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Metal Additive Manufacturing (AM) for the Synthesis of Metastable Materials

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Message from the Guest Editor

Dear Colleagues,

Additive manufacturing (AM) enables the fabrication of complex, near-net shape components with high geometric freedom because of the layer-by-layer build-up. Metal AM technologies have found their way into industry, and are still attracting growing research interest. Key challenges remain with controlling the metal AM processes characterized by extremely high cooling rates (>10^4 K/s) and directional heat extraction via underlying material which then experiences a repetitive heat treatment. Thus, the evolution of metastable microstructures is kinetically favored. Crystalline phases form during metal AM processing although they are not thermodynamically stable, while the formation of stable crystalline phases can be suppressed. In the most extreme case, the supercooled liquid does not crystallize and instead vitrifies, resulting in the synthesis of metallic glass. Crystal growth is strongly affected by the diverse processing conditions and complex thermal cycles, resulting in peculiar microstructural features and defects that influence the mechanical properties of the resulting component.

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