

graphic axis parallel to the  $Z$  optical direction and with  $b$  the obtuse bisectrix. The indices of refraction,

$$\alpha = 1.468, \beta = 1.484 \text{ and } \gamma = 1.515$$

and the axial angle  $2V_{\text{obs.}} = +80^\circ$ , have been previously recorded (Van Tassel, 1945).

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**The monoclinic modification of gadolinium sesquioxide  $\text{Gd}_2\text{O}_3$ .** By O. J. GUENTERT and R. L. MOZZI, *Research Division, Raytheon Mfg. Co., Waltham, Massachusetts, U.S.A.*

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Powder samples of  $\text{Gd}_2\text{O}_3$  form  $B$  were prepared by heating commercially available cubic  $\text{Gd}_2\text{O}_3$  of 99.9% purity at 1400–1500 °C. for several hours. X-ray diffraction patterns were run at room temperature on a Norelco diffractometer using  $\text{Cu K}\alpha$ -radiation and calibrating with a silicon standard. The patterns suggest that  $\text{Gd}_2\text{O}_3$  form  $B$  is isomorphous with the monoclinic  $\text{Sm}_2\text{O}_3$  form  $B$  reported recently by Douglass & Staritzky (1956) and investigated in more detail by Cromer (1957). The observed powder lines and their relative peak intensities are

Table 1. Powder pattern of monoclinic  $\text{Gd}_2\text{O}_3$

$hkl$	$d_{\text{calc.}}$	$d_{\text{obs.}}$	$I_{\text{rel.}}$
20 $\bar{1}$	5.930 Å	5.900 Å	3
20 $\bar{2}$	3.987	3.965	4
202	3.402	3.396	10
111	3.158	3.155	70
401	3.033	3.028	60
40 $\bar{2}$	2.965	2.961	100
003	2.875	2.868	50
310	2.822	2.820	75
11 $\bar{2}$	2.755	2.752	75
600	2.307	2.308	10
11 $\bar{3}$	2.258	2.258	5
312	2.253		
60 $\bar{2}$	2.201	2.195	20
51 $\bar{1}$	2.193		
510	2.187	2.131	45
31 $\bar{3}$	2.131		
313	1.914	1.915	40
020	1.783	1.784	25
80 $\bar{1}$	1.757	1.759	10
404	1.701	1.700	30
71 $\bar{2}$	1.698		
40 $\bar{5}$	1.665	1.665	20
603	1.663		
514	1.654	1.651	30
022	1.648		
711	1.648	1.571	10
115	1.571		
421	1.537	1.539	15
42 $\bar{2}$	1.528	1.530	20
115	1.517	1.518	15
802	1.517		
023	1.515	1.483	7
60 $\bar{5}$	1.515		
804	1.482		

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given in Table 1. The cell dimensions as determined by a least-squares method are:

$$a = 14.061 \pm 0.013, \quad b = 3.566 \pm 0.006, \quad c = 8.760 \pm 0.007 \text{ \AA}, \\ \beta = 100.10 \pm 0.08^\circ.$$

With six formula units per cell the calculated density is 8.33 g.cm.<sup>-3</sup> which compares satisfactorily with the experimental value of 8.22 g.cm.<sup>-3</sup> determined by pycnometric measurements.

Goldschmidt, Ulrich & Barth (1925) reported for  $\text{Sm}_2\text{O}_3$  and  $\text{Gd}_2\text{O}_3$  the two separate forms  $B_1$  and  $B_2$  in the temperature range of the  $B$ -modification.  $B_1$  is described as a low symmetry form (presumably the now identified monoclinic form) whereas  $B_2$  is supposedly a higher symmetry form which was observed in a temperature range somewhat below that of  $B_1$ . In order to check this point a powder sample of cubic  $\text{Gd}_2\text{O}_3$  was heated in a high temperature X-ray camera designed to fit on the Norelco diffractometer and patterns were obtained at successively higher temperatures. The runs taken after six hours of heating at 900 °C. and after additional half-hour steps at about 1050° and 1200 °C. showed only the cubic pattern. Further heating of one hour at about 1400 °C. produced the monoclinic pattern with the cubic lines still strongly present. The next run taken one hour later at about 1600 °C. showed only the monoclinic pattern. These results indicate a direct transition from the cubic to the monoclinic form without any evidence for the existence of  $B_2$ . It seems likely, however, that the impurities in the samples investigated and the duration of the heat treatment affect the transition characteristics which may account for the observation of the intermediate form  $B_2$  by Goldschmidt *et al.* (1925).

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