外加磁场对激光焊接镁/铝界面微观组织与接头性能的影响

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摘 要：采用外加磁场辅助 Ti 箔进行镁上/铝下搭接的镁/铝异种金属激光焊接实验，利用高速相机同步拍摄焊接过程的等离子体羽流形貌，采用最大载荷评价镁/铝搭接接头的拉伸-剪切性能，研究了外加磁场对激光焊接镁/铝界面微观组织与接头性能的影响。结果发现：外加磁场使等离子体羽流受到约束，焊接过程相对稳定，镁/铝焊缝表面连续、均匀，气孔、凹陷和咬边等缺陷明显减少；镁/铝接头性能随磁场强度的增加呈现先增大后减少的变化趋势，磁场强度 30mT 时，接头性能最佳，最大载荷相对未外加磁场时提高 83.4%；外加磁场减弱等离子体羽流对激光的屏蔽作用，熔池吸收更多的激光能量，导致镁/铝层间添加 Ti 箔的熔化量增加，镁/铝界面生成 $TiAl_3$，避免镁/铝相互接触，因此接头性能提高；但磁场强度过大时，熔池的搅拌作用增强，Ti 箔发生破碎，无法起到连接和避免镁/铝直接接触的作用，接头性能下降明显。

关键词：镁/铝异种金属；激光焊接；外加磁场；微观组织

The effect of external magnetic field on microstructure and joint properties of laser welded Mg/Al interface

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Abstract: Magnetic field assisted laser welding experiment for magnesium/aluminum dissimilar metal with a Ti interlayer in magnesium-on-aluminum configuration was carried out, the morphology of plasma plume during the welding process was obtained by using a high-speed camera, the tensile-shear properties of magnesium/aluminum lap joints were evaluated by the use of the maximum load, and the effect of external magnetic field on microstructure and joint properties of laser welded magnesium/aluminum interface was also studied. The results shows that external magnetic field constrains the plasma plume, the welding process is relatively stable, the weld surface is continuous and uniform, and defects such as porosity, depressions and bitten edges are significantly reduced. The performance of Mg/Al joints showed a trend of increasing and then decreasing with the increase of magnetic field strength, the best performance of joints was achieved when the magnetic field strength was 30mT, and the maximum load was increased by 83.4% compared with that without applied magnetic field. The melt pool absorbs more laser energy because of the external magnetic field which weakens the shielding effect of the plasma plume on the laser, resulting in an increase in the melting of Ti foil between the Mg/Al interface and the formation of Ti/Al compounds such as $TiAl_3$ at the Mg/Al interface to avoid the mutual contact of Mg/Al, thus improving the joint performance. When the magnetic field strength is too large, the stirring effect of the melt pool is enhanced, resulting in the breaking of Ti foil, which cannot play the role of connection and avoid direct contact between Mg/Al, so the performance of the joint decreases significantly.

Key words: Magnesium/Aluminium dissimilar metals; Laser welding; External magnetic field; microstructure

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