Structural characteristics of TiNi alloys after thermal treatment

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Shape memory alloys based on NiTi, commonly known as "Nitinols", are nowadays successfully used in different areas of the medicine, as for instance plates and nails in traumatology, vascular stents, surgery catheters, root canal instruments or orthodontic braces. Other properties, in addition to the shape memory behaviour, are also very good corrosion resistance, biocompatibility, advantageous strength/density ratio or high damping ability. The shape memory effects and superelastic behaviour of Ni-rich NiTi alloys, it means more than 50.6 at% Ni, are significantly dependent on microstructural modification provided through heat treatment. It is generally known that thermal treatment of Ni-rich NiTi alloys induces diffusion processes that lead to precipitation of different phases: metastable Ni_4Ti_3, metastable Ni_3Ti_2 or stable Ni_3Ti. Owing to an appropriate thermal regime the austenite-martensite transformation temperatures can be modified.

These and other microstructural changes can have a major impact on the martensitic transformation in NiTi alloys and, essentially, on the transformation temperatures. In addition, the precipitation of secondary phases can also contribute to a substantial increase in the strength of NiTi alloys. Another critical factor affecting the properties of these materials is the composition.

The experimental samples of NiTi alloy with 50.7 at% Ni were subjected to heat treatment. The thermal regimes consisted of aging treatment at 300, 350 and 400 °C for 30 minutes followed by air cooling. The microstructures before and after the heat treatment were observed by optical microscopy. The study was completed by microhardness measurement and X-ray analysis. The obtained results show that the aging temperatures led to microstructural and microhardness changes for the investigated alloy.

This work has been elaborated in the framework of the Projects: No. FV40306 "Development of new implants for correction of angular pediatric deformities in sterile design", supported by the Ministry of Industry and Trade of Czech Republic; RRC/10/2017 "Support for Science and Research in the Moravia-Silesia Region 2017", financed from the budget of the Moravian-Silesian Region; SGS projects SP2019/128 and SP2019/43, financed by Ministry of Education, Youth and Sports of the Czech Republic.