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METALLURGY OF A Ti-Au ALLOY SYNTHESIZED BY CONTROLLED ELECTRIC RESISTANCE FUSION

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Introduction

Alloying titanium with gold for the manufacture of medical products is one of the possible ways to improve their operational properties [1]. This is especially true for dentistry [1–6], since both metals of the Ti-Au system have unique characteristics that are well suited for implants and other dentist structures. The Ti-Au alloys have improved corrosion resistance [7, 8] and hardness. As a result, the reliability and the durability of the orthopedic products are increased.

Based on the foregoing, the study of the interaction of titanium with gold under controlled heat input is necessary and promising, since all the mentioned research have been performed using the Ti-Au alloys melted in a crucible by induction or arc heating in an atmosphere of argon or helium. However, a significant volume fraction of metastable phases, and phases formed inconsistently with the Ti-Au phase diagram, have been found in the studied small ingots even under described conditions. The reason has been the fact that the Ti-Au phase diagram has been drawn on the basis of the data measured at slow heating and cooling rates, and some of the dependences have been assessed theoretically.

Materials, methods and results

Commercially pure titanium plates (VT1-0 according to the Russian classification that equal to Grade 1 in compliance with the International one) with a thickness of 0.3 mm and the gold (99.99%) foil with a thickness of 50 μm were used to synthesize an alloy sample. The titanium plates and the gold foil between them were squeezed by dome shaped hemispherical electrodes made of the Cu-1%Cr-0.05%Zr bronze according to the scheme presented in Figure 1.

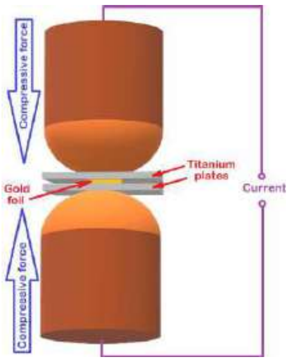

Fig. 1. The synthesis scheme of the Ti-Au alloy sample

A specimen for metallography and microhardness measurements was made by cutting the weld nugget across. Microhardness was measured by nanoindentation using a ‘Nano Indenter G 200’ facility. The facility enabled to draw indentation curve in real time, as well as automatically calculate microhardness values in accordance with ISO 14577.

The following conclusions can be drawn based on the obtained results:

1. The proposed SSRSW procedure can be considered suitable for synthesizing the Ti-Au alloys. This statement is based on the fact that the sound weld nugget has been formed with the

optimal dimensions for the titanium alloys without expulsions.

2. The average gold content in the synthesized Ti-Au alloy was about 16 at. % (42 wt. %). It was distributed rather evenly throughout the nugget volume in a ratio of 10…20 at. % (30…50 wt. %). In addition to the α-Ti and Au particles, which were in the alloy according to the Ti-Au phase diagram, the alloy included the Ti_3Au and $TiAu_2$ compounds corresponding to the gold content of 25 and 67 at. % respectively. These compounds had been formed in microvolumes with a high concentration of gold for a period of not more than 3 ms. Microhardness values were about 6…7 GPa in the regions most enriched in gold, and they were approximately 4 GPa at minimum concentrations.

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