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THERMODYNAMICS OF THE PHASE TRANSITION IN NiTi ALLOYS

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Abstact: NiTi alloys, widely known for shape memory effect and pseudoelasticity, require stable, reliable properties with thermal cycling through the transformation temperatures range. Transformation cycling is here adopted to investigate specimens corresponding to different start physical states.

1. Introduction

Transformation temperatures, the thermal hysteresis cycle width and thermodynamic properties are critically dependent upon parameters as stoichiometry, thermomechanical treatment and aging, which can induce thermal instabilities. Thermal cycling through M<->P can settle the requested stability allowing alsoever to follow the transformation temperatures evolution.

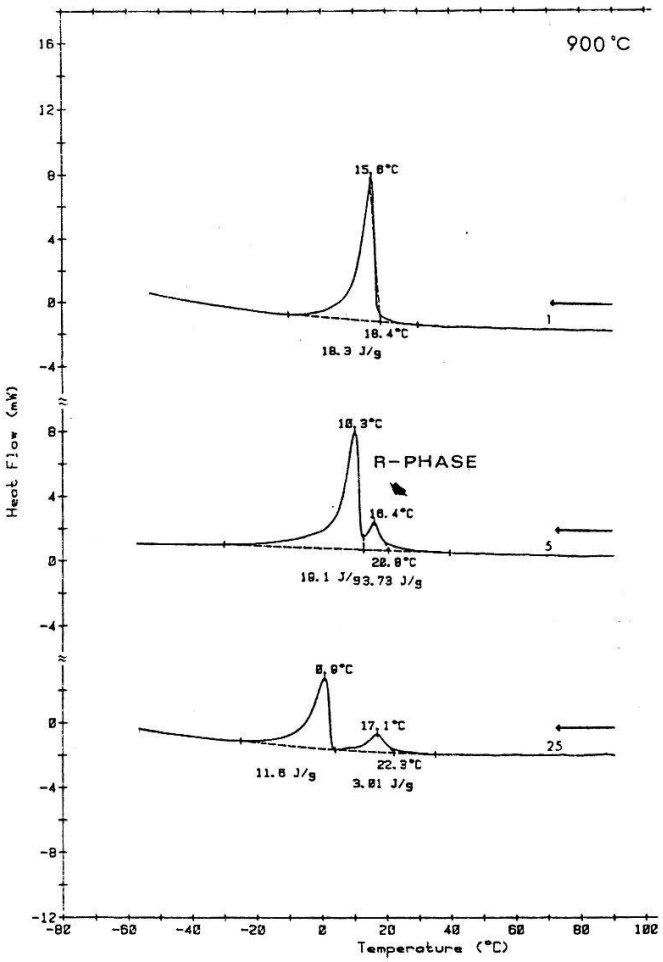
2. Experimental

NiTi alloys with different compositions are examined. Two different thermal treatments under vacuum are investigated: aging 1h at 500 C or annealing 1h at 900 C. Both are followed by water quench. Resistance and calorimetry (DSC) measurements are performed as already specified (1).

3. Results

Annealed specimens at 900C generally present instabilities. Thermal cycling through M<->P introduces dislocations (2) which, once reached a saturation density, promote stability. This is well depicted in fig.1 where the 1st, 5th, 25th DSC scans on cooling are plotted. P->M transformation temperatures reach a stationary value after approximately 20 cycles. Dislocations built up with cycling however modify the local internal stress fields, promoting at the same time,the appearance of an intermediate rhombohedral R-phase (3).

The aging treatment at 500 C promotes a P->R step well separated from R->M as shown in fig.2 and does not induce instabilities in transformation temperatures under thermal cycling.



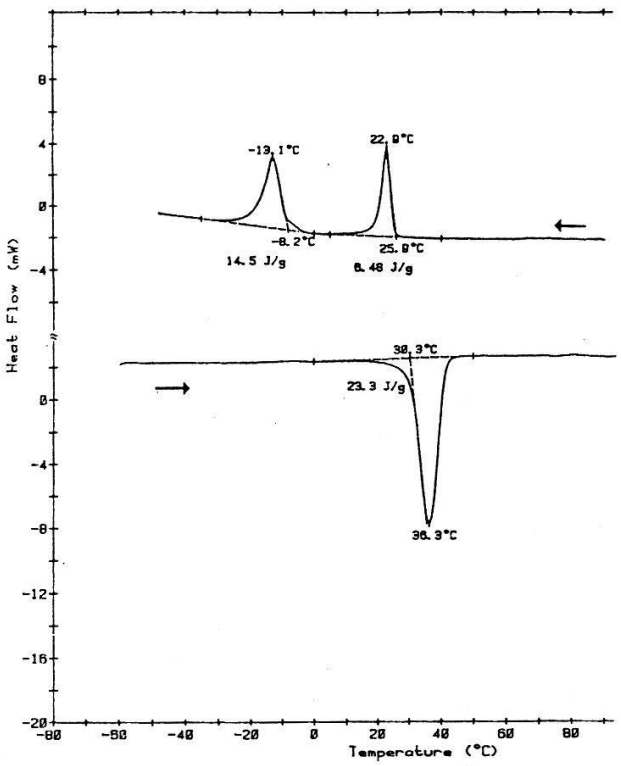


Fig.2-Cooling and heating DSC scans for a specimen aged at 500 C.

Fig.1-1st,5th,25th, DSC scans on cooling for annealed specimen

3. Conclusions

Thermal instabilities in NiTi system introduced by an annealing treatment can be overcome by thermal cycling through M<->P. A short aging treatment at 500 C is apt to separate the R-phase step from martensite without inducing instabilities in transformation temperatures.In NiTi system, calorimetry seems a viable method to check specimen chemical composition.

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5. References

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