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蓝光-红外激光复合焊接工艺参数对铜焊缝成形的影响

郑江鹏，孙涛，杨军红，扈金富，王家赞，王枭

广东粤港澳大湾区硬科技创新研究院，广东广州 510700

*Email: cm_lb1987@126.com

摘要：铜因具有优异的导电、导热性能，被广泛应用于电气设备、电动汽车等制造领域。随着这些领域大电流传输和高动态负载要求的增加，对于大截面铜排可靠焊接的需求也越来越迫切。蓝光-红外复合激光焊接既可以提高铜对传统的红外激光的吸收率，减少焊接飞溅，又可以克服目前蓝光激光器的功率还较低的问题，在铜的快速、高质量焊接方面展现出巨大潜力。而目前关于蓝光-红外激光复合焊工艺的报道还相对较少，本研究采用红外-蓝光双光束复合焊接设备进行了 8mm 厚 T2 紫铜板焊接试验，探讨了复合焊接过程中蓝光和红外激光的作用，研究了红外激光功率、焊接速度对复合焊接飞溅以及焊缝成形的影响。结果表明，单红外激光焊接时存在严重的飞溅现象，焊缝孔洞缺陷多。增加蓝光复合后，可以降低飞溅和孔洞缺陷，有助于提高焊缝外观和一致性。蓝光功率对于焊接熔深影响较小，熔深主要取决于红外激光功率，随着红外激光功率提高，焊缝宽度、熔深逐渐增加，熔深与红外激光功率呈近似线性关系。随着焊接速度提高，焊缝变窄，熔深有逐渐减少的趋势，熔深与焊接速度呈近似 3 次方的关系。

关键词：铜；蓝光激光；复合焊接

Influence of blue and infrared laser hybrid welding process parameters on weld appearance of copper plate

ZHENG Jiangpeng, *SUN Tao* ,*YANG Junhong*, *WANG Xiao*

（Guangdong Key and Core Technology Innovation Institute, Guangzhou 510700）

Abstract： Copper is widely used in electrical equipment, electric vehicles and other manufacturing fields because of its excellent conductivity and thermal conductivity. With the increasing requirements of high current transmission and high dynamic load in these fields, the demand for reliable welding of copper bars with large section thickness is becoming more and more urgent. Blue-Infrared hybrid laser welding can not only improve the absorptivity of copper to traditional infrared laser and reduce spatters, but also overcome the problem of low power of blue light laser at present. It shows great potential in the rapid and high-quality welding of copper. At present, there is few research on the Blue-Infrared hybrid laser welding process. In this study, the BOP welding test of 8mm thick T2 copper plate was carried out by using Blue-Infrared hybrid laser welding equipment, and the effects of infrared laser power and welding speed on welding spatter and penetration were studied, the role of blue and infrared laser in the hybrid welding process was discussed. The results show that there are serious spatter phenomenon and hole defects in single infrared laser welding, while these can be greatly reduced with the combination of blue laser, which is helpful to improve weld appearance and consistency. Blue light power has little effect on welding penetration which mainly depends on the infrared laser power. With the increase of infrared laser power, the weld width and penetration gradually increase, and the penetration is approximately linear with the infrared laser power. With the increase of welding speed, the weld narrowed, and the penetration gradually decreased. The relationship between penetration and welding speed was approximately cubic.

Key words: copper, blue laser, hybrid welding.

Table 1 Comparison of weld appearance and cross section morphology of IR laser and hybrid laser welding

Welding Process	Weld appearance	Weld cross section

Single IR welding（P_{IR}=5850W, V=30mm/s）		
Hybrid laser welding（P_B=850W, P_{IR}=5000W, V=30mm/s）		

*郑江鹏（报告人）联系方式：15528814950，cm_lb1987@126.com