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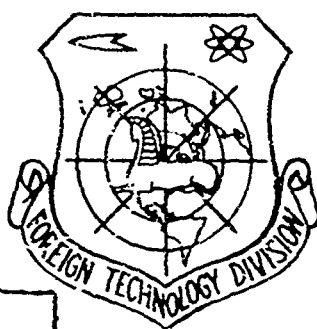
FOREIGN TECHNOLOGY DIVISION



SOLDERING TITANIUM ALLOYS FOR MEDICAL EQUIPMENT

By

N. F. Belavin and V. G. Shakhmatov



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SOLDERING TITANIUM ALLOYS FOR MEDICAL EQUIPMENT

N. F. Belavin and V. G. Shakhmatov
The Scientific Research Institute of Experimental
Surgical Apparatus and Instruments (NIIEKhAII), Moscow

Titanium alloys, being contemporary and promising materials for many branches of industry, in particular for medicine, are distinguished by a wide range of different mechanical and physical properties.

In comparison with stainless steels, which are more widely used in the medical instrument industry, titanium alloys have a higher corrosion resistance, lower specific gravity and higher strength and, as a result of these two qualities, they have a higher specific strength. According to the data of the NIIEKhAII, the neutrality of titanium to tissues of a living organism is equal to that of chromium-cobalt alloys, which makes it possible to apply it as a material for a means of joining tissues.

In spite of the positive properties that have appeared in different operating conditions, because of its high prime cost titanium and its alloys have not yet obtained wide use as a construction material in general machine construction and particularly in the production of medical equipment. However, the recent successes of the metallurgical industry concerning titanium and its alloys allow us to

significantly decrease the production cost both for coverings and for different rolled profiles.

Work [1] reports about the advantages of titanium over stainless steel and compares the prime cost of titanium and stainless steel at different stages of production and exploitation. Considering the prime cost of titanium (according to 1957 prices), the specific gravity and the service life of equipment, the author of work [1] concludes that in many cases the use of titanium turns out to be more suitable than the use of steel.

The corrosion resistance, the neutrality to tissues of a living organism and the strength of titanium alloys must attract the attention of designers who are working on medical instruments, apparatuses and equipment.

At the NIIEKhAII we have investigated a method of joining titanium alloys by soldering with a preliminary nickel-phosphorus covering.

The great stability of oxide films of titanium in ordinary conditions and the high chemical activity of titanium, which easily combines with different elements upon heating, create certain difficulties in connection with active saturation of the metal of the joint by oxygen, nitrogen and other impurities during welding and soldering in ordinary conditions.

Although titanium welds are widely applied in industry, this method has a number of considerable deficiencies [2]. It was previously established that prolonged heating, especially in resistance butt welding, causes a significant growth of grain size and a decrease in the pliability of joints. Furthermore, to join titanium alloys by welding it is necessary to apply an inert gas (argon, helium) to

protect the fussed metal and all the heated parts of the welded article from the action of air. The inert gas must be sufficiently pure, i.e., its water content should not exceed 5%, and the total content of oxygen and nitrogen in it should not exceed 0.25% [3].

Methods of joining titanium by soldering are presently being intensively developed. As a result of investigation [3] it was established that the formation of a durable and pliable soldering joint is obstructed by oxides, hydrides and the layer that is formed under the oxide layer as a result of saturation by nitrogen and oxygen when titanium is heated above 450°. Different methods of protecting the metal from the action of oxygen, nitrogen and hydrogen are used during soldering to prevent their formation. For this purpose argon or helium of sufficient purity is used during soldering or soldering is conducted in a vacuum. Before the articles are soldered they are cleaned without allowing oxygen access to them and fluxes which dissolve the film and protect the metal from oxidation are used.

The difficulty of selecting a solder for soldering titanium is that many metals form with titanium fragile chemical compounds, which decrease the pliability and strength of the soldered seam.

The simplest method of soldering titanium and its alloys with light solders and without a protective atmosphere is the method applied in the aviation industry, which has been investigated in our conditions to apply it for soldering medical equipment. This method is that the parts or the places of soldering are preliminarily subjected to chemical nickeling.

To investigate soldering with preliminary chemical nickeling we selected titanium alloys of three brands, VT5-1, OT4-1, VT14 and T5Kh13 stainless steel, the chemical composition of which is given in

the table.

Chemical Composition of Titanium Alloys VT5-1, OT4-1, VT14 and 3Kh13 Stainless Steel

Brand of the alloy	Chemical composition in % (the remainder is titanium)										
	Al	Mn	Fe	Si	C	Sn	Mo	S	V	Cr	Ni
VT5 - 1	4,0-5,5	—	0,3	0,15	0,1	2,3	—	—	—	—	—
OT4 - 1	1,0-1,25	0,8-2,0	0,4	0,15	0,1	—	—	—	—	—	—
VT14	3,5-4,5	—	0,4	0,15	0,1	—	2,5-3,5	—	0,7-1,5	—	—
3Kh13	—	0,6 (Not more than)	0,6 (Not more than)	0,6 (Not more than)	0,25-0,34	—	—	0,03	—	12-14	0,6 (Not more than)

Note. Steel 3Kh13 contains not more than 0.035% P.

We investigated the junction of titanium alloys on examples of soldering samples in the form of plates 20 x 5 mm in cross section and 100 mm long, both titanium with titanium and titanium with steel. Two variants of soldering were used: butt and lap.

Before soldering, samples of titanium alloys were given a nickel-phosphorus covering according to the following technology: 1) degreasing with organic solvents; 2) sandblasting the surface; 3) etching in a bath of the following composition: HCl-30 ml, HF-20 ml, H₂O-950 ml at 20° for 4 - 6 minutes; 4) washing in hot and cold water; 5) chemical nickeling (nickel-phosphorus covering) of the surface at the place of soldering in a bath of the following composition: nickel chloride - 30 g/liter, sodium, potassium or calcium hypophosphite - 10 g/liter, sodium acetate - 10 g/liter; heating to 90 - 98°, holding for 20 - 30 minutes; this produces a covering 5 - 8 μ thick; 6) washing in cold and hot water; 7) drying and heat-treating at 250 - 300° for 2 hours.

The interruption between separate operations should be no more than 10 minutes. Sandblasting the surface can be replaced by etching

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in a bath of the following composition: HCl - 30 ml, HF - 20 ml, H₂O - 950 ml at room temperature for 10 minutes.

Samples with a nickel-phosphorous covering can be well plated with POS30 or POS90 solder by dipping them in liquid solder. The plated samples can be soldered electrically and also with heat on a high-frequency stand. As a flux we applied this composition: zinc chloride - 2 parts by weight, ammonium chloride - 1 part by weight, with water added until a slurry is formed.

Our experiments on soldering titanium alloys both with each other and with 3Kh13 steel showed that this method of joining by light solders without a protective atmosphere and with preliminary nickeling is reliable and fully sufficient for factories of the medical instrument industry.

An investigation of the strength of the soldered seam showed its good positive qualities: the lack of blisters, good filling and wettability.

The seams of soldered samples of titanium with titanium and titanium with 3Kh13 stainless steel had the following magnitudes: tensile strength, 2.9 - 9.5 kg/mm²; shearing strength, 1.3 - 3.5 kg/mm².

On the basis of these and comparable investigations the given method of soldering was introduced for equipment (suturing apparatuses of the NIIEKhAII construction).

The body of UKL-60 suturing device was made from titanium alloys with all the technological operations being controlled, i.e., with a determination of the possibility of treating titanium alloys on the existing equipment of medical instrument factories.

It should be noted that at the Krasnogvardeyets factory free forging and drop forging and at the NIIEKhAII experimental factory

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machining (milling, drilling, notching, etc.) have been satisfactorily conducted on a stand designed for 3Kh13 steel.

A matrix of 4Kh13 steel has been electrically soldered to a UKL-60 body of titanium with light POS30 solder in ordinary conditions according to the above stated technology. At the soldered places the titanium body had a nickel-phosphorus covering.

The testing of suturing apparatuses made from titanium alloys in the medical section of the NIIEKhAII showed their good quality.

Conclusions

1. A nickel-phosphorus covering makes it possible to reliably join parts from titanium alloys both to stainless steel and to titanium by light soldering without application of a protective atmosphere.

2. The titanium alloys VT5-1, OT4-1 and VT14 should find application for parts of medical apparatuses and instruments, especially where high corrosion resistance, neutrality to tissues of a living organism, strength and low specific weight are required.

REFERENCES

1. A. A. Gol'denberg. Metallovedeniye i obrabotka metallov, No. 4, str. 56, 1957.
2. M. Kh. Shorshorov and G. V. Nazarov. Svarka titana i ego splavov. M., 1959.
3. N. M. Pul'tsin. Titanovyye splavy i ikh primeneniye v mashinostroyenii. M. - L., 1962.

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