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A toolbox towards first-time-right production in powder bed fusion

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A significant factor slowing down the establishment of metal-based additive manufacturing techniques as production processes is insufficient reproducibility and productivity. Among all additive manufacturing processes, the highest maturity level is shown by laser-based powder bed fusion of metals (PBF-LB/M). Nevertheless, the process is characterized by several phase changes and a highly dynamic melt pool, which may lead to the formation of process defects. Currently, continuous wave, vector-based exposure using Gaussian spots with spot diameters in the range of 40 to 120 µm represents the standard approach to laser-based powder bed fusion of metals. Within the keynote, the potential of tailoring the energy input in time and space on melt pool dynamic, process behavior, and resulting component properties are shown. The talk is guided by two technical innovations in PBF-LB/M (i) the potential of beam shaping technology for smoothening the process dynamic and increasing productivity and (ii) the capability of pulsed exposure for a support-free building process and thus reduction of post-processing. We have shown in selected examples a significant increase in the production speed with the change of the spatial energy input (beam shaping). This combined with the reduction of support structures via tailored temporal energy input leads to an essential reduction of the overall process chain in PBF-LB/M. In the future, a toolbox with different process strategies will empower the first-time-right manufacturing and the voxel-based tailoring of components in PBF-LB/M.

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