Computational Analysis of Stress-induced Phase Transformation of Shape Memory Alloys

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Shape memory alloys exhibit the ability of the shape memory effect and pseudo-elasticity effect. The shape memory effect for their original shape is related with temperature state, and pseudo-elasticity effect is related with loading state. The temperature change induces a phase transformation from the austenite to martensite phase. This phase transformation involves the crystal-lattice rearrangement that includes additional elastic energy from the original structure and it produces the unique structural morphology, which is called twinned structure. Furthermore, shape memory alloy experiences the detwinning process related with the pseudo-elasticity effect, which can be represented to the structural transition with the loading and unloading states. Here, for a systematic understanding of the overall phase transition, a computational model is developed based on a phase field approach, which incorporates the effect of temperature and elastic fields.

Keywords: Phase field model, Shape memory alloy, Martensitic phase transformation, Temperature field, Elastic field