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Macroscopic Support Structure Design for the Tool-Free Support Removal of Laser Powder Bed Fusion-Manufactured Parts Made of AlSi10Mg

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Abstract : The additive manufacturing process laser powder bed fusion offers many advantages over conventional manufacturing processes. For example, almost any complex part can be produced, such as topologically optimized lightweight parts, which would be inconceivable with conventional manufacturing processes. A major challenge posed by the LPBF process, however, is, in most cases, the need to use and remove support structures on critically inclined part surfaces ($\alpha < 45$ ° regarding substrate plate). These are mainly used for dimensionally accurate mapping of part contours and to reduce distortion by absorbing process-related internal stresses. Furthermore, they serve to transfer the process heat to the substrate plate and are, therefore, indispensable for the LPBF process. A major challenge for the economical use of the LPBF process in industrial process chains is currently still the high manual effort involved in removing support structures. According to the state of the art (SoA), the parts are usually treated by simple hand tools (e.g., pliers, chisels) or by machining (e.g., milling, turning). New automatable approaches are the removal of support structures by means of wet chemical ablation and thermal deburring. According to the state of the art, the support structures are essentially adapted to the LPBF process and not to potential post-processing steps. The aim of this study is the determination of support structure designs that are adapted to the mentioned post-processing approaches. In the first step, the essential boundary conditions for complete removal by means of the respective approaches are identified. Afterward, a representative demonstrator part with various macroscopic support structure designs will be LPBF-manufactured and tested with regard to a complete powder and support removability. Finally, based on the results, potentially suitable support structure designs for the respective approaches will be derived. The investigations are carried out on the example of the aluminum alloy AlSi10Mg.

Keywords : additive manufacturing, laser powder bed fusion, laser beam melting, selective laser melting, post processing, tool-free, wet chemical ablation, thermal deburring, aluminum alloy, AlSi10Mg
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