激光技术 2013, 37(6) 712-717 DOI: 10.7510/jgjs.issn.1001-3806.2013.06.002 ISSN: 1001-3806 CN: 51-1125/TN

激光与光电子技术应用

填镁改善5052铝合金激光焊接接头机械性能研究

邹宇峰[1], 金湘中[1], 何依宁[2], 张宏圭[1], 杨洪亮[1]

1. 湖南大学 汽车车身先进设计制造国家重点实验室, 长沙 410082;
2. 山东大学 材料科学与工程学院, 济南 250061

摘要： 在铝合金激光搭接焊中,镁元素烧损将大大降低焊缝的抗拉强度。为了消除铝合金激光搭接焊中镁元素的烧损对焊接接头的负面影响,采用在铝合金激光焊接接头中填加镁粉的方法,研究焊接速率对镁元素烧损的影响。实验中,测量了焊缝中镁元素在垂直和水平方向的分布,并对焊接接头抗拉强度进行了测试;分析了焊接接头中镁含量和抗拉强度之间的关系,比较了填镁量不同时各焊接接头的抗拉强度。结果表明,镁元素的烧损极大地影响了焊缝的抗拉强度,在激光焊接中填镁能有效地提高焊缝的抗拉强度;相比没填镁,填镁的焊接接头抗拉强度最大改善可以达到36.06%;当焊缝中镁元素的质量分数大约是0.026时,抗拉强度强度达到最大值。这为改善铝合金激光焊接接头强度提供了新的理论依据和方法。

关键词： 激光技术 抗拉强度 填镁 铝合金

Study on improving mechanical properties of the welds by filling magnesium powder during laser welding 5052 aluminum alloy

ZOU Yu-feng[1], JIN Xiang-zhong[1], HE Yi-ning[2], ZHANG Hong-gui[1], YANG Hong-liang[1]

1. The State Key Laboratory of Advanced Design and Manufacturing for Vehicle Body, Hunan University, Changsha 410082, China;
2. School of Material Science & Engineering, Shandong University, Ji'nan 250061, China

Abstract: Magnesium is an important strengthening alloying element in aluminum alloy, the burning loss of which will greatly reduce such mechanical property of the welds as the tensile strength during laser lap welding of aluminum alloy. In order to eliminate the negative effect of the burning loss of magnesium on mechanical property of the welds, filling magnesium powder is adopted filled in laser welding aluminum alloy. The contents of magnesium in the welds were measured both in the vertical and horizontal directions, and the effect of welding velocity on the burning loss of magnesium was experimentally studied. Then, the tensile strength of the welds was tested. Compared after comparing the tensile strength of the welds under different magnesium contents, the relationship between the content of magnesium element of the welds and tensile strength was studied. The results show that the reduction of magnesium content due to the burning loss of magnesium can greatly affect the tensile strength of the welds, filling magnesium during laser welding can effectively improve the tensile strength of the welds, the maximum of the improvement can reach to 36.06% compared to those without filling magnesium. When the mass fraction of the magnesium element in the welds is about 0.026,the tensile strength of the welds reaches the maximum. This study provides new theoretical basis and methods to improve the strength of aluminum alloy laser welded joints.

Keywords: laser technique tensile strength filling magnesium aluminum alloy

收稿日期 2013-02-27 修回日期 2013-03-06 网络版发布日期 2013-09-24

DOI: 10.7510/jgjs.issn.1001-3806.2013.06.002

基金项目:

国家自然科学基金资助项目(50875079);湖南省自然科学基金资助项目(09JJ3088)

通讯作者: 金湘中

作者简介: 邹宇峰(1987-),男,硕士研究生,主要从事激光加工焊接方面的工作。

作者Email: jin9000xz@hotmail.com

参考文献：

[1] EL-BATAHGY A,KUTSUNA M. Laser beam welding of AA5052, AA5083 and AA6061 aluminum alloys [J]. Advances in Materials Science and Engineering,2009,2009: 974182.
[2] KUO T Y, LIN H C. Effects of pulse level of Nd-YAG laser on tensile properties and formability of laser weldments in automotive aluminum alloys[J]. Materials Science and Engineering,2006, A416(1/2):281-289.

[3] ZHAO H, DEBROY T. Weld metal composition change during conduction mode laser welding of aluminum alloy 5182[J]. Metallurgical and Materials Transactions,2001, B32(1):163-172.
[4] MUNDRA K, DEBROY T. Calculation of weld metal composition change in high-power conduction mode carbon dioxide laser-welded stainless steels[J]. Metallurgical and Materials Transactions,1993, B24 (1):145-155.
[5] QI X D, LIU L M. Fusion welding of Fe-added lap joints between AZ31B magnesium alloy and 6061 aluminum alloy by hybrid laser-tungsten inert gas welding technique[J]. Materials and Design,2012,33 (4):436-443.
[6] YU Y Ch, WANG Ch M, YU Sh F, *et al*. Microstructures and property of butt laser joint of aluminium alloy 5A06 sheets with fiiler[J]. Laser Technology,2010,34(1):34-36(in Chinese).
[7] BRAUN R. Nd:YAG laser butt welding of AA6013 using silicon and magnesium containing filler powders[J]. Materials Science and Engineering,2006, A426(1/2):250-262.
[8] XU F, CHEN L, GONG Sh L, *et al*. Microstructure and mechanical properties of laser welding 5A06 aluminum with filling wire[J]. Applied Laser,2009,29(2):83-86(in Chinese).
[9] JANDAGHI M, PARVIN P,TORKAMANY M J,*et al*. Alloying element losses in pulsed Nd:YAG laser welding of stainless steel 316[J]. Journal of Physics,2008,D41(23):235503.
[10] HE X, DEBROY T. Alloying element vaporization during laser spot welding of stainless steel[J]. Journal of Physics,2003,D36(23): 3079-3088.
[11] DILTHEY U, GOUMENIOUK A, LOPOTA V, *et al*. Development of a theory for alloying element losses during laser beam welding[J]. Journal of Physics,2001,D34(1): 81-86.
[12] JANDAGHI M, PARVIN P, TORKAMANY M J, *et al*. Measurement of the composition change in Al5754 alloy during long pulsed Nd:YAG laser welding based on LIBS[J]. Applied Physics,2009,42(20): 205301.
[13] LIANG N, SHENG Y F. Effect of active element-magnesium on the properties of vacuum brazed joints of aluminum alloy[J]. Transactions of the China Welding Institution,2007,28(7):61-64(in Chinese).
[14] ZHANG Y H, SHI Ch Ch. Research on the role of magnesium in the process of aluminum alloy vacuum brazing[J]. Transactions of the China Welding Institution,1983,4(2):55-69(in Chinese).
[15] ZHANG H G, JIN X Zh, CHEN G Y, *et al*. A study on the burning loss of magnesium element in fiber laser welding of aluminum alloy 5052[J]. Laser Technology,2012,36(6):713-718(in Chinese).

本刊中的类似文章

1．陈爽, 冯莹, 王玲.基于GLM的多模光纤放大器模式控制研究[J]. 激光技术, 2010,34(1): 128-131

2．于益, 王卫民, 鲁燕华, 谢刚, 彭跃峰.二极管激光光谱合束技术实验研究[J]. 激光技术, 2010,34(1): 138-140

3．张芳沛, 楼祺洪, 李红霞, 韩文杰, 邢宇华, 董景星, 沈严, 薛海中.1064nm激光诱导等离子体开关控制355nm脉宽可调输出[J]. 激光技术, 2010,34(1): 17-19,40

4．卢彦兆, 王新兵, 董句, 张学玲.双波长可调谐TEA CO_2激光器的脉冲输出特性[J]. 激光技术, 2010,34(1): 88-90,94

5．何建平, 周智, 吴源华, 欧进萍.光纤布里渊与布喇格光栅共线技术的温度互补偿[J]. 激光技术, 2010,34(1): 13-16

6．余阳春, 王春明, 余圣甫.5A06 铝合金的激光填丝焊接头组织与性能[J]. 激光技术, 2010,34(1): 34-36,52

7．秦海永 张永康 尤建.高能激光辐照诱导声波频率特性的实验研究 [J]. 激光技术, 0,(): 105-105

8．储晓猛, 顾佩兰, 杨建新.高密度聚乙烯塑料激光焊接工艺参量试验研究[J]. 激光技术, 2010,34(1): 116-119

9．姜银方, 应才苏, 刘赤荣, 石朝阳, 周桂生.激光功率密度对板料激光冲击成形性能的影响[J]. 激光技术, 2010,34(1): 95-98

10．柳娟, 唐霞辉, 彭浩, 秦应雄, 邓前松.高效率3工位激光焊接系统的控制优化[J]. 激光技术, 2010,34(1): 56-59