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Heat Treatment and Eletrothermal annealing Effect on the R-phase Evolution in Ti-Ni Alloys

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Abstract – Large changes might be induced in shape memory response by variation on Heat treatment and electric resistance treatment applied to the material. This paper uses calorimetric technique and electric resistivity to studies the comparison between samples heat treated and submitted to direct current. The R-phase precipitates are sensitive to annealing and recrystallization process inducing modifications in stress fields between matrix and precipitates. The main objective of this study is to understand R-phase and martensitic transformation in Ti-Ni wire defining an electrical current interval to industries applications.

Ti-Ni alloys are among the most important and studied functional elements. This element exhibits the shape memory effect and the superelastic effect. Many studies on strain recovery in equiatomic alloys are developed to obtain actuators used in many engineering or medical applications. R-phase transformation presence, induce interesting modification on martensitic transformation and theses modification are wildly study with the aim to completely understand its mechanism.

In this paper as-received Ti-50,2%Ni wire is submitted to heat treatment at 500ºC for 24 hours and culling in water at 25ºC and then to Eletrothermal annealing with electrical current of 2,5A and 3A for 1, 2, 4 and 8 hours. These procedures can induce modification in martensitic transformation. This modification can be observed by temperature transformation alteration. Research already developed on R-phase transformation observed in Ti-Ni alloys discovered that rich-Ni alloys, thermal cycling and ageing may induce R-phase transformation in material. Samples annealed form precipitates like Ti_3Ni_4 witch is involved with R-phase transformation [1,2].

Calorimetric curve in figure 1 show the temperature transformation for material heat treated at 500ºC. The 24 hours homogenization makes transformation in one single step as can be see in figure 1. Temperature transformation obtained by this procedure is 39ºC and 26ºC as start and finish martensitic transformation and 57ºC and 73ºC as start and finish austenitic transformation. X-ray diffraction analysis in sample heat treated showed in figure 2 reveals same of the precipitates observed in annealed Ti-Ni alloys. Ti_3Ni_4 precipitate responsible for R-phase transformation is revealed in diffraction, but R-phase transformation peak is not observed in DSC calorimetric curve.

R-phase precipitates and the stress field generated with the matrix is responsible for R-phase transformation. The density of this precipitates is important for material to exhibits the pre-martensitic transformation. Ageing induced by heat treatment and eletrothermal annealing reduce the precipitates in material. These procedures start decomposition in to precipitates less involved with R-phase transformation.

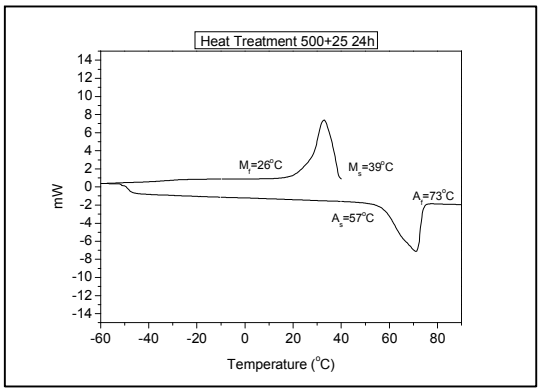

Figure 1: Calorimetrical curve for sample heat treated at 500T

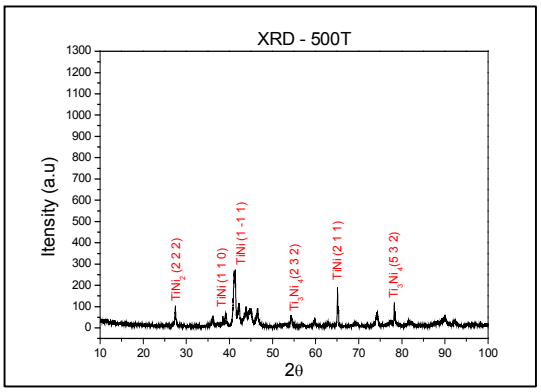

Figure 2: X-Ray diffraction results for sample heat treated at 500T

References

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