

# Supplementary Material to "Realization of large low-stress elastocaloric effect in TiZrNbAl alloy"

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## Supplementary caption:

The Supplementary Materials contain the effect of mechanical training on superelasticity, the room-temperature phase distribution, and the temperature dependence of transformation strain across martensitic transformation of the Ti-19Zr-14Nb-1Al (at.%) alloy.

## Contents:

SI: Effect of mechanical training on superelasticity.

SII: Room-temperature phase distribution measured by EBSD.

SIII: Temperature dependence of transformation strain across martensitic transformation.

SIV: Reference.

## I. EFFECT OF MECHANICAL TRAINING ON SUPERELASTICITY

Fig. S1 shows the cyclic stress-strain curves of the 1Al alloy. The critical stress  $\sigma_{cr}$  of superelasticity decreases drastically during the first several cycles and then gradually tends to be stable. This phenomenon, known as the mechanical training effect [1], has also been observed in TiZrNbSn [2], TiNbZr [3] and TiNbMo [4] alloys. After the mechanical training, the 1Al alloy exhibits perfect superelasticity with high stability.

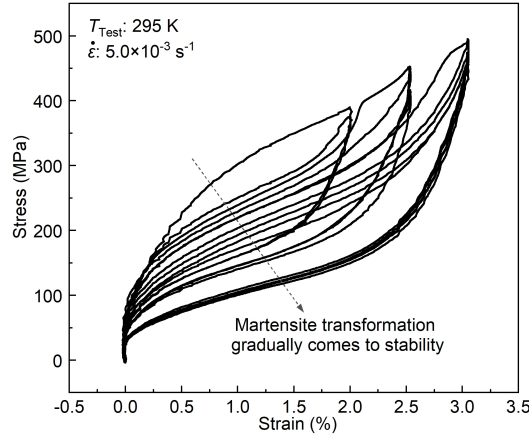


FIG. S1. Evolution of stress-strain curves during 10-cycle mechanical training. At the 1<sup>st</sup>-2<sup>nd</sup>, 3<sup>rd</sup>-5<sup>th</sup> and 6<sup>th</sup>-10<sup>th</sup> cycles, the applied strain gradually increases from 2.0% to 2.5% and 3%.

## II. ROOM-TEMPERATURE PHASE DISTRIBUTION MEASURED BY EBSD

Fig. S2 shows the phase distribution map of the 1Al alloy measured by the EBSD technique at room temperature. Clearly, the alloy is composed of a single austenite phase at room temperature, and no martensite phase is detected.

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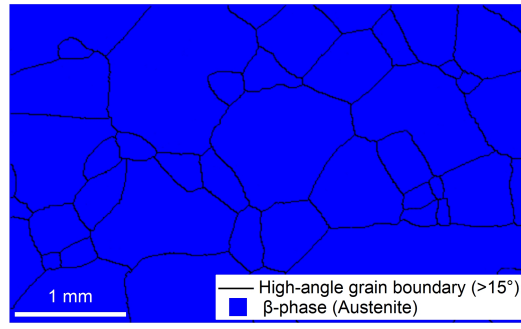


FIG. S2. **Phase distribution map of the 1Al alloy.** The blue area represents the  $\beta$ -phase (austenite). The black lines represent the grain boundaries with a misorientation angle larger than  $15^\circ$ .

### III. TEMPERATURE DEPENDENCE OF TRANSFORMATION STRAIN ACROSS MARTENSITIC TRANSFORMATION

Fig. S3 shows the temperature dependence of transformation strain ( $\Delta\epsilon_{tr}$ ) of the 1Al alloy.  $\Delta\epsilon_{tr}$  varies slightly within the temperature range of 255 K to 355 K, reaching its maximum at 355 K. When the testing temperature is below 255 K or above 355 K,  $\Delta\epsilon_{tr}$  significantly decreases.

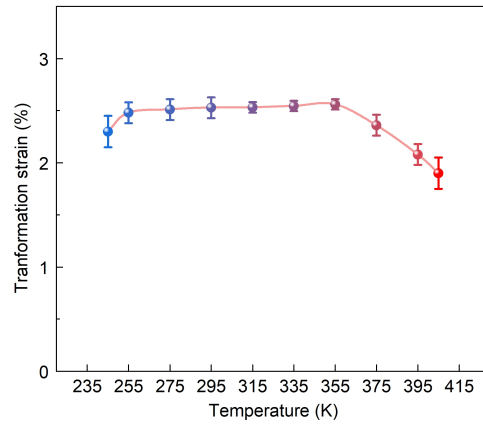


FIG. S3. **Temperature dependence of transformation strain of the 1Al alloy.**

### IV. REFERENCE

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- [1] Feng X Q, Sun Q. Shakedown analysis of shape memory alloy structures, *International Journal of Plasticity*, 2007, 23(2): 183-206.
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