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Welding Behavior of Biocompatible Ti-Mn Alloys

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Background & Objective	Research Method	Key Results
The welding behavior of inexpensive Ti-Mn alloys is very important because a large part of the manufactured components are available mainly in the form of sheets and plates. **Goal**: Evaluate the welding behavior of new Ti-Mn alloy for medical applications.	1. Obtaining the new TiMn alloy by vacuum arc remelting of inexpensive raw material. 2. Machining the ingots for obtaining sheets and welding using TIG process (Tungsten Arc Welding in argon shielding atmosphere).	1. The weld microstructure showed columnar grains of beta-Ti phase, oriented in the direction of heat flow, without any imperfections such as pores or cracks. 2. By alloying with Mn, the microhardness increased from 356 HV0.1 (for the Ti6Al4V base alloy) to 418 HV0.1. .

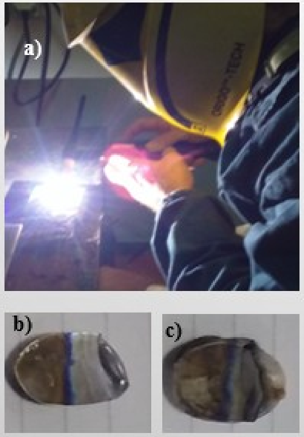

Fig 1. TIG welding process (a) and overlap welded samples (b and c)

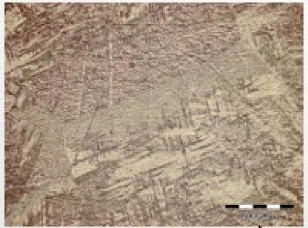

Fig. 2. Base material

Fig 3. Weld joint

Fig. 4. Heat affected zone (HAZ)

Welding parameters: welding current, Is of 40A and 55A; arc voltage, Ua of 10V; Welding Gas flow of 14l/min; Root Gas flow of 5 l/min.

The increase in hardness of TiMn alloys is primarily due to the formation of solid solutions. By insertion of Mn atoms in the titanium alloy matrix, the internal energy increases, and the crystal lattice is strained. Since the cooling after welding occurred at a high speed, both titanium and Mn alloys tend to form quenched martensite structures, which are characterized by high hardness (Fig. 5 and 6).

Alloying with Mn increased the hardness from 418HV0.1 for Ti3Mn to 427HV0.1 for Ti5.7Mn.

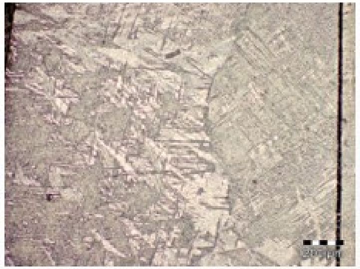

Fig. 5. Acicular Martensite in TiMn base material

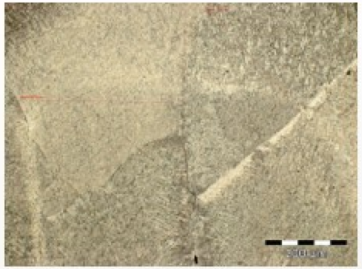

Fig. 6. Very fine acicular martensite in the weld accompanied by grain growth

Conclusion

The paper presents results obtained from electric arc welding in an inert gas environment of a biocompatible Ti-Mn alloy. The experimental alloy was obtained by melting in the VAR ABJ 900 equipment, using as raw material Ti6Al4V alloy shavings resulting from mechanical processing and Mn grains with 99.5% purity to obtain the desired chemical concentration (0.018 wt.%C, 0.07 wt.%Si, 3.07 wt.% Mn, 0.10 wt.% Fe, 0.06 wt.% Al, 0.04 wt.% V, 0.72 wt.% Sn and Ti balance).

For welding, the Ti3Mn alloy plates were overlapped, and the edges were melted together using the TIG welding process in an argon shielding atmosphere. After welding, the samples were sectioned, and the surfaces were prepared (chemical attack with Kroll's reagent) for microstructure analysis and microhardness measurement of the main characteristic zones (weld, heat-affected zone and base material).

The weld microstructure showed columnar grains of beta-Ti phase, oriented in the direction of heat flow, without any imperfections such as pores or cracks.