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Electrical Resistivity and DSC measurements of phase transformation temperatures in Ni-Ti shape memory alloys

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Abstract –The phase transformation temperatures in a Ni-Ti shape memory alloy before and after thermomechanical treatments were evaluated by differential scanning calorimetry and electrical resistivity measurements. The aim was to achieve a better understanding of the transformations that occurs in this type of alloys in order to control the shape memory effect and project new technological applications.

Nickel-Titanium shape memory alloys have been continuously studied because of their great shape recoverability and superior mechanical properties. The applications of this material are conditioned to the phase transformation temperatures in which the material recovers its original shape after being apparently plastically deformed. The temperatures in which these transformations occur depend on factors such as the Ni content, aging and thermo-mechanical treatments [1]. Such factors will also define how many steps the transformation will have upon heating or cooling: austenite B2 (ordered bcc) ↔ martensite R (trigonal) ↔ martensite B19' (monoclinic), or only martensite B19' ↔ austenite B2 [2]. In this work, a Ni-Ti alloy approximately equiatomic, in wire shape with 0.7mm diameter, was studied. Differential scanning calorimetry (DSC) and electrical resistivity measurements were carried out in non-deformed and tensile deformed samples, in order to determine the shifts in the phase transformations temperatures that occur in the alloy. Both methods were effective to the purpose of identifying the occurrence of phase transformations, as shown in Figures 1 and 2 for a non-deformed sample. They present similar results for the beginning and end of the B19'↔R and R↔ B2 transformations. With the introduction of tensile deformation, however, the reverse transformations overlap in the DSC curves and an accurate analysis of the electrical resistivity curve was made necessary.

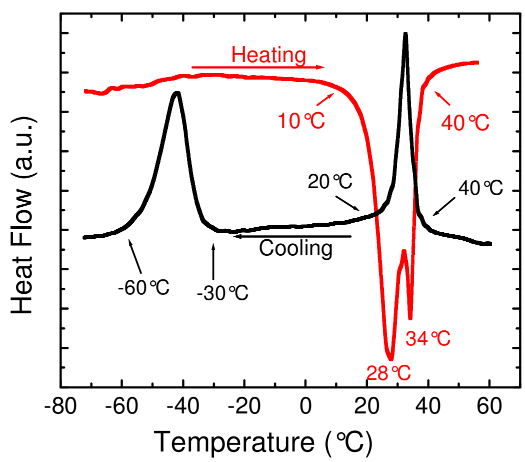

Figure 1: DSC curve of a non-deformed near equiatomic Ni-Ti alloy upon cooling and heating.
Cooling: R_s=40℃, R_f= 20℃, M_s = -30℃, M_f = -60℃.
Heating: A_s = 10℃, A_f = 40℃.

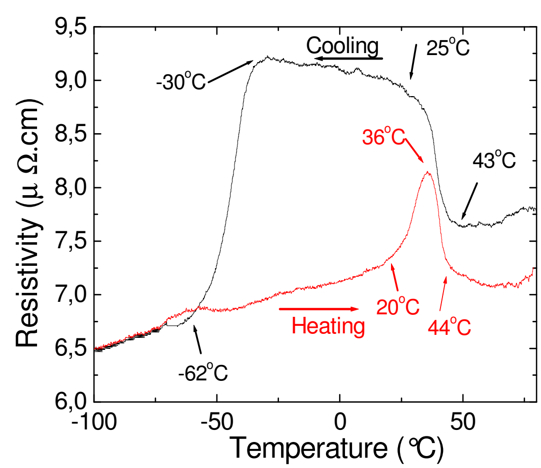

Figure 2: Electrical resistivity curves of the same Ni-Ti alloy.
Cooling: R_s=43℃, R_f= 25℃, M_s = -30℃, M_f = -62℃.
Heating: A_s = 20℃, A_f = 44℃.

References

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