ADDITIVE MANUFACTURING OF METALS: COMPLEX MICROSTRUCTURES AND ARCHITECTURE DESIGN

Introduction

Yu Zou¹, Hang Yu², Matteo Seita³

¹University of Toronto, Canada

²Virginia Tech, USA

³Nanyang Technological University, Singapore

Additive manufacturing (AM) is a disruptive technology, not only because it enables the production of components with complex geometries, but also because it provides unique opportunities for microstructure control and materials design. In contrast to conventional manufacturing technologies, such as casting, forging, and hot rolling, AM offers additional degrees of freedom to “architect” the material microstructure across many length scales. Owing to this unique capability, both beam-based processes—such as power bed fusion (PBF) and directed energy deposition (DED)—as well as non-beam-based processes—such as cold spray, additive friction stir deposition, and ultrasonic additive manufacturing—unlock new opportunities for tailoring mechanical and functional properties of metals and alloys. Understanding the intricate relationships between these complex microstructures and their consequential mechanical and functional properties is key to developing novel material designs.

In this Focus Issue, *Additive Manufacturing of Metals: Complex Microstructures and Architecture Design*, we highlight research on the microstructures resulting from different AM processes and their impact on the mechanical and physical properties of metallic materials. The issue includes both experimental and modeling works focusing on different materials systems, such as steels, aluminum-, titanium-, and nickel-base alloys, refractory metals, and high entropy alloys. We have also captured a portion of the broad spectrum of research in AM,

from finite element simulations and topology optimization to microstructure characterization and mechanical testing. Many new tools, such as machine learning methods, have become powerful for AM. We hope the readers will find this volume to be a significant collection of papers representing the rapid advancement in the field of metal AM.

We are very grateful to both the authors and reviewers of the many high-quality manuscripts submitted to this *JMR* Focus Issue.

ON THE COVER:

Metal AM offers an additional degree of freedom to “architect” materials microstructure across many length scales. Both beam-based processes—such as power bed fusion (PBF, the cover image) and directed energy deposition (DED)—as well as non-beam-based processes—such as cold spray, additive friction stir deposition, and ultrasonic additive manufacturing—unlock new opportunities for the control of microstructure to achieve unique mechanical and functional properties.

The cover of this Focus Issue illustrates a laser power bed fusion process of stainless steels with microstructure revealed using electron backscatter diffraction. This technology exemplifies the freedom to design complex architectures and materials unleashed by additive manufacturing.

This special issue of the Journal of Materials Research contains articles that were accepted in response to an invitation for manuscripts.