Introduction

A functionally graded shape memory alloy was investigated by thermal, mechanical, thermomechanical and structural analysis, namely using in-situ synchrotron-based x-ray diffraction during cyclic tensile load/unload. Diffraction patterns were recorded under applied stress during the stress-induced martensitic transformation, analyzed and interpreted in view of the evolution of microstructure. The phase transformations temperatures were determined by DSC analyses. The thermomechanical behavior was analyzed by three-point bending test. The present study focusses on the localized heat treatment (Joule heat effect) of NiTi wires, using an equipment that gives a large variety of graded treatments [1]. Structural, mechanical and thermomechanical characterization is presented in order to get a perspective of the optimization parameters for the adequate graded functionality.

Experimental results

Figure 1 – XRD analysis of wire heat treated at 300 °C for 10 min:

- a) scan along the gauge length;
- b) Superelastic cycle.

XRD analysis showing the structural evolution of the central point of the gauge length during full superelastic cycle:
- c) 3D plot;
- d) contour plot.
The modified Dilatometer Bähr DIL 805 A/D at the HEMS (P-07, PETRA-III, DESY) has been used to characterize the structural evolution during a full superelastic cycle. Before the tensile test, a full scan of the gauge length was made (Fig. 1-a). Two types of experiments have been carried on during a full load/unload cycle: (i) with the X-ray beam was always hitting the central point of the gauge length (Fig. 1-c,d), (ii) at previously defined points, the load/unload cycle was interrupted and the full gauge length has been scanned (Fig. 2).

**Conclusion**

The preliminary scan along the full gauge length identified the functional gradient created by the localized heat treatment with a clear presence of the R-phase at the central region and the occurrence of two steps for the stress-induced transformation plateau.

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**References**