Observations on Uranium Oxide Single Crystals

The coarsest fraction of the commercial fused grade of uranium dioxide currently used for swaging is composed of rough-shaped particles, several grams in weight, and of appearance as displayed in Fig. 1. The density of most of the individual particles is higher than 99% of theoretical.

The material, swageable grade powder, was procured from Spencer Chemical Company. The chemical analysis of the material (in parts per million) was as given in the tabulation.

	ppm		ppm
Aluminum	4	Manganese	3
Boron	0.1	Molybdenum	1
Cadmium	1	Nickel	6
Calcium	0.5	Phosphorus	20
Carbon	50	Silicon	45
Chromium	6	Silver	0.1
Copper	2	Tin	4
Iron	46	Vanadium	10
Lead	2	O/U ratio	1.998
Magnesium	12		

As revealed by a combination of x-ray and metallographic analyses, many of the particles are single crystals or aggregates of very few single crystals. The crystals show a tendency to cleave, especially after deep etching in nitric acid. The cleaved specimens shown in Fig. 2 were obtained by etching the crystals and dropping them carefully to the bottom of the vessel of etching solution. The larger particle displayed four nearly perfect crystal faces. The smaller one was a tiny sheet delineated by two parallel faces.

FIG. 1. Selected crystals of arc-fused UO_2, × 1.5

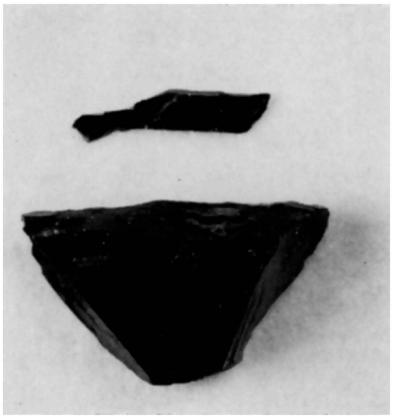

FIG. 2. Cleaved surfaces of UO_2 single crystals, × 4

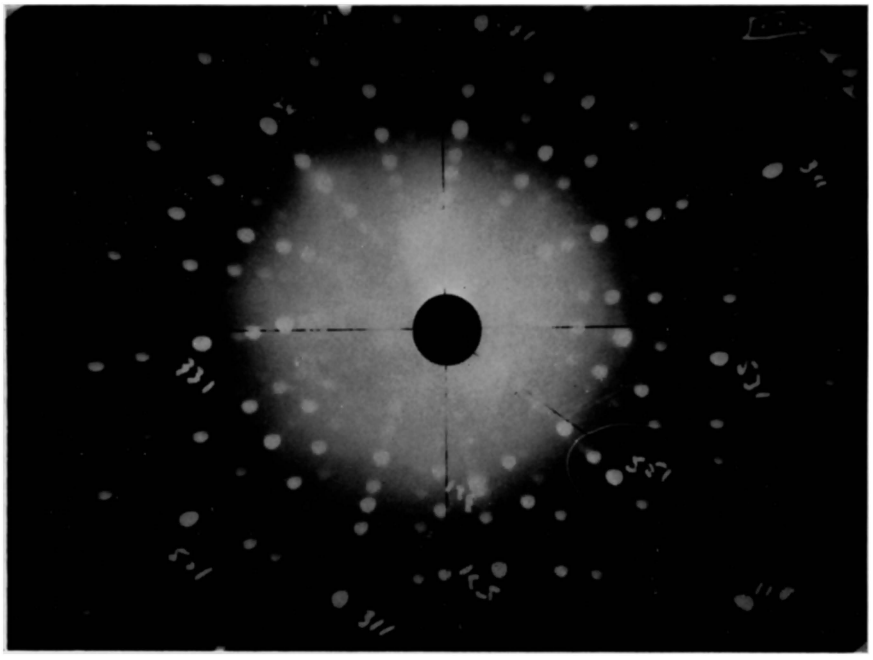

FIG. 3. Laue back reflection x-ray pattern of cleaved UO_2 surface

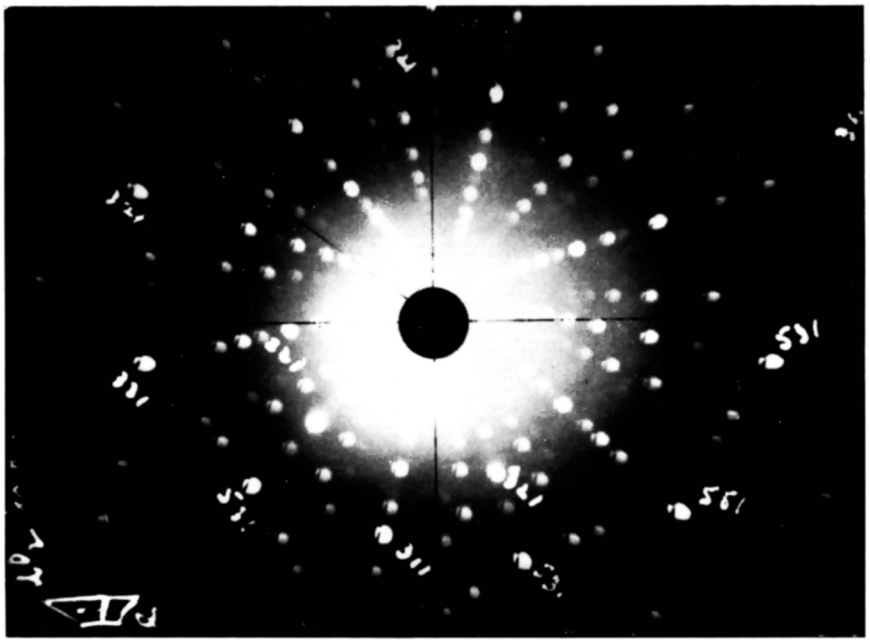

FIG. 4. Laue back reflection x-ray pattern of cleaved UO_2 surface (mirror image of Fig. 3)

Back-reflection Laue patterns were made of the crystals shown in Fig. 2—eight patterns of the large one and three of the small one. Copper radiation and a 3 cm specimen-to-film distance were used for compatibility with a Grenninger chart for indexing. In all instances the cleavage planes were (111). Laue patterns of four additional samples confirmed these results. In one case (Figs. 3 and 4) a twin occurred, the twin crystal being still oriented about the (111) plane but the two patterns being mirror images.

Tukon hardness impressions were made on the largest cleaved face of the larger specimen, using a 100 gm load, since the brittleness of the material prevented the use of higher loads. The average of four Tukon hardness values was 538, to be compared with the only other figures found in the literature (*1–3*)—3.5,5, and 6–7 on the Mohr's scale.

The degree of perfection of one of the crystals, measured by means of the x-ray rocking curve using the Weissman double crystal spectrometer and the copper $K_{\alpha 1}$ radiation, proved to be high; the half width was 72 sec of arc, only a little more than the 40 to 60 sec of arc displayed by a very good nonmetallic crystal, and well below the 200 sec or more for a typical metal single crystal.

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