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Suspended Droplet Alloying: A New Method for Combinatorial Alloy Synthesis; Nitinol-based Alloys as an Example

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Abstract

A new combinatorial alloy synthesis method (suspended droplet alloying) has been developed as a high-throughput approach for alloy discovery. The method is based on using a laser to melt elemental or alloyed wires fed at a controlled rate to achieve a specific chemistry. In this study, the metallurgical characteristics of alloy buttons created using this technique were assessed for TiNi-based shape memory alloy buttons deposited using pure Ni, Ti, and Cu wires. The microstructural and chemical inhomogeneity was assessed using quantitative electron microscopy and X-ray diffraction. Furthermore, the phase transformation temperatures of the coupons have been compared to cast and heat-treated (reference) samples. In general, the samples displayed a limited local deviation from the target chemistry (±1 wt.%), while displaying a fairly homogeneous microstructure with the expected phase distribution. Post-process homogenisation heat treatments enhanced the phase transformation response, approaching the response obtained from the reference samples.

Keywords: metals and alloys; laser processing; nitinol; combinatorial synthesis

1. Introduction

Intensive research has been performed on TiNi-based shape memory alloys (SMAs) due to their unique ability to recover a specific shape through a martensite ↔ austenite phase transformation, which is temperature-induced in the shape memory effect (SME) or deformation-induced in the superelastic (SE) behaviour [1-3]. Certain alloying elements (e.g. Cu, Hf, Pd, Zr, and Pt) are known to strongly influence either the phase transformation

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