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Technical Note

Crystallographic Angles for Titanium and Zirconium

by Carl J. McHargue

THE angles between the crystallographic planes in cubic crystals have been given by Bozorth,[1] in magnesium, zinc, and cadmium by Salkovitz,[2] and in tin by Nicholas.[3] The determination of the orientation of single crystals and the study of plastic deformation require the knowledge of these angles and are often facilitated by use of a standard projection. Tables of these angles and standard projections have not been published for titanium or zirconium which have c/a ratios considerably less than those hexagonal metals for which this data is available. Accordingly, Table I has been prepared giving these angles. Fig. 1 presents a standard (0001) projection of titanium.

The angle between $(h_1k_1i_1l_1)$ and $(h_2k_2i_2l_2)$ was calculated by means of the formula:

$$\cos \phi = \frac{h_1h_2 + k_1k_2 + \frac{1}{2}(h_1k_2 + h_2k_1) + \frac{3}{4}\frac{a^2}{c^2} l_1 l_2}{[(h_1^2 + k_1^2 + h_1k_1 + \frac{3}{4}\frac{a^2}{c^2} l_1^2)(h_2^2 + k_2^2 + h_2k_2 + \frac{3}{4}\frac{a^2}{c^2} l_2^2)]^{1/2}}$$

The c/a ratio for titanium is taken from the data of Clark[4] and that for zirconium from data given the Metals Handbook.[5] For all practical purposes Fig. 1 serves for zirconium as well as titanium, as can be seen from the similarity of the values of all angles.

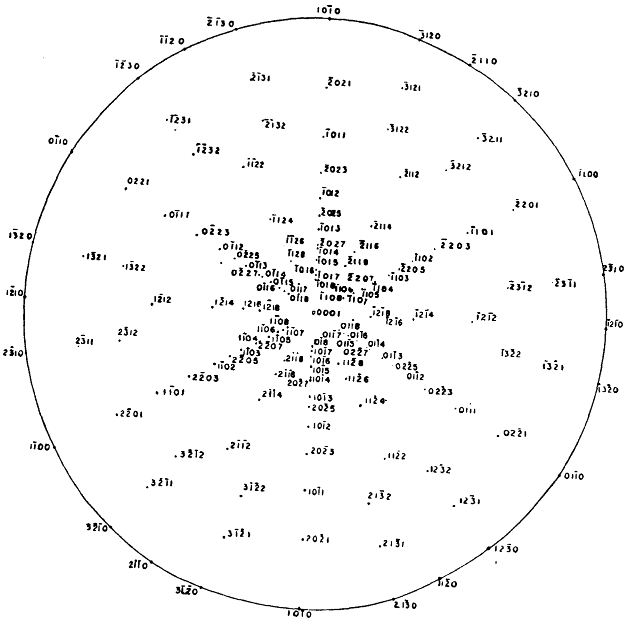

Fig. 1—Standard (0001) projection for titanium, c/a 1.5873.

Table I. Angles between the Crystallographic Planes in Close-Packed Hexagonal Titanium and Zirconium

$(h_1k_1i_1l_1)$	$(h_2k_2i_2l_2)$	Titanium, $c/a = 1.5873$	Zirconium, $c/a = 1.5893$
0001	$10\bar{1}8$	12° 54′	12° 55′
	$10\bar{1}7$	14 41	14 42
	$10\bar{1}6$	16 56	16 58
	$10\bar{1}5$	20 08	20 31
	$10\bar{1}4$	24 37	24 39
	$20\bar{2}7$	25 27	27 41
	$10\bar{1}3$	31 23	31 28
	$20\bar{2}5$	36 15	36 17
	$10\bar{1}2$	42 31	42 32
	$20\bar{2}3$	50 42	50 45
	$10\bar{1}1$	61 23	61 25
	$20\bar{2}1$	74 44	74 47
	$10\bar{1}0$	90 00	90 00
	$21\bar{3}2$	67 35	67 37
	$21\bar{3}1$	78 21	78 22
	$21\bar{3}0$	90 00	90 00
	$11\bar{2}8$	21 36	21 40
	$11\bar{2}6$	27 53	27 55
	$11\bar{2}4$	38 26	38 28
	$11\bar{2}2$	57 47	57 50
	$11\bar{2}0$	90 00	90 00
	$12\bar{3}2$	67 35	67 37
	$12\bar{3}1$	78 21	78 22
	$12\bar{3}0$	90 00	90 00
1010	$21\bar{3}0$	19 06	19 06
	$11\bar{2}0$	30 00	30 00
	$12\bar{3}0$	40 54	40 54
	$01\bar{1}0$	60 00	60 00

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