The lattice parameters of α-alumina and chromic oxide.

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DURING the course of a study of the interaction of certain pure refractory oxides at high temperatures it became necessary to obtain accurate values for the lattice parameters of α-alumina and chromic oxide. Values obtained by previous workers, listed in table I, did not attain a greater accuracy than one part in 2000, whereas the use of large-diameter powder cameras calibrated with quartz now yield lattice parameters accurate to at least one part in 30,000.

Table I.

Author.	α-Alumina.		Chromic oxide.	
	a.Å.	α.	*a*.Å.	α.
W. P. Davey (1923)	5·11	55° 17′	5·33	55° 9′
L. Pauling & S. B. Hendricks (1925) ...	5·12	55 17	—	—
V. M. Goldschmidt et al. (1925)	—	—	5·34	54 58
W. H. Zachariasen (1928)	5·13	55 16	5·35	55 0
E. A. Harrington (1927)	5·130	55 17	—	—
L. Passerini (1930)	5·130	55 6	5·38	54 50
P. E. Wretblad (1930)	—	—	5·348	55 18

Samples of the calcined oxides were examined in a 19 cm. diameter powder camera, alumina with cobalt Kα radiation and chromic oxide with chromium Kα radiation. Results are given in tables II and III.

Table II. Powder data for calcined alumina, α-Al_2O_3, taken with filtered cobalt radiation $K\alpha_1$ 1·78529, $K\alpha_2$ 1·78919 kX.

Intensity.	Indices. Hexagonal.	Rhombohedral.	Sin θ Observed.		Calculated.	Spacing kX units.
m	102	411	0·258		0·257	3·47
s	104	633	0·352		0·351	2·546
m	110	$30\bar{3}$	0·377		0·376	2·375
vs	113	630	0·430		0·429	2·083
s	204	822	0·515		0·514	1·736
vs	116	963	0·560		0·559	1·598
w	108	10.7.7.	0·593		$0·592_5$	1·508
s	214	930	0·638 0·639	0·638	0·637	$1·401_5$
vs	300	$63\bar{3}$	0·652 0·654	0·653	$0·651_5$	1·3709

[1] Recently killed by enemy action.

Intensity.	Indices. Hexagonal.	Rhombohedral.	Sin θ. Observed.		Calculated.	Spacing kX units.
ms	1.0.10	12.9.9	0·723 0·725	0·724	$0·722_5$	1·2365
m	119	12.9.6	0·726 0·727	0·726	0·725	1·2316
wm	220	$60\bar{6}$	0·753 0·754	0·753	$0·752_5$	1·1873
w	306	12.3.3	$0·771_5$ —	0·772	0·772	1·1576
wm	223	$93\bar{3}$	0·780 0·782	0·781	0·780	1·1449
wm broad	312 218	$90\bar{3}$ 13.7.4	0·796	0·796	0·795 0·796	1·1235 1·1218
m	2.0.10	14.8.8	$0·814_5$ $0·816_5$	0·815	0·8145	1·0967
w	0.0.12	12.12.12	0·8266 —	0·8272	0·8268	1·0804
m	314	$11.2.\bar{1}$	0·8301 0·8320	0·8307	0·8302	1·0759
vs	226	12.6.0	0·8583 0·8604	0·8590	0·8584	1·0406
wm	402	$10.\bar{2}.\bar{2}$	0·8793 0·8815	0·8800	0·8796	1·0156
vs	2.1.10	15.9.6	0·8968 0·8989	0·8975	0·8972	0·9957
wm	404	12.0.0	0·9110 0·9132	0·9117	0·9114	0·9806
w	321	$90\bar{6}$	0·9486 0·9507	0·9493	0·9492	0·9411
vw	2.1.11	16.10.7	0·9507 —	0·9514	0·9511	0·9392
ms	318	15.6.3	$0·9570_5$ $0·9591_5$	$0·9577_5$	0·9576	0·9328
m	229	15.9.3	$0·9743_5$ $0·9764_5$	$0·9750_5$	0·9750	0·9162
vs	324	$12.3.\bar{3}$	$0·9853_5$ 0·9876	0·9861	0·9860	0·9060
ms	1.0.14	16.13.13	0·9881 $0·9902_5$	0·9888	0·9887	0·9035

vs very strong, s strong, ms moderately strong, m moderate, wm weak moderate, w weak, vw very weak.

The extrapolated values for the cell dimensions of alumina, α-Al_2O_3, are a 5·1180±0·0001 kX, α 55° 17′.

TABLE III. Powder data for calcined chromic oxide, Cr_2O_3, taken with filtered chromium radiation, $K\alpha_1$ 2·28503, $K\alpha_2$ 2·28891 kX.

Intensity.	Indices. Hexagonal.	Rhombohedral.	Sin θ Observed.		Calculated.	Spacing kX units.
m	102	411	0·317		$0·315_5$	3·62
ms	104	633	$0·431_5$		0·430	2·660
m	110	$30\bar{3}$	$0·463_5$		0·462	2·475
w	006	666	0·507		$0·505_5$	2·262
m	113	630	$0·528_5$		$0·526_5$	2·171
m	204	822	0·6323 0·6332	0·6326	0·6311	1·8121

Intensity.	Indices. Hexagonal.	Rhombohedral.	Sin θ Observed.		Calculated.	Spacing kX units.
s	116	963	0·6859 0·6868	0·6862	0·6850	1·6696
wm	108	10.7.7	—	0·7265	0·7256	1·5773
	212	$71\bar{2}$	—		0·7250	1·5761
ms	214	930	0·7828 0·7837	0·7831	0·7821	1·4621
ms	300	$63\bar{3}$	0·8008 0·8019	0·8012	0·8002	1·4290
m	1.0.10	12.9.9	0·8838 0·8855	0·8844	0·8840	1·2937
wm	119	12.9.6	0·8881 —	0·8886	0·8881	1·2877
wm	220	$60\bar{6}$	0·9240 0·9256	0·9245	0·9240	1·2375
wm	306	12.3.3	$0{\cdot}9464_5$ $0{\cdot}9481_5$	0·9471	0·9466	1·2080
wm	223	$93\bar{3}$	0·9577 —	$0{\cdot}9583_5$	0·9580	1·1936
m	312	$90\bar{3}$	0·9761 0·9777	$0{\cdot}9766_5$	0·9766	1·1711

s strong, ms moderately strong, m moderate, wm weak moderate, w weak.

The extrapolated values for the cell dimensions of chromic oxide, Cr_2O_3, are a 5·3506±0·0001 kX, α 55° 6′.

Summary. Pure α-alumina and chromic oxide have been examined by means of the X-ray powder method. Tables are given showing intensities, indices (hexagonal and rhombohedral), and sin θ values from which accurate parameter values were calculated.

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References.

W. P. Davey, Physical Rev., 1923, vol. 21, p. 716.
L. Pauling and S. B. Hendricks, Journ. Amer. Chem. Soc., 1925, vol. 47, p. 781.
V. M. Goldschmidt, T. Barth, and G. Lunde, Skrifter Norske Vidensk.-Akad. I. Mat. nat. Kl., Oslo, 1925, no. 7. [M.A. 3–181.]
W. H. Zachariasen, Ibid., 1928, no. 4. [M.A. 4–30.]
E. A. Harrington, Amer. Journ. Sci., 1927, ser. 5, vol. 13, p. 467.
L. Passerini, Gazz. Chim. Ital., 1930, vol. 60, p. 544.
P. E. Wretblad, Zeits. Anorg. Chem., 1930, vol. 189, p. 329.