Making Smart Materials Smarter?

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Innovative Processing Technologies

Continued advances in shape memory alloys (SMAs) have facilitated their implementation in countless applications including aerospace, automotive, medical and micro-electromechanical systems (MEMS) devices. The ability of SMAs to ‘remember’ a shape has largely accounted for its popularity and classification as a smart material. Their inherent diffusionless solid-state phase transformation experienced at discrete temperatures is closely linked to the shape memory effects. Until recently, SMAs have been largely limited to ‘remembering’ a single memory. Theoretically, smart materials can be made smarter by locally altering the shape memory effect, which increases the number of memories in a monolithic alloy. The current work details how binary NiTi (Nitinol) alloys are made ‘smarter’ by locally altering phase transformation temperatures. Multiple memory embedment was achieved by exposing NiTi to a high energy density source; predictably preferentially vaporizing nickel to locally alter Ni/Ti ratio. Proof of concept will be demonstrated by embedding additional memories into a monolithic NiTi alloy. Consequently, a novel processing method, called the Multiple Memory Material (MMM) technology was developed.

Possessing the MMM technology promises to enhance SMA functionality while enabling new applications to be realized. It is also envisioned that this processing method can be applied to ternary, or more complex, alloy systems. Future work includes systematically studying the MMM technology, to further enhance the knowledge the process-property-structure relationship.