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Numerical investigation on the homogeneity of the deposited powder mixture during the powder spreading process of PBF-LB/M

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A powder bed fusion – laser beam / metal (PBF-LB/M) process and hot isostatic pressing (HIP) combined producing route was developed to manufacture nitrogen (N) in high-alloyed stainless steels in which mechanically mixed base AISI stainless steel 304L (SS304L) powder and silicon nitride (Si₃N₄) powder was manufactured by PBF-LB/M and further homogenized by HIP. Due to the partially undissolved Si₃N₄ powder in the intermediate product, sufficient N-content was kept and pore formation was reduced in the final product. The greatest difficulty of this producing route is to maintain the homogeneity of the deposited powder mixture during the powder spreading process. Therefore, this study aimed to identify the influencing factors on the homogeneity of the powder mixture during the powder spreading process and to achieve the target N-content in the intermediate product. On the one hand, microstructural characterization by the scanning electron microscope (SEM) was conducted on the deposited powder mixture sampled from the powder bed in a PBF-LB/M machine for qualitative mapping of the local Si₃N₄ fraction and N-content. On the other hand, numerical studies based on the discrete element method (DEM) were carried out to study the effects of layer thickness, substrate surface roughness, and powder properties on the intermediate product. By cross-correlating the experimental and numerical results, the required optimal process conditions can be determined for PBF-LB/M.

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