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Technical Note

Metallographic Identification and Crystal Symmetry of Titanium Hydride

by L. D. Jaffe

IN previous metallographic work on titanium and its alloys, difficulty has been encountered in distinguishing spheroidal particles of titanium hydride, dispersed in α -titanium, from other phases that may be present, such as β -titanium. This problem is common in examination of commercial unalloyed titanium.¹

In the course of an investigation of the Ti-H phase diagram, it was noted that titanium hydride, dispersed in a matrix of α -titanium, showed strong optical anisotropy when examined under polarized light. With sensitive tint illumination, particles of the hydride, when the stage is rotated, changed from bright yellow to bright blue in color. Since β -titanium is cubic, it showed no color change on rotation, remaining dark gray or blue-gray. Although α -titanium is hexagonal, it showed only a minor color change, going from pale pinkish-blue to pale purplish-blue. These colors could be modified somewhat by adjustment of the illumination. They were observed in specimens mechanically polished, both without etching and after etching with hydrofluoric acid-nitric acid mixtures in either water or glycerine. The strong color change of the hydride seems to offer a simple method for its metallographic identification.

Optical anisotropy of titanium hydride is inconsistent with its accepted face-centered-cubic structure.² Samples of iodide titanium containing 6 to 40 atomic pct deuterium were prepared for diffraction studies. After deuterating and slow cooling³ the samples were held 21½ hr at 400°C, water quenched, held 61 hr at 100°C and quenched, then held 64½ hr at 255°C and quenched. Debye exposures with MoK α X-rays and 1.111Å neutrons were made at room temperature of samples as-deuterated and after the 100° and 255°C treatments. Table I shows the lines observed, in addition to those attributable to α -titanium. These data show that the hydride phase was not cubic, but probably tetragonal. The titanium atoms appeared to form a body-centered-tetragonal lattice complex, two titanium atoms per cell, with approximate dimensions:

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Table I. Diffraction Data

Interplanar Spacing, Å	Relative Integrated Intensity		Lattice Complex Indexing	
	X-Ray*	Neutron*	BCT†	FCT‡
2.98	0	25	†	(101)†
2.50	50	<35	(101)	(111)
2.20	<100	<100	(110)	(200)
2.10	10 (?)	50	(002)	(002)
1.81	0	20	†	(211)†
1.55	30	30	(200)	(220)
1.33	<35	<50	(211)	(311)
1.27	<7	<100	(103)	(113)
1.01	10	} <25	(301)	(331)
0.99	0		(104)†	(114)†
			(310)	(420)
			(213)	(313)

* < indicates lines overlapped by lines of α -titanium, so only maximum limit to intensity of hydride line could be set.

† BCT and FCT indicate body-centered-tetragonal and face-centered-tetragonal, respectively.

‡ † indicates neutron lines not fitting indexing of lattice complex of titanium atoms, and presumably arising from scattering by deuterium atoms.

$a = 3.12\text{Å}$, $c = 4.18\text{Å}$, and $c/a = 1.34\text{Å}$. This is equivalent to a face-centered-tetragonal complex, four titanium atoms per cell, with approximate dimensions: $a = 4.42\text{Å}$, $c = 4.18\text{Å}$, and $c/a = 0.946\text{Å}$. The presence of the 2.98 and 1.81Å neutron lines indicates that the true Bravais lattice is not identical with this lattice complex, but may be primitive tetragonal with dimensions some multiple of those of the complex.

The relative intensities of the hydride and α -titanium X-ray lines as functions of overall composition indicated that the hydride, presumably in equilibrium with the α at 100° to 255°C, contained more than 62 atomic pct H.

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