SUBMIT AN ABSTRACT FOR THE FOLLOWING SYMPOSIUM

ADDITIVE MANUFACTURING

Additive Manufacturing of Refractory Metallic Materials

Additive manufacturing (AM) is continually evolving as a cost-effective solution for fabricating intricate components. As this technology progresses, its capabilities are expanding to include more demanding materials, such as refractory metals in both pure and alloyed forms. Traditionally, working with refractory alloys has posed significant challenges, but AM offers a promising alternative, enabling new possibilities where conventional methods are insufficient. In some critical applications, AM remains one of the only feasible manufacturing techniques.
As a result, extensive research efforts are underway to advance metal AM processes for refractory alloys, including those based on tungsten (W), molybdenum (Mo), tantalum (Ta), and niobium (Nb). This symposium will provide a forum for researchers and industry professionals to present their latest findings, accomplishments, and obstacles. Additionally, it will offer a comprehensive overview of the current state of the field, its limitations, and the necessary advancements to drive progress.

The rising interest in AM for refractory alloys is largely fueled by the growing need for high-performance turbine engines, hypersonic technologies for both defense and commercial applications, space-based power systems, and nuclear propulsion for long-duration space missions. Beyond these areas, refractory metals are also crucial for advanced applications, such as superconducting resonance cavities in particle accelerators and quantum computing technologies.

Despite their benefits, refractory metals present distinct challenges due to their extremely high melting points, low ductility, and strong reactivity. Printing these materials remains a complex task; for instance, tungsten has a high ductile-to-brittle transition temperature, leading to severe microcracking during powder-bed fusion. Various approaches, such as preheating to elevated temperatures, have been explored to reduce cracking, though this can also accelerate oxidation. Other strategies, including alloy redesign and sophisticated thermal management during printing, are being actively researched. However, many aspects of the cracking mechanisms are still not well understood, making it difficult to develop reliable solutions. Furthermore, the unique microstructures formed through AM add another layer of complexity in assessing their impact on material performance.

This symposium will bring together experts in the AM community working on both fundamental and applied research related to refractory metal printing. A broad and diverse group of participants, including representatives from industry, government agencies, national laboratories, and academia, is expected to contribute.

Continued on next page.

Topics of Interest Include, but are not limited to:

- Cracking mechanisms associated with solidification and low ductility in refractory alloys during AM
- The influence of alloying elements and impurities on printability
- Alloy design strategies for improving both printability and performance
- Advances in powder feedstock development for refractory metals in AM
- The application of traditional and modern phase transformation models to optimize alloys for AM
- Interactions between solidification structures, impurity segregation, crystallographic formations, and defect generation in AM refractory alloys
- Simulation and modeling of printing processes and phase transformations in refractory metals
- Development and evaluation of key AM components for refractory alloys
- Techniques for joining AM-produced refractory metal components and their related properties

This marks the fifth symposium dedicated to this subject. As interest in refractory metals continues to expand alongside advancements in AM technology, TMS2026 is expected to provide even deeper insights and innovative approaches to overcoming existing challenges.

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