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FOREIGN TECHNOLOGY DIVISION

THE INTERDIFFUSION OF TANTALUM AND TUNGSTEN

by

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EDITED TRANSLATION

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ABSTRACT

(U) To determine the coefficient of interdiffusion between tungsten and tantalum, ground specimens of tungsten and tantalum were held in a vacuum at 2000 degrees C for 48 hr. The diffusion coefficient of tantalum was found to depend on the tungsten content in the interface diffusion layer. The value of the diffusion coefficient of tantalum sharply decreased with increasing tungsten content from 10 to 50 wt. percent, and gradually increased with increasing tungsten content from 60 to 90 wt. percent. The interdiffusion coefficient had a minumum value at a tungsten content of 40-60 wt. percent. Orig. art. has: 2 figures.

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I. A. Tregubov, L. N. Kuzina, and O. S. Ivanov

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For determining the coefficient of interdiffusion of tungsten and tantalum at 2000°C, samples of tantalum and tungsten (6 mm in diameter, ℓ = 8 mm) were brought into contact with each other and were roasted at the given temperature in a special vacuum unit ($2 \cdot 10^{-3}$ mm Hg) for 48 hours. The width of the diffusion zone was $\sim$150 μ.

Thus, the roasting time and temperature were sufficiently high for the depth of penetration to have a measurable order of magnitude. The contact surfaces of the samples were first carefully polished. The required roasting temperature was obtained by passing a current through the sample. The temperature was measured by an optical pyrometer with an accuracy of ±20°. During the heating and subsequent roasting periods the samples of the diffusion couple were constantly compressed against each other with a force of up to 10 kgf/cm^2. The microsection was made perpendicular to the diffusion surface.

Concentration curves were obtained on an MS/46 "Kameka" micro-x-ray-spectral analyzer. The elements in the diffusion layer were analyzed from the tungsten and tantalum L_α lines. The intensity of line L_{α_1} in pure elements amounted to $5 \cdot 10^3$ pulses per second. The signal-to-noise ratio was at least 10^3. The spectral line intensities

were measured by continuous recording on an automatic potentiometer when the sample shifted under an electronic probe at a rate of 17 μ/s. The tungsten and tantalum concentrations were defined as the ratio of the intensity of the element's lines in the diffusion layer to their intensity for the pure element.

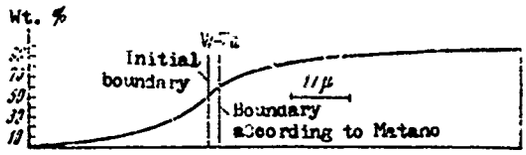

Fig. 1. The curve of measuring the tantalum content in the diffusion layer of a W-Ta system at 2000°, 48 h.

Investigation Results

In Fig. 1 there is shown the curve of the change of the tantalum concentration in the diffusion layer. It is known [1] that the phase diagram of the W-Ta system has a continuous series of solid solutions; therefore the tantalum (or tungsten) concentration changes in accordance with a smooth curve. A more abrupt change of the concentration of the components in the diffusion layer near the tungsten attests to the smaller magnitude of the diffusion coefficient in solid solutions rich in tungsten in comparison to solid solutions based on tantalum. This curve is asymmetrical with respect to the initial area of the section, which indicates the dependence of the diffusion coefficient on the concentration.

The coefficients of interdiffusion were determined by the Matano method [2] as a function of the composition. In Fig. 2 there is shown a curve of the dependence of the diffusion coefficient on the tungsten in the W-Ta system. Attention is drawn to the fact that the diffusion coefficient of tantalum depends strongly on the tungsten concentration. With an increase of the tungsten content from 10 to 50 wt. %, value D decreases sharply from $4.7 \cdot 10^{-11}$ cm^2/s to $0.8 \cdot 10^{-11}$ cm^2/s. An increase of the tungsten concentration from 60 to 90% leads to a gradual increase of the diffusion factor from $0.8 \cdot 10^{-11}$ cm^2/s to $1.9 \cdot 10^{-11}$ cm^2/s. The interdiffusion coefficient is minimum in the region of tungsten concentration from 40 to 60 wt. %.

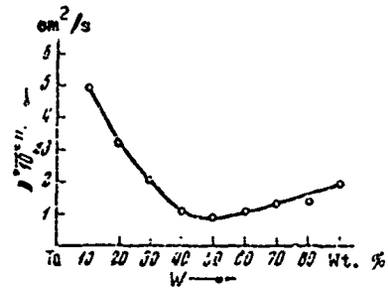

Fig. 2. The curve of the dependence of tungsten diffusion on its concentration in the W-Ta system.

The change of the tantalum concentration in the diffusion layer has been studied and the interdiffusion coefficients of the tungsten and tantalum at 2000°C have been determined by a method of local x-ray spectral analysis.

It has been established that the curve of the change of the tantalum concentration is asymmetric with respect to the initial plane of the section, which indicates a dependence of the interdiffusion coefficient on the concentration. The curve of the dependence of the diffusion coefficient on concentration has a sloping minimum at a tungsten concentration of 40-60 wt. %.

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