SYNTHESIS OF TI-AU UNDER CONDITIONS OF ELECTRON BEAM WELDING

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Titanium is the most suitable material for many medical products, such as implants, endoprostheses, plates for osteosynthesis and cranioplasty of skulls, as well as various fasteners (bridges, staples, screws, etc.) in traumatology and dentistry due to its good combination of physical, mechanical and biomedical properties [1–4]. At the same time, improving both strength and corrosion resistance of such products is an urgent task nowadays [5, 6]. The fact is that commercially pure titanium (CP Ti) possesses advanced inert and biocompatible characteristics, but it has some disadvantages as well, including reduced deformability and insufficient wear resistance [7]. In addition, the high melting point and reactivity of titanium to oxygen and nitrogen complicate its processing and treatment for improving functional properties. Thus, alloying titanium with various metals is the common method for this purpose, but it has some limitations because of incompatibilities with human bodies that greatly narrow the range of possible compositions. So, despite the widespread use of such titanium alloys as the TiNi intermetallic compounds, possessing the shape memory effect, the Ti-6Al-4V alloy, characterized by improved strength characteristics, and the Ti-Nb ones with relatively low elastic modulus [5], there are some issues due to the presence of toxic Ni, Al, V and Nb as their components. Therefore, there is a huge interest in alloying titanium with noble metals (such as silver, gold and platinum) for some dental applications for many years despite their high cost [8–11]. In addition to being non-toxic, they can also have anti-microbial and anti-inflammatory effects on human bodies (silver, as an instance) [12–17]. It should be noted that both mechanical properties and corrosion resistance must be improved in these cases [13, 14, 16], which determine the reliability and durability of such implants or prostheses. Consequently, titanium biomedical alloys with noble metals (first of all, with gold) have been studied in sufficient detail [12–17]. The influence of the Ti-Au alloy compositions on their microstructure, forming phases and mechanical properties has been reported for a fairly wide range of gold concentrations (up to 40%, by weight as a rule) [13, 14, 16] and even from 0 up to 100% [17]. Typically, their phase compositions have been determined on the basis of both equilibrium Ti-Au state diagram (drawn by J.L. Murray [18]) and data, thermodynamically calculated using the CALPHAD method [19]. However, there are still some gaps in knowledge, which the authors of paper [17] have tried to fill by a detailed study of the Ti-Au alloys, connecting the phase diagram plots with Vickers hardness values. Two data arrays have been distinguished: high hardness levels of 6.50–7.80 GPa for the gold concentrations in the range of 22–34 wt.% and low ones of 2.64–2.83 GPa at its contents of 50–80 wt.%. The low hardness range is close to that for cast CP Ti, while the high hardness values are associated with the formation of the Ti3Au intermetallic compound. Respectively, these observed patterns enable to use microhardness tests as an express method for identifying the formation of the Ti3Au phase in the Ti-Au alloys.

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