Phase Transformation in Uranium

IT is well known that pure uranium has three crystalline modifications. The two phases occurring at the lower temperatures are α-uranium, which has an orthorhombic unit cell, containing four atoms[1], and exists from room temperature to 660° C., and β-uranium, which has a tetragonal unit cell, containing thirty atoms[2], and exists in the range 660°–760° C. During an investigation into the crystallography of the β → α phase transformation of uranium chromium alloys at low temperature, the orientation of two α-plates was found relative to that of the β-grain from which they were being precipitated.

The specimen was a piece of 1·4 atomic per cent chromium alloy. This was heated in vacuo in the γ-temperature range, cooled slowly into the β-temperature range, and then quenched to retain relatively strain-free polycrystalline β-solid solution[3].

After further heating in an oil-bath at 80° C. for several hours, microscopic examination disclosed that several plates of α-phase had formed in the β-grains, presumably by a martensitic process[4]. One β-grain had in it two well-separated α-plates (Fig. 1), so that it was possible, by using Cahn's microbeam X-ray camera[5], to obtain Laue photographs from the β-grain and both α-plates. Hence the orientations of the grain and plates were found relative to the surface plane of the specimen and a standard direction on the camera stage unit.

Since only a single surface on the specimen was used, the poles of the habit planes of the α-plates could not be identified by a direct method. However, the plane perpendicular to the intersection of a plate with the surface of the specimen must contain the pole of the habit plane of that plate. This plane, normal to the trace of the habit plane, was determined for each plate and plotted as a great circle on the stereographic projection of the α- and β-orientations.

The planes normal to the traces of the habit planes and the orientations of the α-plates relative to a standard (0,0,1) stereographic projection of the β-grain are shown in Fig. 2. This shows that, within the limit of experimental error, the (0,0,1) α-plane is parallel to a {8,1,7} β-plane, and the (0,1,0) α-plane is approximately parallel to a {12,3,4} β-plane. The calculated angle between the (8,1,7) β-planes and the $(\overline{12},\overline{3},4)$ β-planes is 89° 28′. It is probable that the orientation of the α-plates relative to the β-grain is not quite the same as that of their original nuclei relative to the same grain, since both phases are deformed as the α-plates grow[4]. However this orientation difference should not be more than a degree.

Fig. 1.   Plates of α-phase formed in a β-crystal. The plates examined are marked $a_,$ and $a_,,$. Polarized light.   × 150
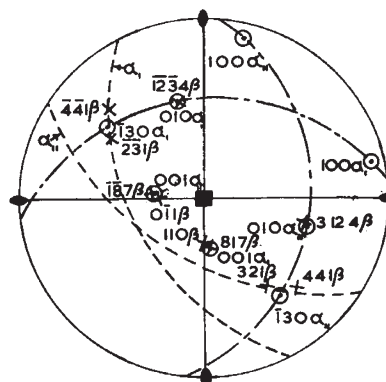

Fig. 2.   ■, Pole of (0,0,1) β-plane ; ◆, pole of {1,0,0} β-planes ; ×, pole of other β-planes ; ○, pole of α-plane ; ——, β-zone ; — · — ·, α-zone ; — — — —, trace normal of habit plane ; α, and $a_,,$, first and second α-needles

Holden[4] reported that the habit plane for this transformation was the {3,2,1} β. Each plane normal to the trace of a habit plane contains a pole of this type of plane ; but accidentally these trace normals are almost equivalent crystallographically, and hence if Holden's result were not known, the pole of the habit plane could be any pole in the trace normals. Such a pole is that of the {4,4,1} β-plane, and it is suspected from measurements on other specimens, where it has not been possible to obtain the orientation of the α-plates, that this may be another habit plane. Neither the {4,4,1} β-plane nor the {3,2,1} β-plane lies parallel to a rational plane in the α-structure ; but it is interesting that both lie near a {1,3,0} α-plane, which is a prominent twinning plane for the α-phase[6].

A fuller account of this work will be published elsewhere.

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A Modified Pettenkoffer Tube

A MODIFICATION of the normal Pettenkoffer tube has been developed to save time and materials and at the same time ensure accuracy in the estimation of carbon dioxide evolved during soil respiration experiments. It has also proved of use in the study of the respiration of Aspergillus niger in work at this Station by Dr. D. J. D. Nicholas.

This modification allows a 1-ml. sample of the absorbent, usually 0·1 N sodium hydroxide, to be withdrawn ; hence the absorption of the carbon dioxide can be studied without frequent changing of the sodium hydroxide. The accompanying diagram shows this adaptation ; half-way along the length of a normal tube, a second glass tube, J-shaped and wide enough to admit a 1-ml. pipette, is joined at its base and arranged at right angles to the main tube, its open end, closed by a rubber bung, lying above the level of the liquid in the main tube.