

热处理对 Ti60 合金激光摆动焊接接头组织及拉伸性能的影响

鲁弈廷, 芦伟, 陈玮*, 林博超, 马旭颐

中国航空制造技术研究院高能束流加工技术重点实验室, 北京, 100024

*Email: werner_nju@163.com

摘要: 针对Ti60合金薄板开展激光摆动焊接, 光束摆动使能量分布更均匀并大幅减少飞溅量, 焊缝熔宽增加约30%, 可为对接焊缝提供更大的间隙裕度。光束摆动对焊接接头的显微组织无显著影响, 焊缝区粗大柱状晶向焊缝中心生长, 柱状晶内部为针状 α' 马氏体相。近焊缝热影响区显微组织由针状 α' 相、针状 α 相和等轴初生 α 相组成; 近母材热影响区显微组织由片层 α 相和等轴初生 α 相组成。焊缝和热影响区显微硬度分别约为435HV和400HV, 均高于母材, 硬度匹配比约为1.13。焊接接头的室温和600°C抗拉强度均与母材相当, 但延伸率较母材低约45%, 断口呈现出韧性断裂特征。在960°C和1010°C热处理120min后, 焊缝区显微硬度降低, 硬度匹配比约为1.02。此外, 焊接接头高温延伸率提高, 力学性能分散性得到改善, 这是由于焊后热处理使得针状 α' 马氏体分解为 α 相和部分等轴 α 相转变为 α/β 组织引起的。

关键词: Ti60合金; 激光摆动焊接; 热处理; 显微组织; 力学性能

参考文献

- [1] 鲁弈廷, 芦伟, 马旭颐, 陈玮. 光束摆动对激光焊接Ti60合金焊缝成形的影响, 焊接学报(已录用)
- [2] 芦伟, 马旭颐, 段爱琴, 王学东. BTi6431S钛合金光纤激光焊接成形及稳定性分析, 激光与光电子学进展, **2020**, **57(13)**, 220–225.
- [3] 芦伟, 马旭颐, 巩玥, 郭路云. 光束摆动对铝合金激光搭接焊缝成形及组织的影响, 应用激光, **2022**, **42(1)**, 9–14.
- [4] Chen W., Chen Z.Y., Wu C.C., Li J.W., Tang Z.Y., Wang Q.J., The effect of annealing on microstructure and tensile properties of Ti-22Al-25Nb electron beam weld joint, *Intermetallics*, **2016**, **75**, 8–14.

*鲁弈廷, 13163171599, yiren0419@163.com

The effect of heat treatment on microstructure and mechanical properties of laser wobble welded Ti60 alloy

Lu Yiting, Lu Wei, Chen Wei*, Lin Bochao, Ma Xuyi

Power Beam processing Laboratory, AVIC Manufacturing Technology Institute, BeiJing, 100024

*Email: werner_nju@163.com

Abstract: Laser wobble welding is performed on a Ti60 sheet. The weld spatter is significantly decreased and the weld width increases 30% due to the more uniform laser energy distribution by wobbling, which can offer a larger gap margin for butt welding. Laser wobbling has little effect on weld microstructure. The fusion zone (FZ) is composed of coarse columnar grains growing towards the weld center, in which α' martensite is dominant. In the heat affected zone (HAZ) close to the fusion zone, there is a mix of α' martensite, needle-like α phase, and equiaxed α_p phase. On the base material side of the HAZ, lamellar α and equiaxed α_p are present. The hardness of the FZ and HAZ is 435HV and 400 Hv, respectively, which is higher than the base material. The hardness matching ratio is approximately 1.13. The tensile strength of the weld at room temperature and 600°C is comparable to the base material, but the ductility is 45% lower. The fracture surface exhibits ductile failure features. After heat treatment at 960°C and 1010 °C, the hardness of FZ decreases and the hardness matching ratio is measured to be 1.02. In addition, the weld ductility is improved at 600°C and the scatter of mechanical properties becomes narrow. This is due to the decomposition of α' martensite to α lamellar and part of the equiaxed α phase transforms into α/β lamella.

Key words: Ti60 alloy; laser wobble welding; heat treatment; microstructure; mechanical properties