Aging treatment of forged wires of NiTi (Ni-rich) alloy for superelastic applications.

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Introduction

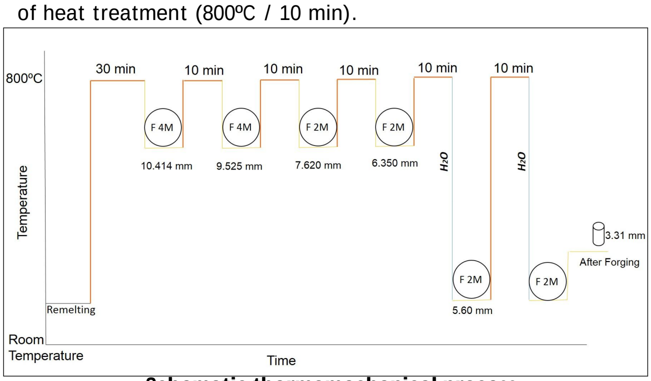
NiTi alloys with shape memory effect, superelasticity properties and further specific characteristics can only be developed under a process with a rigorous control on the production process during the steps of fusion, refine, thermal and mechanical treatments (1). The factors that can affect the material's structure and its shape memory behavior or superelasticity at a given work condition, are: thermal and thermomechanical treatments; Ni and Ti content; incorporation of alloying elements; presence of impurities (Carbon and/or Oxygen) and transformation temperatures. Therefore, it is mandatory to control the chemical composition and thermomechanical treatment's conditions (2,3).

The present study aims to understand the influence of aging treatment in obtaining an austenitic structure at room temperature, into a wire of a Ni-rich NiTi alloy, produced by rotary forging. Additionally, the phase transformation temperature behavior and its mechanical response to facilitate the superelastic properties at room temperature will be evaluated. Thus, it is expected that this material exhibits superelastic conditions, the presence of austenite at room temperature, and body temperature (Af < Tamb).

Materials and Methods

Material: An ingot with approximately 49.2%at of Ti and 50.8%at.

Processing: The whole material was subdivided into smaller samples of approximately 90 g each. After the recast process, the samples passed through a rotary forging thermomechanical process, which started with hot forging (A to D), followed by cold forging (E and F) in the final sequences with interspersed stages of heat treatment (800ºC / 10 min).



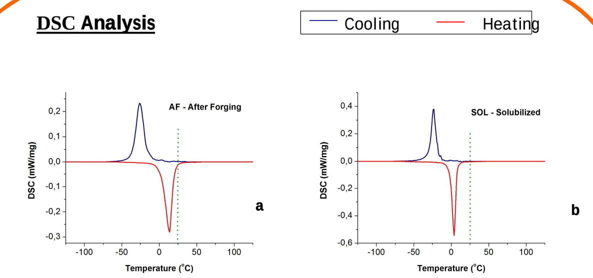
Schematic thermomechanical process

Methods: DSC: Differential scanning calorimetry, hardness and ultramicrohardness test.

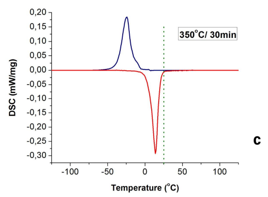
Samples: AF-After Forging; SOL-Solubilization processing conditions of 950°C for 120 minutes; Aging at 350ºC, 400ºC and 450ºC for 30 minutes.

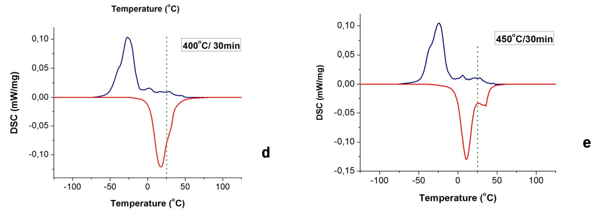
Results

DSC Analysis



Samples	Af
AF	20,1ºC
SOL	10,8ºC
350ºC/30min	20,0ºC
400ºC/30min	37,5ºC
450ºC/30min	39,6ºC

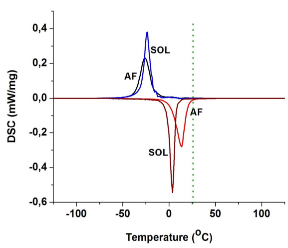


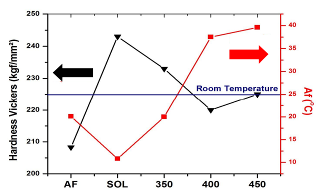


DSC Curves - a) AF - After forging; b) SOL - Solubilized at 950ºC for 120 minutes. Aging temperature (30 minutes soaking time): c) 350ºC, d) 400ºC, d) 450ºC.

Conclusions

It was observed that solubilization at 950°C for 120 minutes with cooling in water at room temperature resulted on a fraction of the B2 phase at room temperature when compared with forging final sample (initial sample), showing a higher value due to an efficient homogenization in the matrix.





The red line shows the values of the austenitic transformation, the black line shows the values of hardnesS. The blue line shows room temperature.

An assessment carried out at room temperature reveals that the sample treated at 350 ° C for 30 min presents an Af below the room temperature and suitable hardness value. Thus, it is possible to predict that this working conditions are the most suitable when the goal is to obtain austenite at temperatures ranging from 33ºC to 37ºC.

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