

CHARACTERISTICS OF Ni-Ti -Cu SHAPE MEMORY ALLOY WITH DENTAL TECHNICS APPLICATIONS

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Abstract: There is a constant concern for obtaining biocompatible alloys with better characteristics in efficient economical conditions. In this paper, we studied several alloys used in dental technics as implants. After alloying with 5% and 10% copper content, several properties of this modified Ni-Ti alloy were investigated.

1. CHARACTERISTICS OF Ni-Ti BIOCOMPATIBLE ALLOY

This alloy called nitinol by Buehler, has Ni and Ti in the same atomic percentage. The main characteristics is corrosion resistance and shape memory effect. For these reasons the elastic modulus in shape memory alloy (SMA) is very low in comparison with other biocompatible alloys.

It was found that Ni-based alloys can produce some allergies and sometimes cancer as effect of its toxicity.

For this effect elimination, and improving biocompatibility, the alloy is coated with different metals. The coating process has a negative influences on the shape memory effect (these phenomenon will be investigate in a future work).

However, this alloy has good shape memory property (two way memory effect) and a very good resistance to most commonly used corrosive substances. The most used alloy has a Ni content of 50.6% and 49.4% Ti.

Shape memory alloy behaviour.

It is known that martensite in shape memory alloy shows good thermoelastic properties, leading to increase deformability of material when its shape has been changed. This deformation has as result the transition of AMF from a thermal stable state to an instable thermal state.

Reversible transformation from a martensite state to austenite state is achieved once the alloy temperature increases. Reversibility is a characteristic of shape memory alloy, in which austenite – martensite and martensite- austenite transformation are both possible in comparison with common steels in which martensite by heating is transformed in tempering constituents not in austenite.

In some AMF austenite-martensite transformation occurs at room temperature, an important feature for use in dental application.

Martensitic transformation for these alloys occurs at 37⁰ C.

Shape memory alloys are used in a wide range of medical application:

- In Cardiology: stents, pulmonary embolism filter etc.

- In Orthopedics: osteosynthesis plates, anchor suturing, clamping, etc
- In Urology: urethral stents, etc..
- In gastroenterology: esophageal stents , biliary stents, etc.
- The dental technology - manufacturer of implants and pins dentare.dentara - by building

2. EXPERIMENTS

Ni-Ti alloy with 5% and 10% copper content were investigated. The samples were subjected to tensile tests an stress-strain curve were obtained for both martensitic and austenitic states.

Figure 1 shows stress-strain curves of a Ni-Ti type alloy with 5% Cu content, and Figure 2 shows the curves for the same alloy with 10% Cu, in the austenitic and in the martensitic states. The tensile test were obtained by using a traction machine with a maximum stress of 2000 MPa.

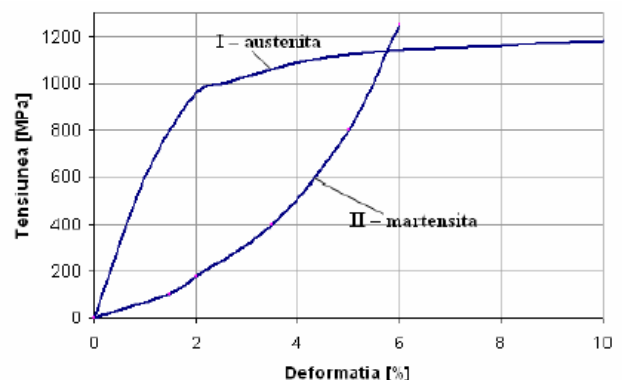


Fig. 1 Curves of a Ni-Ti type alloy with 5% Cu

We used these two alloys, with 10% maximum copper content because increasing of copper content has as result increasing strain in martensitic state, which can have particularly negative influence on biocompatible materials.

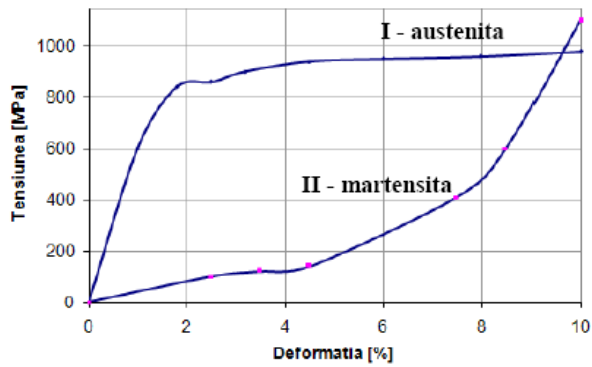


Fig. 1 Curves of a Ni-Ti type alloy with 10% Cu

In Figure 1, the alloy with 5% Cu, shows a strain variation in the austenitic state, very close to the strain level of the alloy with 10% Cu content.

In case of stress-strain curves obtained in martensitic state, there are an important difference between alloys.

If the maximum strain in the alloy with 5% Cu in the martensitic state is almost 4, 8%, in case of alloy with 10% Cu in martensitic state is about 8,7%. This behaviour requires prudence in these Ni-Ti-Cu alloys utilization because the shape memory effect can has a negative impact on human tissue.

3. CONCLUSION

The results from experiments shows that the Ni-Ti can has a good properties if the Cu content are in the range of (5-10)%. Future work will also include Cu-Ni-Ti or Ni -Ti-Nb alloys in order to find some interesting properties especially for biocompatible applications.

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