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Powder-Free Method to Develop New Alloys for Additive Manufacturing

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ABSTRACT

Alloy design for additive manufacturing is of great interest because there is much potential in the fabrication of novel microstructures via the rapid solidification in AM. However, alloy design for AM is challenging because of the extremely high cost of fabricating lab-scale powders with customized compositions for testing. In this work, we present a powder-free method for rapid assessment of compositions using arc-melted bulk alloy as test material. The procedure for the alloy design approach is: (1) select candidate compositions, (2) produce arc melted buttons of test compositions, (3) create single tracks of re-melted material via selective laser melting (SLM) over a range of power and velocity combinations, (4) characterize melt pool size and microstructure to select composition/process variable sets that exhibit potentially promising features and (5) fabricate powder of selected compositions to test if good-quality AM parts can be built. Our current work focuses on steps (1)-(4) with a boron modified Ti6Al4V alloy. This alloy consists of a Ti6Al4V matrix with dispersed titanium boride particles. Maps of acceptable process variables and qualitative trends in microstructure were identified. Microstructure length scales (Ti6Al4V grain size, boride size) were refined in the melt pool. Several boride morphologies were observed depending on composition range and process variables. The hardness of the laser-remelted regions was always greater than the arc-melted buttons. Results could be used to provide guidance on selection of compositions for further study.

BIOGRAPHY

Yining He is currently a second-year PhD student in the Materials Science and Engineering Department at Carnegie Mellon University. Her thesis advisor is Prof. Bryan Webler. She received her BS degree in Materials Science and Engineering from Shandong University, China in 2010 and her MS degree in Materials Science from Carnegie Mellon University in 2016.