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THERMAL EXPANSION AS A FUNCTION OF PHASE TRANSITION CYCLING IN NiTi ALLOYS

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Abstract: Uniaxial thermal expansion embodies the chief property to be mastered in shape memory alloys.
Uniaxial thermal expansion measurements through the hysteresis cycle are performed on NiTi alloys corresponding to different start physical states, both stress-free and under static applied stress. Evidence of a two steps process, corresponding respectively to the R-phase and to the martensite phase, is obtained.

1. Introduction

Shape memory properties of NiTi alloys stem from a first order transition from a b.c.c. parent phase(P) to a monoclinic martensite phase(M): in some case (1,2) evidence of an intermediate rhombhoedral(R) first order transformation can be obtained.
Evidence of both transformations is here given investigating the thermal expansion through the hysteresis cycle M<=>P, stress free or under a static stress state.

2. Experimental

NiTi examined correspond to two different thermal treatments(TT): annealing at 900C(1h) + aging at 500C(1h), or simply aging at 500C. Both TT are followed by water quench.
Uniaxial thermal expansion was detected in the range -80C/+120C by an Instron equipment. Differential Scanning Calorimetry (DSC) was performed in the same temperature range, as previously specified (1).

3. Results

Aging treatment: the R-phase, though present in DSC scans,

does not influence the thermal expansion hysteresis cycle. Specimens evidence a dilatation step on cooling and a contraction on heating, both stress free and under stress.
Annealing+aging: the R-phase, separated from martensite of about 75C, appears on the hysteresis cycle of thermal expansion. Stress free specimens evidence two contraction steps on cooling and the reverse on heating. Under progressively increasing static stress the contraction step modifies into a dilatation step, at 25MPa.

4. Conclusions

The start physical state can drastically modify the behaviour of thermal expansion through the hysteresis cycle of NiTi alloys.
Aging at intermediate temperatures leads to precipitates in the matrix (3) which modify the internal stress field.
R-phase can be exploited provided it is well separated from M-phase on the temperature scale.

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5. References

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