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# 变能量激光选区熔化IN718镍基超合金的成形工艺及高温机械性能

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# Forming process and high-temperature mechanical properties of variable energy laser selective melting manufacturing IN718 superalloy

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**摘要** 开展了基于激光选区熔化技术对IN718镍基超合金直接激光熔化成形的研究.将零件分为心部与轮廓区, 通过改变激光线输入量进行选区熔化研究.首先,建立熔池内烧结的数值模型,改变激光线输入量,获得了激光线输入量对零件致密度的影响规律并观察了成形体中的组织生长.然后,增加轮廓部位扫描,改变激光线输入量与扫描顺序,获得其对零件表面质量的影响规律.最后,通过优化热处理工艺提高零件高温拉伸强度和高温持久性能.试验结果表明,在激光线输入量为300 J/m时,成形体致密度最高,为98.9%,成形体沿层间方向组织为树枝晶加等轴晶,在层内方向组织为等轴晶.采用心部+后轮廓扫描的方式,轮廓激光线输入量为100 J/m时表面质量最优,粗糙度为3.1 μm.对成形体采用1 065 ℃固溶+双时效的热处理可以获得最佳高温性能组合,高温拉伸强度为1 356 MPa,高温持久时间为34 h.结果显示,通过激光选区熔化制作IN718镍基超合金可以满足航空结构件对致密度、表面质量和高温性能要求.

**关键词** : IN718镍基超合金, 变能量激光选区熔化, 激光成形, 致密度, 表面质量, 高温机械性能

**Abstract** : Selective laser melting manufacturing IN718 powder with changed laser energy densities was researched. The part to be machined was divided into a core and a contour, and the selective laser melting manufacturing was performed by changing the laser energy density. Firstly, a numerical model of sintering in melting pool was set up,the influencing factors of changed laser energy densities on the densification of the part were obtained by changing laser energy densities,and the microstructure features of the formed part were observed. Then, by increasing scanning for the contour and changing the laser energy densities, the effect law of changed laser energy densities on the surface quality of the part was also obtained. Finally, the heat treatment processing was optimized and the high-temperature tensile strength and high temperature lasting time properties of the part were improved to obtain the perfect surface quality. The results indicate when the linear laser energy density is 300 J/m, the optimal densification level of formed part is as high as 98.9%. In this condition, the typical microstructures of the formed part are dendrite and equiaxial crystals along the deposition direction and are equiaxial crystal along the inside layer. Using the core + contour scanning way, the optimal surface quality of the part is obtained in laser energy densities of 100 J/m with the roughness of 3.1 μm. The optimal high temperature performance of the formed part is realized by solution + double aging combination in 1 065 ℃, in which the high temperature tensile strength is 1 356 MPa and the high temperature lasting time is 34 h. Results show that the IN718 nickel-based super alloy manufactured by selective laser melting can satisfy the demands of complex aerospace parts for the densfication level, good forming quality and high-temperature mechanical properties.

**Key words** : IN718 nickel-based superalloy variable energy laser selective melting laser-forming density surface quality high temperature mechanical property

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