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PROCEEDINGS

Enhancing Functional Stability of NiTi Tube for Elastocaloric Cooling Through Overstress Training

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ABSTRACT

Tubular NiTi is a promising candidate of eco-friendly solid-state refrigerant for elastocaloric cooling, but the severe functional degradation of NiTi material during cyclic phase transition (PT) is a key concern in the technology development. Here, plastic deformation of 6.7% is applied on the NiTi tube by overstress training under 1900 MPa for five cycles to improve the cyclic PT stability without losing cooling efficiency. It is found that after 106 compressive cycles under an applied stress of 1000 MPa, the overstress-trained NiTi tube exhibits small residual strain (0.5%), stable adiabatic temperatures drop (T=11K) and improved coefficient of performance (COP reaches 55), showing great potential for elastocaloric refrigeration. TEM observations show that the microstructure of the overstress-trained NiTi tube consists of 5-10 nm austenite (B2) and martensite (B19′) nanodomains with near-saturated dislocations ($\rho \approx 5.153\times10^{16}$ m^{-2}). Such dislocation-enriched nanostructure effectively suppresses the further formation and motion of dislocation during the subsequent cyclic compression, thereby significantly enhancing the cyclic stability of the NiTi tube. The residual B19′ nanodomains and dense dislocations change the PT mode from the nucleation-growth of the B19′ phase to the direct growth, reducing the dissipation of the PT process and thus improving the COP of the NiTi tube. Our study provides an economic and effective method for ameliorating the severe functional degradation of bulk NiTi tubes used in solid-state refrigeration.

KEYWORDS

NiTi shape memory alloy; functional stability; elastocaloric effect; dislocation; residual martensite

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