BROD-MB 67-1036

PLUTONIUM 1965

Proceedings of the Third International Conference on Plutonium, London, 1965

Edited by
A. E. KAY *and* M. B. WALDRON
United Kingdom Atomic Energy Authority

LONDON
Chapman and Hall
for
The Institute of Metals

JUL 13 1971

Figure A2-B shows the variation of resistance with pressure for two specimens during two successive experiments and confirms the transformation. The graph of pressure versus gallium content separating the single phase region (δ) from the two phase region (α+δ) (Fig A2-C) can now be drawn. This graph cuts the concentration axis at 0.9 at.-% gallium and is thus the minimum concentration required to stabilize plutonium in the δ-phase at ambient temperature. This limit is difficult to obtain from the temperature-concentration graph by conventional means. In Figure A2-C the corresponding parts of the phase diagrams (temperature-concentration) and (temperature-pressure)[5], are also shown.

5 References

1. F.H. Ellinger, C.C. Land and V.O. Struebing, J. Nucl. Mat. 1964, 12, 226.
2. B. Hocheid et al., in this volume. Paper 16.
3. G.C. Kennedy in "Progress in Very High Pressure", p 307, 1960, New York.
4. P.W. Bridgman, "The Physics of High Pressure", p 232, 1952 London (Bell).
5. D.R. Stephens, J. Phys. Chem. Solids, 1963, 24, 1197.

A 3 The pressure/temperature behaviour of pure plutonium:

M. B. Brodsky

Preliminary studies of the pressure temperature behaviour of unalloyed plutonium are described. They indicate that the possibility of growing large grains of alpha-plutonium is not very high.

The pressure temperature diagram up to 65 kbar has been obtained by differential thermal analysis (Fig. A3-A).

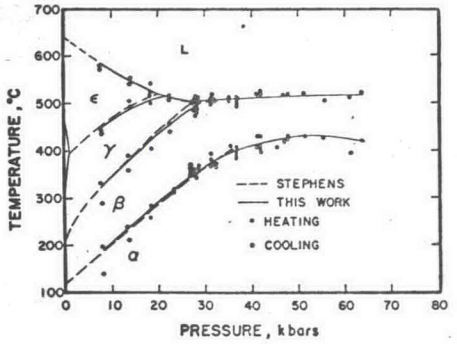


Fig A3-A Pressure temperature diagram for plutonium

The low pressure region is similar to the data of Stephens, but at high pressures there is a decrease in the slope of the alpha to beta boundary with an increase in pressure, ultimately reaching zero and possibly becoming negative. Furthermore the beta to liquid transformation is found to increase with increasing pressure so that an alpha-beta-liquid triple point now seems to be unattainable. Although these results are somewhat discouraging from the viewpoint of growing single crystals of alpha plutonium, considerable atomic mobility

has been observed at high pressures. Thus samples heated at 390°C and 38 kbar - high in the alpha region - showed fully recrystallized grains of alpha plutonium with metallographic examination. X-ray diffraction studies verified the strain-free condition of the grains. Treatments of this type have yielded grains measuring more than several millimeters in their largest dimension.

A sample slowly cooled after β phase treatment at 465°C and 31 kbar (Fig A3-B) showed mainly recrystallized grains although some strained grains were also present.

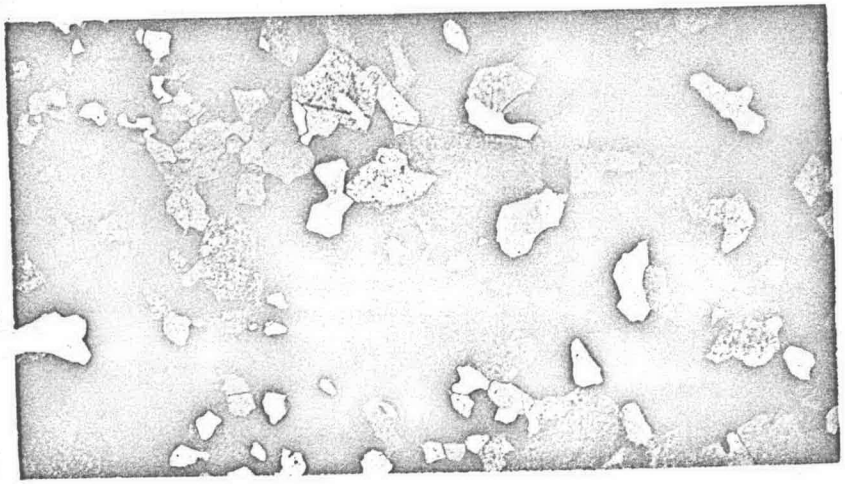


Fig A3-B Microstructure of sample cooled from β-phase (X 200)

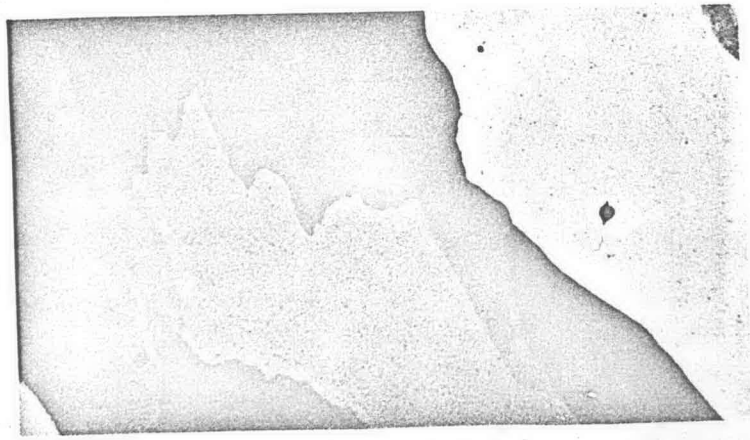


Fig A3-C Microstructure of sample cooled from the melt (X 60)

On cooling from 560°C and 39 kbar at 10°C/h generally columnar grains without substructure and with elongation in the direction of applied pressure were obtained (Fig A3-C). If a 24 hour hold at 390°C in the α-phase was interposed in the cooling cycle the grains were much less columnar (Fig A3-D).



Fig A3-D Microstructure of sample cooled from the melt and reheated to the high α-phase (X 40)

It seems, therefore, that the possibility of growing large grains of alpha plutonium from the melt under pressure is no too likely. However, it seems that single crystals of alpha plutonium might be grown by use of high pressure and high te perature techniques.