will be completed by an extensive study of the growth parameters: temperature, gradient, flow rate, and, chiefly, quality of the starting materials (source and substrate).

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A New Slip System in Sapphire

During the course of high-temperature tensile tests on whiskers, the authors have obtained evidence of a slip system which has not previously been reported in sapphire. A large sapphire whisker, grown by a halide oxidation process, and having its axis along $<0001>$, was tensile-tested at 1200 ($\pm$ 15)° C in a modified Marsh tensile-testing machine [1]. A constant strain rate of 10^{-3} min^{-1} was used. Deformation was elastic up to a tensile stress of 93 ($\pm$ 5) kg/mm^2; at which stress, yield occurred followed by fracture. Examination of the two fracture portions revealed two sets of slip bands, the fracture having occurred at the intersection of two conjugate bands. The angle between the trace of the slip bands and the whisker axis was measured on all six $\{11\bar{2}0\}$ faces of the whisker. The measured angles were 32 and 56°, slip steps being visible on faces where the latter was observed but not for the former. This information suggests that the slip system is $\{\bar{1}011\}$ $<10\bar{1}2>$, for which these angles can be calculated to be 32.4 and 51.7°. Fig. 1 shows the two fracture portions orientated so that slip steps are visible on the whisker faces.

The possible Burgers vectors for the sapphire lattice have been listed by Scheuplin and Gibbs [2], and the four smallest are shown in the table, together with information on slip planes where known.

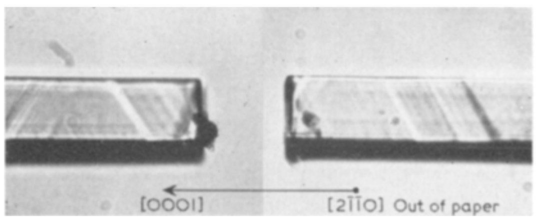

Figure 1 Optical micrograph of the two fracture portions of a sapphire whisker showing slip bands due to $\{\bar{1}102\}$ $<10\bar{1}1>$ slip. ($\times$300)

Indices	| b | (Å)	Slip plane	Interplanar spacing (Å)	Minimum temperature of observation (°C)
$\frac{1}{3}[11\bar{2}0]$	4.75	(0001)	12.97	900
$\frac{1}{3}[10\bar{1}2]$	5.12	$(\bar{1}011)$	3.48	1200
$\frac{1}{3}[20\bar{2}2]$	6.98	—	—	Not observed
$[10\bar{1}0]$	8.22	$(1\bar{2}10)$	2.38	1600

The present observations of the operation of $\{\bar{1}011\}$ $<10\bar{1}2>$ at 1200° C are consistent with the previously observed slip systems in sapphire – increasing Burger's vector or decreasing slip-plane spacing leading to an increase in the minimum temperature of observation. The reason why the new slip system has not previously been observed in single crystals is that a specimen orientation is required which will prevent basal slip, which would otherwise occur readily at 1200° C. The only reported work on specimens of such an orientation [3] was with large single crystals at relatively low stresses ($\leqslant$ 10 kg/mm^2) and strain rates, and, in this case, plasticity was not observed below 1600° C.

The observation of a non-basal slip system implies that the Taylor-von Mises criterion for plastic deformation of a polycrystalline aggregate can be satisfied by alumina at elevated temperatures. A good deal of experimental work has been carried out on polycrystalline alumina at temperatures above 1200° C [4-7], but only at low strain rates, where the experimental data can be explained in terms of Nabarro-Herring creep [8, 9], and where non-basal slip would not be expected to occur.

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Note The observed $\{10\bar{1}1\}$ slip bands can be distinguished from $\{10\bar{1}1\}$ twins, produced by the authors in <0001> whiskers, as the two types of deformation behave quite differently under polarised light.

Book Reviews

Refractory Metals and Alloys III: Applied Aspects

AIME Metallurgical Society Conferences Volume 30

R. I. Jaffee (editor)

Pp xli + 996 (Gordon and Breach, 1966) £21 16s, paperback in two volumes at £3 16s and £4 6s

As the editor observes, the time (1963) was ripe for a conference devoted to manufacturing technology and the problems of application of the refractory metals (niobium, tantalum, molybdenum, and tungsten) and their alloys. With the incentive provided by the needs of the aerospace industry, basic studies of the general physical metallurgy of these materials had already been pursued with considerable enthusiasm during the previous ten-year period. These studies formed the substance of the first two AIME conferences on refractory metals held in 1960 and 1962, and they are a necessary prelude to a conference on applied aspects.

Most of the papers published in this volume deal with specific applications or with production difficulties associated with such applications, and the problems of using these materials under service conditions. It is interesting that a majority of the applications discussed are for advanced aerospace systems – solid propellant rockets, re-entry vehicles, and liquid-metal containment for space power systems – rather than for the more urgent needs of the air-breathing gas-turbine. The editor implies that the latter can expect no assistance from the refractory quartet, and it is presumably on the consistent failure of attempts to develop satisfactory oxidation-resistant coating systems that he bases his implication, for it would appear from reading this book that most of the other problems associated with the use of these materials have been solved.

This is a well-organised volume, as AIME conferences usually are, and the papers are grouped under the following sub-titles: Extrusion; Forging and Forming Operations; Tubing Technology; Brazing Alloy Development and Techniques; Consolidation into Shapes by