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METHODS FOR STUDYING THE STRUCTURE AND MECHANICAL PROPERTIES OF REFRACTORY METALS

and about. Assoc. Urokov K.
Karshi State University
Karshi, Uzbekistan
*E-mail: **uroqov74@mail.ru***
https://orcid.org/0009-0001-1714-4073

Abstract: This article discusses macro and microstructural studies of initial workpieces, as well as semi-finished products for all technological schemes. In this case, samples for microstructural analysis were prepared according to the usual method. During the analysis of the microstructure, its uniformity of size and elongation of grains, texture, the presence of impurities, micropores and microcracks were assessed.

Key words: semi-finished product, template, identifier, microhardness, rod, diamond pyramid, structure, deformation, tools.

Introduction.

Macro and microstructural studies of initial workpieces, as well as semi-finished products for all technological schemes (Fig. 2.4) [1] were carried out according to the usual method [1.2].

Samples for microstructural analysis were prepared as follows: cut teleete were mechanically polished using a suspension of fine aluminum oxide in an alkaline solution of red blood salt, then electropolished in a concentrated solution of sulfuric acid for 3 min. and etching.

Viewing of thin sections and taking photographs was carried out using a MIM-8M microscope at a magnification of 200 and 300 times.

During the analysis of the microstructure, its uniformity of size and elongation of grains, texture, the presence of impurities, micropores and microcracks were assessed.

Methods.

The microhardness measurements of the structural components of molybdenum and niobium in the work were carried out using a PMT-3 device at a load of 100 g according to GOST 9450-60 [2.3].

The identifier was a diamond pyramid with a square base of regular tetrahedral shape with an angle at the apex between the opposite faces of the pyramid.

When testing for microhardness, the surface of the diamond pyramid and the test surface of the sample must be dry.

After pressing the identifier (Fig. 1) under the specified load into a clean flat surface, a small square imprint remains on it.

By measuring its diagonals d_1 and d_2 using a microscope, we found their arithmetic mean:

$$d = \frac{d_1 + d_2}{2}; \qquad (1)$$

The hardness value N_m is the quotient of the load divided by the conditional area of the lateral surface of the resulting print

$$F \cdot H_M = \frac{P}{F}; \qquad \text{from here } F = \frac{d^2}{2\sin 68^0} = \frac{d^2}{1{,}854}; \quad \text{that}$$

$$H = \frac{1{,}854P}{d^2} \text{ kg/mm}^2 \qquad (2)$$

where: P - load on the pyramid, kg; d - the arithmetic mean of the lengths of both diagonals of the print after removing the load.

When testing for microhardness, the load value was chosen so that the diagonal of the indentation was at least 1.5 times less than the thickness of the material being tested; The depth of the indentation must be at least 10 times less than the thickness of the material being tested.

The duration of exposure under load was 6 seconds.

The mechanical properties of the original blanks and rods obtained by pressing, longitudinal rolling, rotational and radial forging were assessed by plasticity indicators (δ%, φ%) and strength characteristics (σ_b, $\sigma_{0.2}$).

Mechanical tensile tests (GOST 1497-73) of cylindrical samples were carried out on a vacuum tensile testing machine, consisting of a testing system, a vacuum system, a heating device and a measuring system /14/. The installation diagram is shown in Fig. 2.

The installation consists of a testing machine, a vacuum chamber, including a vacuum, heating and force-measuring systems, as well as instruments for regulating and monitoring temperature, and an installation control panel.

Research results.

The testing machine ensures: maintaining the tightness of all systems when moving the machine's grippers; centering of the sample due to the presence of a bellows and uniform heating over the cross-section and length due to the rational installation of a tantalum sheet heater in the chamber.

The sample temperature is controlled by a tungsten rhenium thermocouple.

Loading occurs through the gearbox and worm gear; the deformation speed can be adjusted within 0.1-2 mm/min.

To cool the installation and heater components, an external water jacket is provided, which ensures a temperature on the outer casing of no more than 35^0C.

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Specimens of vacuum-melted molybdenum and niobium and sintered powdered molybdenum were subjected to tensile testing at various temperatures under vacuum conditions of 1.10-4 MPa.

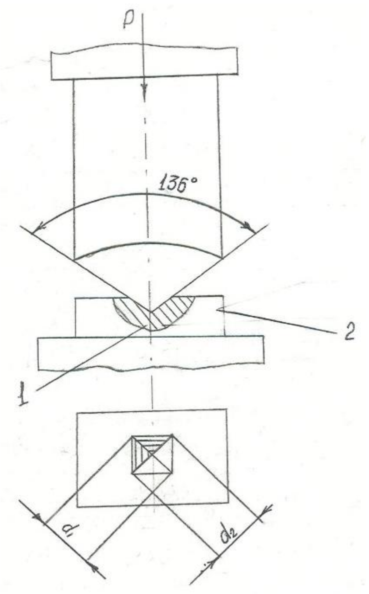

Fig - 1. Scheme of microhardness test.

1-diamond pyramid, 2-test object.

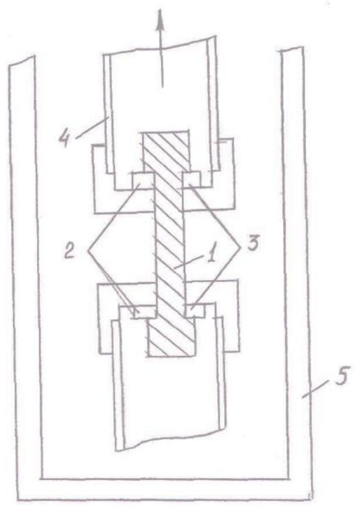

Fig - 2. Diagram of the installation for testing tensile samples in vacuum.

1-sample for mechanical tensile tests, 2-crackers, 3-cams, 4-rods, 5-heater.

The indicator of the stress state of the K_j material was determined as the average value [3.4]:

$$K_j = \frac{1}{L_\rho}\int_\circ^l \frac{\delta}{T} d\Delta \qquad (3)$$

Here: $\frac{\delta}{T} = \frac{1}{\sqrt{3}} \cdot (1 + \frac{3}{4} \cdot \frac{d}{R})$

where: R - radius of curvature of the sample along the neck d after destruction.

В связи с разбросом экспериментальных данных механических испытаний и определенных на их основе L_ρ и K_j математическую обработку результатов проводили по методу наименьших квадратов [4.5].

Due to the scatter of experimental data of mechanical tests and $L\rho$ and K_j determined on their basis, mathematical processing of the results was carried out using the least squares method [4.5].

Conclusions:

For a comparative analysis of the effectiveness of existing and proposed technological schemes for the production of small-diameter rods and assessment of their quality, macro and microstructural studies were carried out, and various methods for studying mechanical and technological properties were used.

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