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**Validation of a Multiscale Modeling
of Thermomechanical Behavior of Shape Memory Alloys
thanks to in-situ X-Rays Diffraction**

M. Daro Fall, K. Lavernhe-Taillard, A. Maynadier, O. Hubert

LMT Cachan

The increasing use of Shape Memory Alloys (SMA) for complex applications requires a robust modeling of phenomena governing their behavior. The development of micro-macro multi-axial model is relevant. Such approach relies the definition of transition scale rules, depending on the microstructure of the studied material, and an appropriate description of the behavior of constituents. On the other hand, it requires experiments for identification of parameters such as enthalpies or kinetic constants and validation of the model. This second point is addressed.

A multiscale model is proposed relevant for multi-axial stress and thermal loading in a pseudo reversible framework. The first scale involved for which homogeneous state can be considered is the variant scale. Indeed the model is based on the comparison of the free energies of each variant and calculation of associated volume fractions thanks to a probabilistic approach. The intermediate scale is the single crystal scale. Averaging operations allow calculating the macroscopic quantities at the polycrystalline and final scale.

A texturized nickel-titanium SMA is considered, exhibiting both martensitic and R-phase transformation. Differential Scanning Calorimetry and tensile tests have been conducted for identification purpose. In situ X-Rays Diffraction (XRD) measurements are performed during tensile tests and heating-cooling cycles to validate the modeling. XRD permits monitoring of the average volume fraction of phases in presence. Its operation requires the coupling of the multiscale, diffraction pattern and geometric diffraction apparatus models. Comparison of the diffratograms either experimentally obtained or model predicted leads to conclude about the model quality and points to improve.