Optimization of SLM and DED Process Parameters for the Development of Hybrid Additive manufactured Ti6Al4V Structures

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To combine the advantages of the two AM technologies, SLM and DED, we propose completely new approach for the development of Hybrid Additive manufactured Ti6Al4V parts for aerospace applications. The combination of both technologies will enable us rapid manufacturing of larger parts and geometrically complex structures with reduced weight and optimized mechanical and corrosion properties. The great challenge also represents the optimization of the interface between the two joined parts due to the microstructure difference and encountered residual stresses.

To achieve good properties and bonding characteristics at the interface between both AM parts we have to consider appropriate powders for feedstock. Powder has to be analysed before SLM and DED processing. Size, shape, defects analysis and elemental analysis (Ti, V, Al, trace elements like H, O and N) have to be performed. These parameters are important since they can markedly influence SLM and DED processing as well as the mechanical properties of the finished samples (increased H, O and N contents can cause embrittlement while non spherical powder with defects can increase porosity level). Process parameters such as direction of the building (vertical or horizontal), layer thickness, scan spacing, scan strategy, laser power, powder flow rate (DED) and scan speed, for both AM technologies will be tailored. On one hand optimal microstructure has to be achieved (columnar or equiaxed grain structure → anisotropy in mechanical properties). On the other hand, residual stresses have to be reduced (warping of the part and occurrence of micro and macro fractures during processing). For hybrid specimens' geometry, laser power, scan strategy and scan speed have to be considered to minimize the size of heat affected zone (balance between heat introduction due to laser and heat dissipation via heat conduction, convection and radiation). In the case of longitudinal building pattern, the most optimal angle of inclinations has to be considered as well. Different angles of inclination can influence powder flow characteristic in the deposition zone which can lead to occurrence of defects like of lack of fusion sites.