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Nucleation and Motion of Phase Boundary in Shape Memory Alloy Microtubes

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Experimental phenomena and deformation mechanism of helical-type martensite band nucleation and propagation in superelastic NiTi SMA microtube under tension and torsion are investigated using a continuum theory. A simple constitutive relation with intrinsic strain softening is employed to approximate the material behavior during stress-induced transformation. 3D FEM simulation of the tube is performed and a combined analytical-experimental approach is used to extract the constitutive parameters of the material from the experimental measurement. The observed phase boundary motion and deformation patterns are clearly reproduced in the simulation. The results demonstrated that both material and geometric instabilities are responsible for the observed martensite band nucleation and growth. Compared with previous investigations, the issue of mesh sensitivity is demonstrated and addressed in the present simulation, which needs to be solved by a non-local constitutive theory in the future investigation where the interface free energy is taken into account.

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