Pu_3Ga) at point "H" on PT binary PuGa diagram were determined. Point "H" is a projection on the PT plane of the HH line. It is line of intersection of two three-phase equilibrium surfaces on the PTC phase diagram (see Figure 3). Above and below point H the δ-eutectoid decomposition results in βPu + Pu_3Ga and αPu + Pu_3Ga, respectively.