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On the interaction of ceramic fillers with metal matrix during laser action under LPBF synthesis

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Fabrication of metal matrix composites with improved properties requires an understanding of how laser action interacts with ceramic fillers and metal matrices in laser powder bed fusion (LPBF) synthesis. This work investigates the dynamic behavior and chemical reactions that occur during LPBF synthesis when laser energy is applied to the interface between metal matrices and ceramic fillers. The mechanisms underlying the interaction process are elucidated through a combination of computer modeling and experimental investigation, paying particular attention to the phenomena of diffusion, melting, solidification, and phase changes. A particular focus is on understanding how the laser parameters – power, scanning speed, and energy density – affect interfacial interactions and subsequent microstructural development. In addition, the influence of the size, shape, and composition of the ceramic filler on the morphology of the ceramic-metal interface, the formation of intermetallic compounds, and the overall properties of the composite is investigated. The insights gained from this research advance the use of additive manufacturing to produce high-performance 3D components for a range of industrial sectors by optimizing LPBF processes for the production of metal matrix composites with tailored microstructures and enhanced mechanical, thermal, and electrical properties.

Speaker Country

Deutschland

Primary author: Prof. GROMOV, Alexander (IMKF-AM, TU Bergakademie Freiberg)

Co-authors: Dr ALIEV, Rezo (IMKF-AM, TU Bergakademie Freiberg); Prof. BAST, Jürgen (IMKF-AM, TU Bergakademie Freiberg); Prof. ZEIDLER, Henning (IMKF-AM, TU Bergakademie Freiberg)

Presenter: Prof. GROMOV, Alexander (IMKF-AM, TU Bergakademie Freiberg)

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