A Variational Model for Microstructural Evolution in Shape Memory Alloys

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Shape memory alloys (SMAs) have been extensively used in sensors and actuators. Their behavior is dominated by the microstructures. However, due to high nonlinearity of the material, the relationship between the overall response and microstructural evolution has not yet been revealed. In this study, a variational model is developed to capture the dissipative nature of interface motion in microstructures when phase transformation occurs. Microstructural transitions from one type of laminate pattern to another are also included in the model. The model is applied to study superelasticity effect in Cu-Al-Ni single crystals subjected to a variety of loads. The results are compared with those in the literature, having good agreement. The current numerical model can provide guidelines to engineer the microstructures and to optimize the performance of the applications of SMAs.

Keywords: Shape memory alloys, Microstructures, Superelasticity, Variational principle.