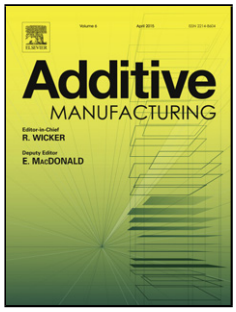

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Analysis of melt pool dynamics in laser cladding and direct metal deposition by automated high-speed camera image evaluation

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Abstract

Although the melt pool convection currents influence the dilution, porosity and distribution of potentially included hard phase particles such as carbide or other ceramic particles, which are added to increase the wear resistance of the deposited material, there is only limited knowledge of melt pool dynamics within blown powder additive manufacturing processes. In the pursuit of a deeper understanding, a high-speed camera has been used to observe melt pool dynamics during laser cladding at a frame rate of up to 67’000 frames per second, allowing for the particles that swim on the surface to be traced automatically. The resulting videos allow for the melt pool surface behavior to be investigated using a specifically developed automated high-speed camera image evaluation technique. This method has been tested for reliability and applied to investigate the process parameter influence on melt pool dynamics. The results show, that there is no pronounced laminar flow on the melt pool surface, instead a remarkable randomness to the direction of particle flow can be observed. That being said, it is still possible to identify certain flow tendencies that can be explained by surface tension phenomena like the Marangoni effect and which depend on the process parameters.