STRAINS, TEXTURES AND MICROSTRUCTURES GENERATED BY MARTENSITIC TRANSFORMATIONS TAKING PLACE UNDER EXTERNAL STRESS IN NITI SHAPE MEMORY ALLOY WIRES

PETR SITTNER

Although superelastic NiTi shape memory alloy wire displays very high resistance to plastic deformation in austenite and martensite phases, incremental plastic strains are recorded whenever the cubic to monoclinic martensitic transformation (MT) proceeds under external stress leading to functional fatigue degradation. Therefore, special closed-loop thermomechanical loading tests were performed to shed light on the mechanism by which the incremental plastic strain are generated. Recoverable transformation strains and plastic strains generated by separately the forward and reverse martensitic transformation (MT) were evaluated, martensite variant microstructures in grains of the cooled wire were reconstructed by nanoscale orientation mapping in TEM and martensite textures were evaluated by high energy x-ray diffraction.

The experiments revealed that both forward and reverse MTs occurring above certain stress thresholds generate plastic strains specific for the [temperature, stress] conditions under which the MTs occurred. While the forward MT upon cooling does not produce plastic strain or permanent lattice defects up to 500 MPa stress, the reverse MT upon heating starts to generate them from 100 MPa. While plastic strain generated by the forward MT merely elongates the wire, plastic strain generated by the reverse MT also reduces the recoverable strain. The characteristic thresholds and magnitudes of plastic strains generated by the forward and reverse MTs define the functional fatigue limits for specific NiTi wires.