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Extreme Processing of Binary NiTi Shape Memory Alloys

This work explores processing of binary NiTi shape memory alloys (SMAs) in nonconventional ways and the resulting effects on pseudoelastic response. Among the approaches employed are: (1) augmented laser impact welding of the SMA and brass; (2) Taylor impact studies of SMA cylinders; (3) laser powder bed fusion of oxide dispersion strengthened binary NiTi. For (1) and (2), the imposed strain rates exceeding 10^4/s can augment the competition between the stress-induced martensitic transformation, detwinning, and austenite/martensite plasticity. Nanoindentation reveals a 50% increase in hardness and a 50% decrease in hysteresis while maintaining up to 80% recoverable displacement. For (3), nm-scale titanium and yttrium oxides are observed, consistent with an oxide dispersion strengthened structure. Corresponding nanoindentation over a range of temperatures indicates that the oxides may stabilize the response of the binary NiTi at higher temperatures, compared to laser powder bed fusion processing without yttrium oxides. Hypotheses for the observed trends in (1), (2), and (3) are discussed in terms heterostructured SMAs created by extreme processing.

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