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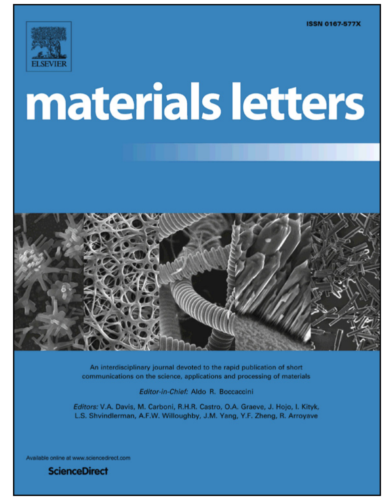

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Effects of grain size on compressive behavior of NiTi polycrystalline superelastic macro- and micropillars

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Abstract

Polycrystalline NiTi pillars of 0.5 μm diameter and 1.5 μm height with average grain sizes from 10 to 421 nm are fabricated by focused ion beam and compressed by nanoindentation. It is found that stress-strain hysteresis loop area, transformation stress and transformation strain vary non-monotonically with grain size. Analysis of the results reveals that increasing the grain size from 10 nm enhances the transformation by promoting the nucleation and growth of martensite domains. When the grain size approaches the pillar size, the transformation is suppressed by an increase in granular constraints and heterogeneity of internal stress-strain state among large grains.

Keywords:

Size effect; Shape memory alloys; Martensitic phase transformation; FIB; Nanoindentation.

1. Introduction

Unique properties of NiTi shape memory alloys (SMAs) have made them a suitable candidate for a wide range of applications from aerospace engineering to medical devices and microelectromechanical systems[1]. Recent research shows that grain size (GS), as one of the key microstructural internal length scales, plays an important role in controlling the transformation stress (σ_{tr}), transformation strain (ε_{tr}) and hysteresis loop area (H) or damping capacity of SMAs. Decreasing GS down to nanoscale causes a significant decrease in mechanical energy dissipation of the material (H) by changing the transformation mechanism[2,3]. Application of SMAs in nano- and microelectromechanical systems[4] involves a considerable reduction of external length scale of SMA

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