

Structure of the ω -Precipitate in Titanium-16 per cent Vanadium Alloy

In many titanium alloys the body-centred cubic β -phase, stable at high temperatures, can be retained on quenching. When re-heated to temperatures below 500° C., the alloys may first become hard and brittle. This has been associated with the precipitation of an intermediate phase termed ω ¹.

Single-crystal X-ray work has been carried out on titanium-16 per cent vanadium alloy to determine the structure associated with the hard and brittle condition. Samples of 0.014 in. thick sheet were heated in vacuum for 2 hr. at 1,250° C. to produce crystals up to 5 mm. in diameter. The specimens were afterwards re-heated for 30 min. at 900° C. in argon and quenched in water. Some crystals were aged for 5 min. at 460° C. in molten tin, a treatment leading to high hardness and brittleness. Suitable crystals were thinned to 0.005 in. by solution in acid and orientated with [100] β vertical. Oscillation and stationary crystal photographs were obtained using molybdenum $K\alpha$ radiation.

Both the quenched and aged crystals showed diffractions in addition to those from β -titanium. The additional diffractions (presumably due to ω -precipitation) were elongated and joined by diffuse streaks in the photographs of the quenched crystals. The extra diffractions from the aged crystals were all sharp, so that the particles of precipitate would be greater than 300 Å. in all directions. The additional diffractions occurred on layer lines, Fig. 1, and could be indexed on a cubic lattice with axes parallel to those of the original β -titanium, but three times as large. The indices were simplified by transforming to a hexagonal cell with $a_\omega = 4.60$ Å. and $c_\omega = 2.82$ Å., and oriented so that [0001] ω //[111] β and (11 $\bar{2}$ 0) ω //(1 $\bar{1}$ 0) β ; consequently, there are four possible orientations of ω in a given β -crystal.

Fair agreement between calculated and observed intensities was obtained with the atom positions 000, $\frac{1}{3} \frac{2}{3} \frac{1}{2}$ and $\frac{2}{3} \frac{1}{3} \frac{1}{2}$.

The relation between the structure of β -titanium and the proposed ω -structure is most easily revealed by a (111) β plane projection (see Fig. 2). Every second and third plane of β amalgamates into one plane in the ω -structure.

The spots from the quenched crystals were elongated in $\langle 110 \rangle_\beta$ directions, showing lack of

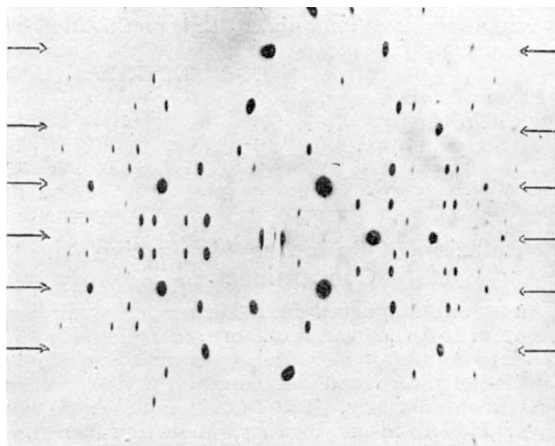


Fig. 1. Oscillation film from titanium-16 per cent vanadium alloy aged 5 min. at 460° C. [001] β vertical; molybdenum $K\alpha$. Arrows indicate β -titanium layer lines

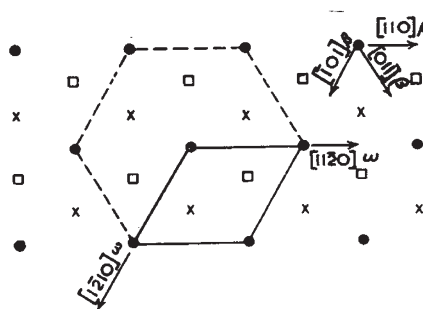


Fig. 2. Projection of atomic positions on (111) β and (0001) ω planes. The parameters of ω are $a = 4.60$ Å. and $c = 2.82$ Å.

Key:

| | | | | |
|---|---------|------------------|---|----------------|
| ● | β | z co-ordinates | ● | ω |
| × | | | × | |
| □ | | | □ | |
| | | | ● | 0 and +2.82 Å. |
| | | | × | +0.94 Å. |
| | | | □ | +1.88 Å. |
| | | | ● | 0 and +2.82 Å. |
| | | | × | and +1.41 Å. |

periodicity in the $\langle 11\bar{2}0 \rangle_\omega$ directions. The ω -precipitate may be in the form of platelets parallel to {11 $\bar{2}$ 0} ω and {110} β planes; but the hypothesis needs further testing.

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¹ Frost, P. D., Parris, W. M., Hirsch, L. L., Doig, J. R., and Schwartz, C. M., *Trans. Amer. Soc. Metals*, **46**, 231, 255, 1056, 1073 (1954).

Equilibrium of Hydrogen-Bond Formation in the Excited State

In the course of studies on the influence of the addition of a proton acceptor upon the fluorescence of aromatic compounds, which are proton donors, we have found evidence that the excited molecules in many cases have a greater tendency to form hydrogen bonds and that a new equilibrium is reached during the life-time of the excited state. Taking β -naphthol as the fluorescent substance (proton donor), for example, we have examined the effects of the addition of several proton acceptors such as dioxane, methyl, ethyl and *n*-butyl acetate, ethyl chloracetate and others upon the fluorescence and absorption spectra and upon the intensity of fluorescence of β -naphthol dissolved in *n*-hexane.

In the case of ethyl chloracetate, a remarkable quenching of fluorescence was observed; but all the other substances cited cause the intensity to increase somewhat. Some examples showing the relative intensities, f/f_0 , plotted against the concentrations of proton acceptors are shown in Fig. 1. Some changes of the absorption and fluorescence spectra characteristic of hydrogen-bond formation are, of course, observed in all cases¹.

The fluorescence and absorption of β -naphthyl methyl ether in *n*-hexane are not affected by the above substances, whereas carbon tetrachloride quenches the fluorescence of both β -naphthol and