Effect of heating and mechanical strain on a nickel-titanium alloy

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The transformation of austenite-martensite phase, in the shape-memory NiTi alloy, is a non-diffusive process involving solid phases and it occurs at very high speeds. This transformation can be explained by the difference of free energy which exist among the structures involved in the process and therefore induce modifications in the chemical bonds and in the crystallographic nature. This new arrangement main characteristic is: temperature dependence and property of reversibility. In these alloys, the small variations in temperature or mechanical stress causes the nickel and titanium atoms to move from their original positions, changing the lattice. Depending on the chemical composition, temperature and mechanical stress alloys exhibit super-elastic or thermal active behavior. Currently these alloys are imported and the technological challenge is a fabrication process with chemical composition control of the typical microstructure associated with the austenite-martensite transformation. The objective of this research was to fabricate the nickel-titanium alloy using an electric arc furnace with controlled atmosphere. On the melting load preparation was used nickel-titanium scrap alloy from orthodontic wires. In the case of nickel-titanium alloy melted in the temperature range from 1200 to1300 ° C, the oxygen percentage is critical because of the titanium´s poor oxidation stability. After pouring the material in a copper mold in the form of a semi-sphere, alloy samples were prepared and rolled at different temperatures. Assessments in the effects of temperature and mechanical deformation were made by using Vickers microhardness testing and microstructure analysis before and after processing. Preliminary analysis with differential calorimetry technique suggests the possible formation of the austenitic phase TiNi accompanied by the intermetallic Ti3Ni4 and TiNi3 during the heating. It has been observed in various grains a typical strain-induced martensite formation. These results are certainly a huge contribution to the knowledge regarding the microstructure and the effects of mechanical conformation on a nickel-titanium alloy. [1]

Keywords: Shape memory, NiTi alloy, super-elastic, orthodontic wires.

[1] MARIANI LUCAS DOS SANTOS, C. Ligas Ni-Ti ricas em Ti Tratamento Térmico, Termomecânico e Efeito de Micromemória de Forma. 2006. Tese (Doutorado em Ciências dos Materiais) – Instituto Militar de Engenharia, IME, Rio de Janeiro, 2006.

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