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Elastocaloric effect and local temperature evolution associated with structural transformation in superelastic alloys: A phase-field study

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ABSTRACT

The elastocaloric effect in superelastic materials is an important physical property and opens up new routes for solid-state refrigeration. Phase-field method is used to investigate the elastocaloric effect associated with the stress-induced martensitic transformation in shape memory alloys. The simulated results confirm that the adiabatic temperature change (ATC) is closely related to the loading style, temperature, and strain rate, which helps optimize the processing device and technology so as to obtain the maximum ATC. The temperature gradient of the system is found to decrease during the structural relaxation, and the direction of thermal fluent is connected with the immigration of martensite/parent interface instead of martensitic twin boundary. The local temperatures around martensite/parent interface and twin boundary have been studied and compared. The distribution of internal stress during the phase transition is calculated and found to be temperature dependence and microstructure dependence. Interfacial stress wave and interfacial thermal stress are important for the nucleation and growth of martensite as well as the self-accommodation of martensitic variants.

KEYWORDS: elastocaloric effect, martensite transformation, superelastic materials, interfacial stress, phase field method