

激光内送粉变姿态熔覆成形薄壁零件的实验研究

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摘要 为了探索在非水平基面上激光熔覆成形薄壁零件的成形规律, 拓展激光熔覆成形及再制造技术的广泛应用。本文基于激光内送粉技术, 通过对激光加工机器人的程序控制实现熔覆头相应姿态的变化, 分别在 0° 、 30° 、 60° 、 90° 、 120° 和 150° 的倾斜基板上进行薄壁墙的成形实验, 研究了不同倾斜角度下薄壁墙的成形规律, 分析了倾斜基面下非水平熔池的受力规律, 建立了熔池受力模型。实验结果表明: 随基板倾斜角度的增大, 熔池长度变短, 熔池宽度增加, 薄壁墙的总高度增大; 随着基板倾斜角度的增大, 成形薄壁墙的尾部塌陷逐渐严重, 在基板倾斜角度 150° 时, 塌陷倾斜角度达到 21° 的斜坡。研究结果为非水平基面上激光熔覆成形及再制造提供参考价值。

关键词 激光增材修复; 内送粉; 非水平基面; 薄壁墙

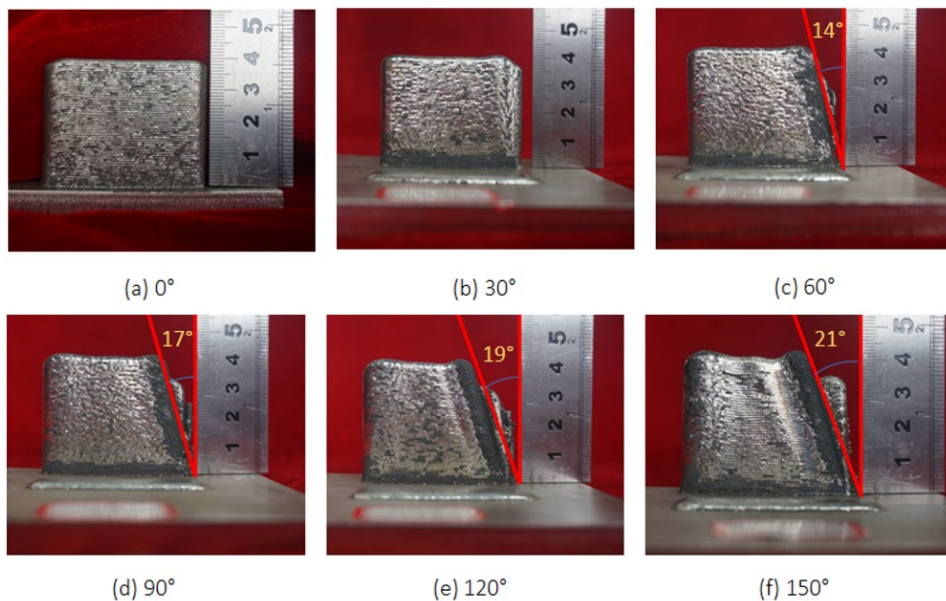


Fig.1 Thin-walled parts fabricated with different inclination angles by laser cladding forming

参考文献

- [1] 徐滨士, 董世运. 激光再制造[M]. 北京: 国防工业出版社, 2016: VII.
- [2] Luo J, Gao JJ, Gou SW, Li YL, Lin HX, Wu XR, Qi SY. Study on microstructure and mechanical properties of Ni60+WC/Ni35/AISI1040 functional surface gradient structure of remanufacturing chute plate for the mining scraper by a low cost high power CO₂ laser cladding technique[J]. Materials Research Express, 2020, 7: 086521.
- [3] 朱刚贤, 石世宏, 傅戈雁, 等. 基于激光加工机器人的光内送粉变基面熔覆研究[J]. 中国激光, 2015, 42(3): 0303010.

- [4] Milewski JO, Lewis GK, Thoma DJ, et al. Directed Light Fabrication of a Solid Metal Hem-isphere Using 5-axis Powder Deposition[J]. Journal of Materials Processing Technology, 1998, 75(1): 165-172.
- [5] Liu Lifeng, Yang Xichen, Wang Fei, et al.. Flexible laser remanufacturing system based on robot[J]. Chinese J Lasers, 2011, 38(12):1203003.
刘立峰, 杨洗陈, 王非, 等. 基于机器人的柔性激光再制造系统[J]. 中国激光, 2011, 38(12): 1203003.
- [6] Dwivedi R, Zekovic S, Kovacevic R. A novel approach to fabricate uni-directional and branching slender structures using laser-based direct metal deposition[J]. International Journal of Machine Tools & Manufacture, 2007, 47: 1246-1256.
- [7] Yu Chao, Miao Qiuyu, Shi Longfei, et al.. Experimental Research on Laser Engineered Net Shaping of Thin-walled Structures with Large Inclination Angles[J]. China Mechanical Engineering, 2020, 31(5):595-602.
余超, 苗秋玉, 石龙飞, 等. 大倾斜角薄壁结构激光近净成形实验研究[J]. 中国机械工程, 2020, 31(5):595-602.
- [8] Shi Shihong, Fu Geyan, Wang Anjun, et al.. Laser forming manufacturing process and nozzle of inside- laser powder feeding[P]. China Patent: 200610116413.1, 2006-09-22.
石世宏, 傅戈雁, 王安军, 等. 激光加工成形制造光内送粉工艺与光内送粉喷头[P]. 中国专利: 200610116413.1, 2006-09-22.
- [9] Paul, C P, Mishra S K, Kumar A, et al.. Laser rapid manufacturing on vertical surfaces: Analytical and experimental studies[J]. Surface and Coatings Technology, 2013, 224(12): 18-28.
- [10] Nowotny S, Scharek S, Beyer E, et al. Laser beam build-up welding: precision in repair, surface cladding, and direct 3D metal deposition[J]. Journal of Thermal Spray Technology, 2007, 16(3):344-348.
- [11] C.F.Scott, G.C.Sander, J.Norbury. Computation of Capillary Surfaces for the Laplace Young Equation. The Quarterly Journal of Mechanics and Applied Mathematics, 2005, 58(2):201-212

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