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Carburizing the surface of tantalum in a sealed container using an induction machine

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Introduction

Tantalum and its alloys are widely used as structural materials in rocket, aviation, space and nuclear technology. Technically pure tantalum is plastic, has high heat transfer coefficients, a high gas absorption capacity, heat resistance, refractoriness, biocompatibility, and has a low hardness of 1.4–1.6 GPa.

Tantalum interacts with non-metallic elements that form interstitial solid solutions (H, C, N, O). The absorption of gases is negative, since the products of interaction are chemical compounds with different properties. However, in some cases, the phenomenon of gas diffusion is used to impart the required properties. The use of saturating technologies makes it possible to increase the operational properties of this metal, for example, heat resistance, surface hardness and wear resistance.

It is possible to obtain the necessary compounds on the surface of metals and their alloys using chemical thermal treatment (CTT). CTT allows effective hardening of metal products due to diffusion layers and coatings on the surface with the required physical and mechanical properties.

One of the effective methods of tantalum CTT can be considered carburizing in a solid carburizer (graphite), and eddy currents arising during induction heating are used as a heating source.

Methodology

For this, a sample with a carbon-containing medium was placed in a container (1). The container was placed in a quartz tube (2) located in an inductor (3), the inductor was water-cooled (4) (Figure 1, a). The container was subjected to induction heating in an air atmosphere at an inductor current from 3.0 kA to 4.5 kA to a temperature of 1000–1200 ºC. At the same time, the rate of reaching the stationary holding temperature was 40-50 s. Then produced exposure at this temperature for 4 minutes.

Results

Based on the simulation results, it was evident that the temperature field in the carburizing container was fairly uniform in the range of the inductor. The carburizer was heated to a temperature higher than the surface temperature of the metal container. This was due to the accumulation of heat, which in turn intensified the saturation of the surface of metal samples with carbon. This temperature difference was about 50 °C and that was clearly shown in the temperature distribution map in the container with an inductor current of about 2 kA in the stationary heat treatment mode since the warm-up time of 90 s (***Fig b***).

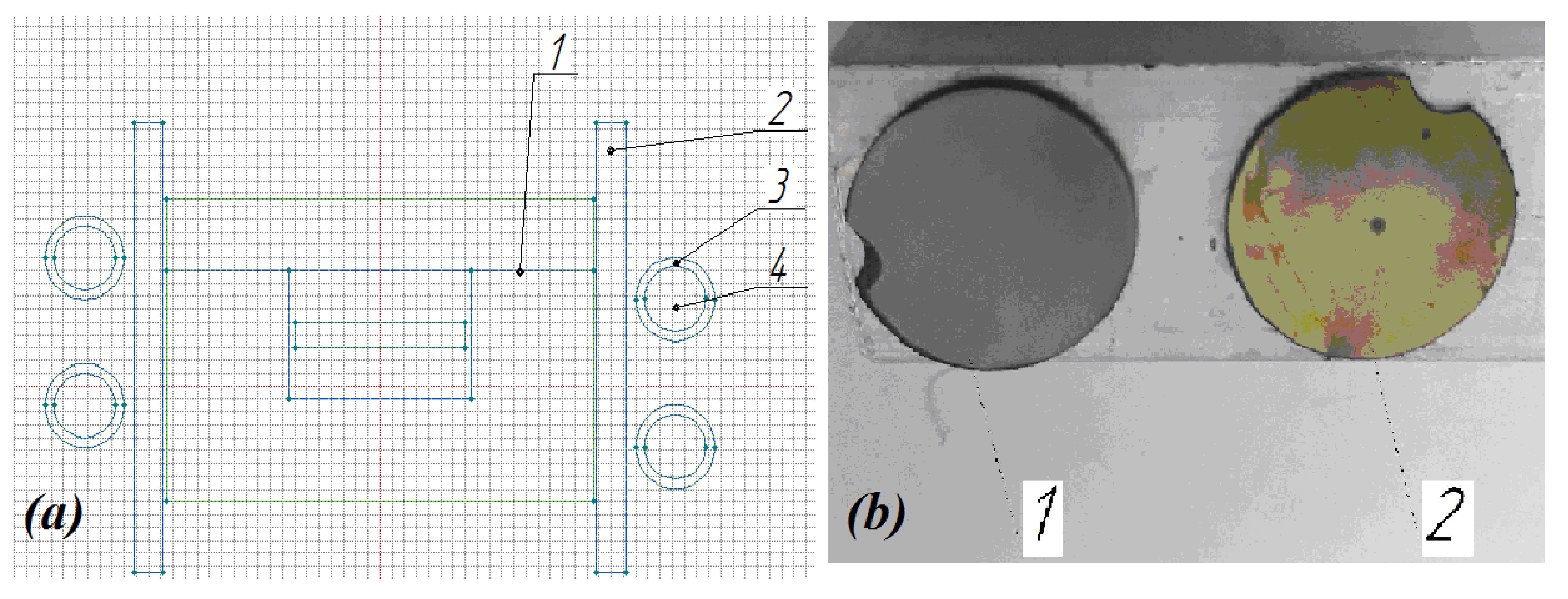

Figure 1. *a* - The layout of the container in the inductor: 1 - container, 2 - quartz tube, 3 - inductor, 4 - water cooling; *b* - General view of tantalum samples: 1 - initial view, 2 - after CTT

Conclusions

After CTO, the samples had a golden-colored coating on the surface. The samples in the initial state were characterized by a microhardness equal to 1.4 GPa. The formation of a coating on the surface of samples of technical tantalum, which has a higher microhardness, about 8 GPa, was observed at a temperature of 1200 ° C and holding for 4 min..

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