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TMS2024

153rd Annual Meeting & Exhibition

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HYATT REGENCY ORLANDO
ORLANDO, FLORIDA, USA
#TMSAnnualMeeting

SUBMIT AN ABSTRACT FOR THE FOLLOWING TMS2024 SYMPOSIUM:

ADDITIVE MANUFACTURING

Additive Manufacturing of Refractory Metallic Materials

As the metal Additive Manufacturing (AM) technology evolves and is showing itself as a technically and economically viable option for actual component production, the technology boundaries are being expanded towards more challenging materials, like refractory metallic materials, both alloys, and pure metals. As manufacturing involving refractory alloys has been a persistent challenge, the use of additive manufacturing for the production of complex parts presents itself as a potentially economically viable alternative, and for some key applications, AM seems to be one of the few options available. As a consequence, the exploration and development of metal additive manufacturing of alloys based on W, Mo, and Nb, among others, has attracted many researchers and organizations. This symposium allows them to share their work, achievements, and challenges while enabling the researchers and engineers to clearly understand the state of the art, the current limitations, and the path forward.

The growing interest and research activity on AM for refractory alloys has been driven in part by the growing interest in high-performance turbine engines, hypersonic technology for many defense and commercial applications, in addition to space power generation, and the need to implement nuclear propulsion for long-range space exploration. However, many other applications involve these materials, like the production of superconductive resonance cavities for particle accelerators and even quantum computing. Refractory metals present unique inherent challenges like elevated reactivity, low ductility, and of course high melting temperatures.

As a result, the printing of these materials has shown to be quite challenging. For example, W is known for having an elevated ductile-to-brittle transition temperature what makes powder-bed fusion printing of this material a cracking nightmare for the AM practitioners. Developments have been proposed using preheating to elevated temperatures to minimize cracking while printing of refractory alloys, which further enhances oxidation. Other approaches like alloy re-designing and smart thermal engineering during printing could be the solution and several researchers are working on it. Some of the cracking phenomena associated with printing are still unclear and therefore robust solutions have been elusive. Finally, the final obtained microstructures from AM, are unique in several aspects and their influence on performance has also been a matter of study.

This symposium brings together the additive manufacturing community engaged in fundamental and applied aspects of refractory metals printing from industry, government agencies, national laboratories, and university researchers. Topics of interest include, but are not limited to:

- The varied and complex cracking phenomena associated with solidification and solid-state low ductility on the different refractory alloy systems during AM.
- Alloy elements and impurities effect on refractory alloys printability
- Alloy design for improved printability and performance of refractory alloys
- The use of conventional and advanced phase transformation models on the design and optimization of refractory alloys is better suited for different AM processes.
- Relationships between solidification structure, impurities segregation, solid-state crystallographic structure, and defect formation during additive manufacturing and the use of fundamental understanding to propose engineering solutions.
- Modeling and simulation of the printing process and phase transformations associated with AM refractory alloys.
- Specific applications or development for key components

Successful symposia dedicated to this topic were held at TMS2022 and TMS2023. With increasing interest in this material system and further advances in AM technologies, this third symposium will provide even more extensive knowledge to help overcome existing challenges.

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