MM 33: Invited Talk: Stefan Nolte

Time: Thursday 15:00–15:30 Location: SCH/A251

Invited Talk MM 33.1 Thu 15:00 SCH/A251

LPBF with Ultrashort Laser Pulses - Additive Manufacturing Beyond Current Limits — •Stefan Nolte[1,2], Hagen P. Kohl[1], Lisa Matthäus[1], Tobias Ullsperger[1], Dongmei Liu[1], and Stephanie Lippmann[1] — [1]Friedrich Schiller University Jena, Institute of Applied Physics, Jena, Germany — [2]Fraunhofer Institute for Applied Optics and Precision Engineering IOF, Jena, Germany

Ultrashort-pulse lasers introduce additional degrees of freedom to powder bed fusion through the choice of pulse duration, repetition rate, and pulse energy. The short interaction times enable extremely high local temperatures and highly confined melt pools, with heat accumulation tunable through the pulse repetition rate. This allows precise control over melt dynamics, thermal gradients and cooling rates, which remain largely fixed in continuous-wave systems. A key outcome is accelerated solidification and pronounced grain refinement. The confined melt geometry and reduced heat accumulation suppress segregation, cracking, and vaporization-driven compositional shifts, enabling alloys and microstructures that are difficult to achieve with conventional laser melting. These processing characteristics contribute to improved mechanical uniformity, enhanced phase distribution, and greater design flexibility in alloy development. We will introduce the governing mechanisms of ultrashort-pulse interaction in metal additive manufacturing and highlight their impact through material case studies. Demonstrated benefits include grain refinement in Al-Si, dense and crack-free structures in refractory metals, and reduced vaporization with improved composition control in hypereutectic Al-Li.