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AM-SMAs-Additive manufactured shape memory alloys

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Additive Manufacturing of Shape Memory Alloys (AM-SMAs) is a novel processing method for those classes of alloys. Shape memory alloys (SMAs) have the unique ability to recover large deformations via either of two material responses: the shape memory effect (SME) or pseudoelastic effect (PE). For SME, deformation is recovered via heating and it is recovered during unloading for PE. NiTi-based SMAs represent the most commercially successful to date. The alloys recover deformations via heating or unloading due to an underlying solid-solid B2-to-B19' martensitic transformation (MT). It is well known that machining NiTi-based alloys is difficult and thus fabricating complex geometries is challenging. For AM, parts are built-up layer-by-layer using laser melting of successively deposited layers of metallic powder. The build path for the layer is set using computer-aided design. The process methodology is similar in principal to rapid-prototyping. Thus AM offers the ability to synthesize near-net shape SMA structures. Moreover, complex geometries with hierarchical structures are possible for AM-SMAs. This presentation investigates NiTi SMAs and utilizes elemental and pre-alloyed powders to deposit material from which experimental specimens are micro-machined. We report on the influence of AM operating parameters and Ni-concentration based on atomic-/micro-structure interrogations and chemical composition in as-deposited samples using differential scanning calorimetry. We report on the SME and PE in AM SMAs and contrast the response of conventional thermo-mechanically processed SMAs. The current systematic characterization advances the understanding of the processing-structure-property relationships for laser-based DDM of shape memory alloys.

Biography

Reginald F Hamilton has completed his PhD in 2008 and Postdoctoral studies in 2010 from the University of Illinois Champaign-Urbana Mechanical Science and Engineering Department. He is currently an Assistant Professor of Engineering Science at The Pennsylvania State University, University Park Campus. He is the Director of the Multifunctional and Adaptive Materials Laboratory at Penn State University. He has published many publications on shape memory alloys and the martensitic transformation in reputable journals.

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