General Design Considerations for the Thermally Triggered SMP Composites with Internal Heating

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Abstract: Shape memory polymers (SMPs) are a group of adaptive polymers that can recover the permanent shape from one (or sometimes multi) temporary shape (s) when a proper stimulus is applied. Among a variety of external stimuli for polymer actuation, temperature is the most commonly used. However, due to slow heating rates, recovery of this type of SMP is usually slow. Towards to improve the heating rate, many efforts have been made by using novel heating methods. Among them the most popular way is embedding internal heating sources to volumetrically activate the SMPs. In this study, we use a three dimensional (3D) constitutive model to analyze the thermomechanical characteristics of two types of SMP composites: reinforced by magnetic particles that is activated by a magnetic field and by a microvascular system that is heated/cooled by the flow of water. The finite element simulations revealed some considerations should be followed in designing such SMP composites. In particular, the influences of filler size, volume fraction, heating temperature and rate to the shape recovery behavior were studied. The results in this paper provide a meaningful guidance for further designs and applications of such thermally triggered SMP composites.

Keywords*: Shape memory polymers; Polymer composites; Microvascular systems*