激光光束不同摆动模式对镁/钢接头显微组织与性能的影响

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摘要：针对钢、镁熔沸点差异大，Mg 在 Fe 中不固溶，且 Mg 与 Fe 不能形成金属间化合物等钢/镁焊接面临的难题，本文探索镁上/钢下搭接的镁/钢摆动激光焊接技术，研究了激光光束不同摆动模式下镁/钢接头的显微组织及性能。结果表明：镁/钢焊缝表面形貌良好，裂纹和凹坑等缺陷明显减少，钢表面预置 V 型结构槽，利于上层熔化状态的镁嵌入槽内，添加 Ni 粉，Ni 与 Fe、Mg 发生冶金反应，镁/钢界面形成 Mg-Al-Ni-Fe 金属间化合物层，V 型槽内添加 Ni 粉较好实现了镁/钢机械+冶金的连接，镁/钢接头最大拉伸-剪切载荷约 1.3 kN；激光光束未摆动时，熔池内形成等轴晶（63μm）；激光光束圆形摆动，等轴晶细化（20μm）；由圆形摆动到直线摆动时，晶粒尺寸进一步细化（13μm），激光光束发生摆动，匙孔在熔池内的旋转加剧熔池内的流动，沿熔池两侧生长的枝晶被打碎，为等轴晶的成形提供更多的晶核，导致熔池内晶粒被细化，当激光光束直线摆动时，镁/钢接头性能最佳，其最大拉伸-剪切载荷约 2.2kN，相对未摆动时提高 69.23%。

关键词：钢/镁；摆动激光焊接；显微组织；性能

Effects of oscillating laser beam on the microstructure and properties of magnesium/steel joints

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Abstract: It is difficult realizing reliable welding for steel and magnesium due to the melting and boiling point difference, Mg and Fe almost no solution each other and no generating intermetallic compound. In this paper, oscillating laser welding technology for magnesium-on-steel configuration has been explored, and microstructure and properties of steel/magnesium joints with various oscillating laser modes was also studied. The results show that the weld surface is superior, cracks and pits are decreased. Meanwhile, V-groove on steel are conducive to the embedding of molten magnesium into the groove.Adding Ni powderundergoes metallurgical reaction with Fe and Mg, resulting in the formation of Mg-Al-Ni-Fe intermetallic compound layer at magnesium/steel interface. Ultimately,adding Ni powder in V-groove realize the bonding of magnesium/steel by the process of mechanical and metallurgy, the maximum tensile-shear load of joint is about 1.3 kN.When laser beam is not oscillating, the equiaxed crystals with the average grain size of 63μm are formed in Mg molten pool. With circular oscillating laser, the grain (20μm) are refined.However,with line oscillating laser, the grain size is further refined (13μm). The rotation of keyhole by oscillating laser intensifies the flow in molten pool, breaking up the dendrites growing along the sides of the melt pool and providing more nuclei for the formation of equiaxed crystals, leading to the refinement of the equiaxed grains. The magnesium/steel joint has the best

performance with line oscillating laser, and its maximum tension-shear load is about 2.2k N, 69.23% higher than that without oscillation.
Keywords: Steel/magnesium;oscillating laser welding; microstructure;tensile-shear properties.