haustion both of the crew and of the electrical power, as well as to fear of grounding in the darkness, the survey was not continued northeastward of the 460-m sounding. An extrapolation of the two ridges in the shallow echograms indicates a near-surface summit about 3½ km farther northeast (*8*).

I propose to name the newly discovered volcano in honor of Gordon A. Macdonald, professor of geology at the University of Hawaii and an authority on Pacific volcanism.

On the assumption that the explosions recorded by sofar emanated from Macdonald Volcano, the sofar fix is found to be in error by 32 km. Although this is less than 1 percent of the distance to the hydrophones, it represents a speed of sound propagation about 5 m sec^{-1} faster than the sofar axis speed (*9*). This discrepancy is considerably greater than any reasonable uncertainty in the speed of sound in the ocean (*10, 11*). A likely interpretation is either that the explosion was sufficiently far off the sofar axis so that maximum energy was carried along higher-speed off-axis rays, or that intervening islands and seamounts intercepted the near-axis rays. In partial substantiation of the latter view, no signals from the sofar bombs detonated on 20 July were received at any of the hydrophone stations although a pair of bombs detonated on 17 July, in a position northeast of Morotiri, were recorded 15 db above background at Eniwetok and Wake islands.

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Refractory Oxide–Metal Composites: Scanning Electron Microscopy and X-ray Diffraction of Uranium Dioxide–Tungsten

Abstract. *Unidirectional solidification of a melt, consisting of uranium dioxide and 5 to 15 percent by weight of tungsten, formed well-ordered arrangements of tungsten fibers or platelets in the uranium dioxide matrix. Fiber shape and orientation relations of the components indicate the development of several dominant growth modes.*

Uranium dioxide–tungsten (5 to 15 percent by weight) composites were solidified unidirectionally by a modified floating-zone process named the internal centrifugal zone growth technique (*1*). The metal solidified with the oxide and yielded well developed tungsten fibers or platelets regularly dispersed in the UO_2 matrix. The lattice constants of the metal and oxide were 3.1650 ± 0.0003 Å and 5.4715 ± 0.0003 Å, respectively. These figures agree, within the experimental error, with generally accepted values. The

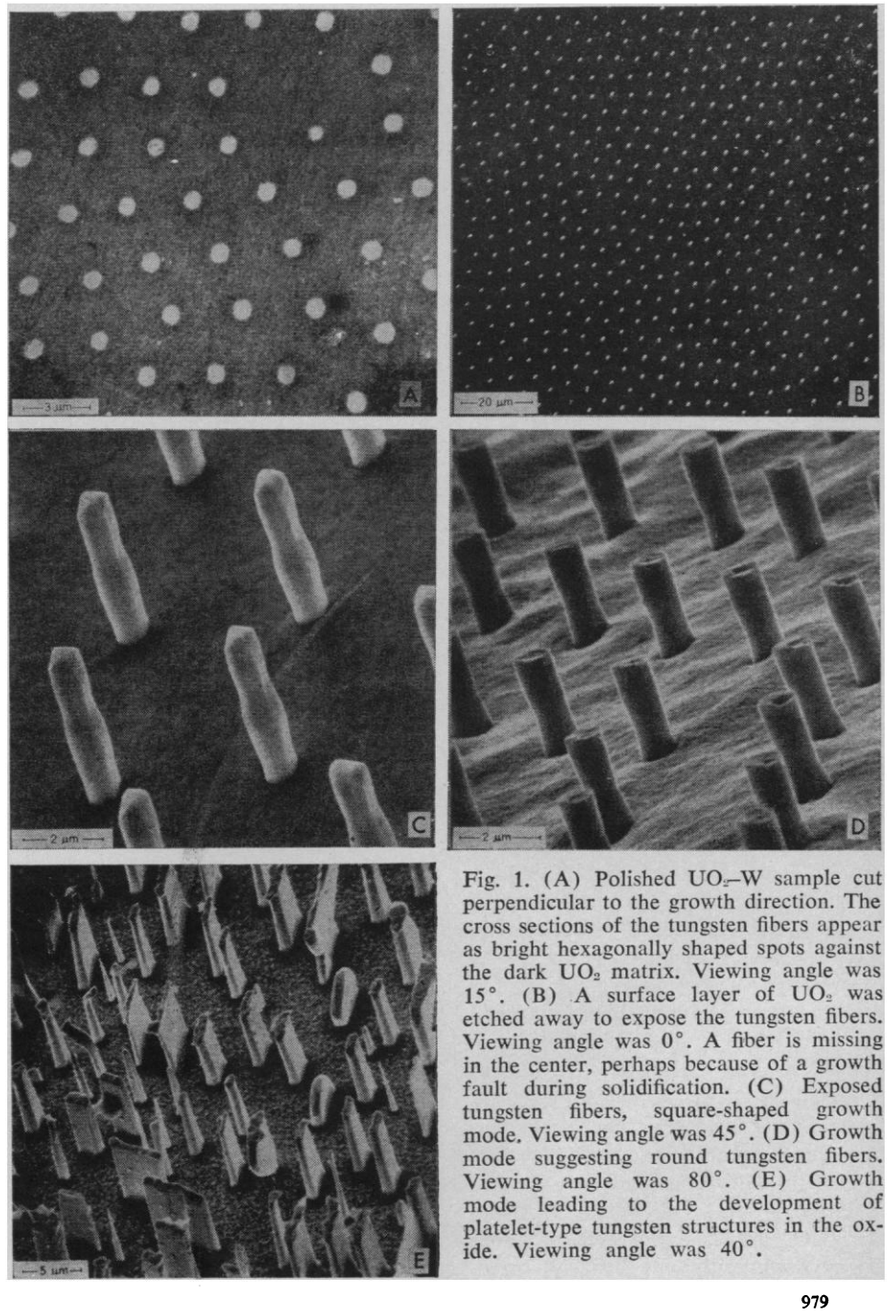

Fig. 1. (A) Polished UO_2–W sample cut perpendicular to the growth direction. The cross sections of the tungsten fibers appear as bright hexagonally shaped spots against the dark UO_2 matrix. Viewing angle was 15°. (B) A surface layer of UO_2 was etched away to expose the tungsten fibers. Viewing angle was 0°. A fiber is missing in the center, perhaps because of a growth fault during solidification. (C) Exposed tungsten fibers, square-shaped growth mode. Viewing angle was 45°. (D) Growth mode suggesting round tungsten fibers. Viewing angle was 80°. (E) Growth mode leading to the development of platelet-type tungsten structures in the oxide. Viewing angle was 40°.

lattice constants indicate little mutual solubility between oxide and metal phases.

Samples were cut perpendicular and parallel to the growth direction. Circular specimens with a radius of 8 to 12 mm and 3 to 5 mm thick were examined in the light microscope and, in particular, in the scanning electron microscope (Stereoscan). Specimens were polished, and in some cases a surface layer of UO_2 was etched away (*2*) to expose the tungsten fibers or platelets. For examination in the scanning electron microscope, further preparation (for example, coating with a conductive film) was not needed. The secondary emission mode of the scanning electron microscope was used. The micrograph suggests that tungsten fibers are hexagonal (Fig. 1A). The contrast is due to differences in materials rather than in topography.

The appearance of the sample after it had been etched to expose the tungsten fibers is quite similar to the view one obtains in a light microscope except that the magnification and the depth of focus are significantly increased (Fig. 1B). Emission of secondary electrons from tungsten was much stronger than from UO_2 and makes the tungsten appear in the form of white dots. The fibers are quite well ordered with spacing of fibers ranging from 3 to 6 μm.

The etched fibers in Fig. 1C show well-developed facets, although the pattern of growth may have been altered during etching. The fibers in Fig. 1D are round, and their diameter varies from 0.85 to 1 μm. The different growth forms also imply that several different orientations developed during solidification. Fibers extended the length of the samples studied. Fibers were formed at growth rates of approximately 12 mm/hr. In some isolated areas tungsten solidified in platelets at a growth rate estimated in excess of 20 mm/hr. These platelets were 0.8 to 1 μm thick, extending to more than 50 μm in width and several millimeters in length. A region of less-extensive platelet growth is shown in Fig. 1E.

Orientation relations between metal and oxide were studied in a diffractometer (General Electric, XRD 5) equipped with a goniostat type of single-crystal orienter. The specimens were cut perpendicular to the direction of growth. They consisted of a number of large (several millimeters in diameter) UO_2 grains. Small areas containing predominantly one UO_2–W orientation were examined in a number of specimens. The orientation relation most frequently observed was $(110)_W \parallel (111)_{UO_2}$ (planes perpendicular to growth direction) and with $\langle 110 \rangle_W \parallel \langle 110 \rangle_{UO_2}$. The indicated parallelism of planes and directions between W and UO_2 denotes only the mutual arrangement of metal and oxide. A number of other less frequently occurring orientation relations were observed as well.

The application of unidirectionally grown refractory oxide-metal composites (cermets) for structures or devices is essentially unexplored. The ordered high-elastic modulus fibers, bonded strongly to the oxide matrix, certainly must enhance the mechanical properties of the oxide. The thermal and electrical behavior of the composite will be very directional.

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Water in the Earth's Mantle: Melting Curves of Basalt-Water and Basalt-Water–Carbon Dioxide

Abstract. *At depths below about 45 kilometers in the earth, the presence of high proportions of carbon dioxide does not significantly affect the temperature of the beginning of melting of basalt-water compositions. Water must be present only in trace amounts in the solid part of the silicate mantle if it contains appreciable proportions of basaltic composition.*

The upper mantle of the earth is thought to consist predominantly of peridotite (*1*), which on partial melting, together perhaps with differentiation, yields melts of basaltic composition (*2*). The pervasiveness of basaltic magmas through most of geologic time indicates that at least parts of the mantle have been at temperatures above those of the basalt solidus during most of its thermal history. Experimental determinations of the dry melting of basalt (*3*) and peridotite (*4*) at high pressures place an upper limit on temperatures in the interior of the earth. However, it is now well known that water under pressure greatly lowers the melting temperatures of rock-forming silicates, and previous high-pressure studies on granite (*5*) and basalt (*6*) saturated with water place lower limits on the temperature of melting in the crust and mantle of the earth. Although some of the volatiles present in the primordial earth escaped shortly after accretion (*7*), the compositions of volcanic gases in equilibrium with basalts (*8*) and the concept that the hydrosphere and atmosphere evolve by degassing (*9*) suggest that significant amounts of water are contained within the interior of the earth.

We have succeeded in determining the beginning of melting of a natural tholeiitic basalt (*10*) to pressures of 30 kb in the presence of water and water–carbon dioxide mixtures. We use the term "basalt" to refer to a composition, not a rock type. All experiments were performed in a piston-cylinder apparatus (*11*) using a 2.5-cm sample chamber. The charges were sealed in Ag-Pd capsules (*12*) either with 15 percent of water by weight or 9 to 15 percent oxalic acid, which dissociates and oxidizes to produce a mixture of 50 mole percent each of water and carbon dioxide (71 percent of carbon dioxide by weight) (*13*). Additional experimental details and results have been obtained and are forthcoming (*14*).

Curves representing the beginning of melting and the upper stability limits of plagioclase and amphibole appear in a simplified pressure-temperature projection (Fig. 1). Clinopyroxene, epidote, and quartz are part of the subsolidus assemblages for both compositions above 10 kb pressure. Garnet and clinopyroxene are stable above the amphibole-out curves at pressures above about 15 kb. Note that at high pressures the stability of the hydrous mineral amphibole is increased as the result of the lowering of the activity of water, by the addition of carbon dioxide, as predicted from work in synthetic systems (*15*).

Our vapor-saturated solidus for ba-