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EDITORIAL

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Review and perspective in mechanics

In this second article of the Review and Perspective in Mechanics series, we present the work of Professor Dimitris Lagoudas and his team at Texas A&M University on shape memory alloy composite systems. Shape memory alloys represent a class of multifunctional materials whose underlying deformation mechanism is by the reversible, diffusionless phase transformation from austenite to martensite. The process is highly sensitive to the level of stress and temperature. By an intelligent control of the mechanical and thermal loading, a wide range of microstructures can be developed. As such, SMAs are particularly useful for a wide range of applications in sensing, actuation, vibration control, and damping. But precise determination of the material properties as a function of the loading history and, conversely, the control of the loading history to generate the desired material properties, are very complex. This is even more so when SMAs are integrated into a composite system. In this paper, the authors tried to sort out these complex issues first by examining a variety of experimental observations in polymer matrix composites, metal matrix composites, ceramics matrix composites, and SMA matrix composites. They also tried to connect the processing methods to the product properties, and then to their applications. In order to provide a better theoretical understanding, they then presented various modeling methodologies. In this regard, both the bulk SMA models and the micromechanics models such as the Mori-Tanaka, self-consistent, second-order variational method, and full-field computational approach, are also presented. The authors concluded the presentation with their unique perspectives on future fabrication, characterization, and modeling techniques, as well as on the microstructure-sensitive analysis, inverse property determination, and predictive modeling under uncertainty conditions. It is a truly comprehensive presentation on the subject of SMAs and SMA composites.

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