Chapter 3

Modeling of the Two-Way Shape Memory Effect

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Additional information is available at the end of the chapter

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Abstract

The shape memory alloys (SMA) are distinguished from other conventional materials by a singular behavior which takes many forms depending on the thermomechanical load. The two-way shape memory effect is one of these forms. The interest that exhibits this behavior is that the material can remember two states, so this leads to many industrial applications. This thermoelastic property is driven by the temperature under residual stress of education. To model this effect in 3D, we considered stress and temperature as control variables and the fraction of martensite as internal variable; choosing Gibbs free energy expression and applying thermodynamic principles with transformation criteria have permitted to write the constitutive equations that control this behavior. The constructed model is then numerically simulated, and finally, the proposed model appears applicable in engineering.

Keywords: two-way, simulation, hysteresis, transformation

1. Introduction

Shape memory alloys (SMA) as they are called are a kind of particular materials which have a singular behavior, they can be largely deformed (about 10%) under an applied mechanical, a simple heating is sufficient to recover the previous form, that is why they are called that way.

By varying controlled parameters (stress and temperature), these alloys can exhibit other properties like pseudoelasticity, two-way shape memory effect, one-way shape memory effect [1, 2], and reorientation effect [3].

These properties derive from phase transformations, i.e., higher temperature phase (austenite) to lower temperature phase (martensite).