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ISOThERMAl SECTION OF THE DIAGRAM OF THE SYSTEMS U-Mo-B
AND U-Re-B

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So far there has not been any systematic study of the interaction of the components in
the system U-Mo-B and U-Re-B. It is known that the borides UMoB4 and UReB4 with a structure of the
type ThMoB4 (table in [1]) form in them. Since the molybdenum, uranium, and rhenium borides
belong to the high melting compounds, the present investigation was carried out with the
object of obtaining new three-component high melting compounds, determining their crystal
structure, and constructing the phase equilibrium diagrams of the systems U-Mo-B and U-Re-B.

The binary systems U-B, Mo-B, and Re-B were studied in detail, and data on them were
systematized in [2, 3]. Figure 1 shows the compositions of reliably existing binary borides.
The compound U2Mo forms in the solid state at 600°C [4, 5], and at the temperature chosen
for the system U-Mo-B it must not be detected. The phase diagram of the system U-Re
is presented in [4]. The compound URe2 forms congruently at 2200°C, and at 180°C it undergoes
polymorphic transformation: the high-temperature modification has a structure of the type
MgZn2, the low-temperature modification has a rhombic structure [4]. The second compound
U2Re forms by peritectoid reaction at 680°C [4, 5].

The test specimens were made from compact (99.7 weight %) and preliminarily compacted
powdered molybdenum (99.98%), rhenium (99.8%), and boron (99.3%), the charge being fused in
an electric arc furnace in purified argon. The deviation of the weight of the specimens
from the weight of the charge did not exceed 2%. Homogenizing annealing was carried out
in vacuumized quartz ampuls for not less than 500 h at 1000 (U-Mo-B) or 800°C (U-Re-B).
The radiographs of the specimens were made in CrK-radiation in chambers with a diameter of
57.3 mm. The diffractograms of the new powdered borides were obtained in CuK-radiation
(installation DRON-3,0). Of the system U-Mo-B we investigated 48 specimens, of the system
U-Re-B 30 specimens. When the atomic fraction of uranium in the specimens exceeded 30%,
the powders became partly oxidized and formed UO2, in spite of the protection by indifferent
oil. In our opinion the easily oxidized phase is uranium base solid solutions.

Considerable solid solutions based on binary borides were not found in the systems
under study (Fig. 1). In the system U-Mo-B there exist four ternary borides (Table 1): the
previously known UMoB4, and three new ones. On the section 67% boron there forms the
compound U2MoB6 with rhombic structure of the type Y2ReB6 [6]. We did not succeed in ob-
taining the boride U2MoB6 in pure form: the diffractograms of the specimen of U2MoB6 showed,
in addition to maxima of the boride U2MoB6, also peaks of the phase UB2. This may indicate
the formation of the boride U2MoB6 by a peritectic reaction between the melt and UB2.
The identification of the maxima of the diffractogram belonging to the new ternary boride showed
that its structure undoubtedly belongs to the type Y2ReB6. The lattice periods of the

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TABLE 1. Crystallochemical Characteristic of Ternary Compounds of the Systems U-Mo-B and U-Re-B

<table>
<thead>
<tr>
<th>Compound</th>
<th>Spatial group</th>
<th>Type of structure</th>
<th>Lattice periods, nm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>a</td>
</tr>
<tr>
<td>UMoB4</td>
<td>Cmmm</td>
<td>ThMoB4</td>
<td>0.7300</td>
</tr>
<tr>
<td>U2MoBe*</td>
<td>Pbarn</td>
<td>Y2ReB6</td>
<td>0.9301(9)</td>
</tr>
<tr>
<td>UReB4</td>
<td>Cmmm</td>
<td>ThMoB4</td>
<td>0.7318--0.7311</td>
</tr>
<tr>
<td>U2ReB6*</td>
<td>Pbarn</td>
<td>Y2ReB6</td>
<td>0.9373(9)</td>
</tr>
</tbody>
</table>

*Data of the present work. We did not manage to determine the spatial group and the structure of the borides UMo4B4 and UMo2B6.

In the system U-Re-B two new borides (Table 1) were discovered for the first time. The compound U2ReB6 with a structure of the type Y2ReB6 was also obtained in a mixture with UB2. The compound UReB3 has a hexagonal structure of its own type.*

In the spatial group P63/mmc the uranium atoms occupy a regular system of points 2(d) 1/3, 2/3, 1/4, the rhenium atoms 2(a) 000, and the boron atoms 6(h) x, 2x, 1/4 (x = 0.774(7)); the final uncertainty factor is R = 0.06. The boron atoms in the structure of UReB3 are bound into the groups B3 arranged in planes perpendicular to the Z axis; the interatomic distances B-B are equal to 0.164 nm. The structure of UReB3 is related to AlB2 and ZrBeSi.

Our investigation makes it possible to compare the interaction of the components in the systems U-Cr-B [7], U-Mo-B, and U-W-B [8]. The system U-Mo-B is the most complex one: in it, four ternary compounds form whereas in the system U-Cr-B one compound forms, and in U-W-B two compounds form. Common to the systems U(Mo, W) is the formation of the isostructural compounds UMB4 and U2MB6 (where M is Mo, W) with the structures of the types ThMoB4 and Y2ReB6, respectively. In the system U-Cr-B the compound UMB4 (M-Cr) also forms but its structure belongs to the type YCrB3 [9].

LITERATURE CITED


*The special features of the structure of UReB3 will be the subject of a separate publication.