金属学报 2010, 46(02) 135-140 DOI: 10.3724/SP.J.1037.2009.00192 ISSN: 0412-1961 CN: 21-1139/TG

论文

316L不锈钢激光快速成形的微观组织模拟

贾文鹏[1], 汤慧萍[1], 贺卫卫[1], 林 鑫[2], 黄卫东[2]

1.西北有色金属研究院金属多孔材料国家重点实验室, 西安 710016
2.西北工业大学凝固技术国家重点实验室, 西安 710072

摘要:

针对316L不锈钢激光快速成形(LRF)薄壁试样的凝固组织形态分布,从凝固理论出发, 建立了激光快速成形柱状晶/等轴晶转变(CET)及一次枝距λ_1与有限元温度场耦合数值模型, 模拟了成形高度为2.8 mm的LRF薄壁 试样凝固组织形态及分布. 结果表明: 316L不锈钢LRF组织由致密、均匀、外延生长的细长柱状晶组成, 一般不发生CET转变, 组织中λ_1在6.5-17 μm范围内, 且随熔覆高度的增加而逐渐增大, 模拟结果与实验符合很好. 在此基础上, 对成形高度为40 mm薄壁件的凝固组织形态及分布进行了预测.

关键词: 316L不锈钢 激光快速成形(LRF) 微观组织 模拟

NUMERICAL MICROSTRUCTURE SIMULATION OF LASER RAPID FORMING 316L STAINLESS STEEL

JIA Wenpeng[1], TONG Huiping[1], HE Weiwei[1], LIN Xin[2], HUANG Weidong[2]

1.State Key Laboratory of Porous Metals Technologies, Northwest Institute for Nonferrous Metal Research, Xi'an 710016
2.State Key Laboratory of Solidification Processing, Northwestern Polytechnical University, Xi'an 710072

Abstract:

The laser rapid forming (LRF) as an advanced solid freedom fabrication technology, has been developed rapidly in recent decade. By rapid prototyping with laser cladding, LRF realizes the direct net shaping of the components with irregular shapes and fine inner structures, and gives a short–route, low–cost and high–flexibility fabrication of aero components, aero–engine parts and biomedical implants. In the LRF, melting and solidification are happened in a dynamic non–equilibrium, high temperature gradient and rapid solidification manner, so that the microstructure of the laser rapid formed part is finer than that of ordinary cast or forge part and presents a characteristic of typical epitaxial growth. Therefore, to achieve the predict and control of the microstructure evolution is a key problem. Much efforts have been devoted to narrating the solidification and crystallization in melting pool, but little attention has been paid to stuy the microstructure of LRF part. In this paper, the evolution otemperture field and solidification of LRF part were concerned, the relationships between as–deposited microstructure and the local solidification conditions such as solidification velocity and temperaturgradient of moving melting pool were also investigeted. A coupled 2D transient finite element LRF epitaxial growth model was developed. The morphology evolution and first order dendrite arm space λ1 distribution in 2.8 mm high LRF 316L stainless steel wall were simulated. The results show that the microstructure of LRF 316L stainless steel wall is mainly columnar austenitic dendrites, and the λ_1 gradually becomes larger from the bottom about 6.5 μm to the top about 17 μm which is in good agrement with te experimntal. Further more, on the basis of the validated model, morphology volution and λ1 distribution in 40 mm high LRF 316L stainless steel wall are also predicted.

Keywords: 316L stanless steel laseapid forming (LRF) microstructure numerical simulation

收稿日期 2009-03-27 修回日期 2009-06-30 网络版发布日期 2010-01-18

DOI: 10.3724/SP.J.1037.2009.00192

基金项目:

国家科技支撑计划项目2007BAE07B05和国家自然科学基金项目50331010资助

通讯作者: 贺卫卫

作者简介: 贾文鹏, 男, 1969年生, 博士

作者Email: jwp1731@sina.com.cn

扩展功能
本文信息
Supporting info
PDF(1257KB)
[HTML全文]
参考文献[PDF]
参考文献
服务与反馈
把本文推荐给朋友
加入我的书架
加入引用管理器
引用本文
Email Alert
文章反馈
浏览反馈信息
本文关键词相关文章
316L不锈钢
激光快速成形(LRF)
微观组织
模拟
本文作者相关文章
贾文鹏
汤慧萍
PubMed
Article by Gu,W.P
Article by Tang,H.P

参考文献：

[1] Huang W D. Laser Solid Forming. Xi’an: Northwestern Polytechnical University Press, 2007: 16
(黄卫东. 激光立体成形. 西安: 西北工业大学出版社, 2007: 16)
[2] Liu Z X, Huang W D, Yang S. Chin J Nonferrous Met, 2002; 12: 458
(刘振侠, 黄卫东, 杨 森. 中国有色金属学报, 2002; 12: 458)
[3] Zhao Y Z, Shi Y W. Mater Rev, 2003; 17: 14
(赵玉珍, 史耀武. 材料导报, 2003; 17: 14)
[4] Dress W B, Zacharia T, Radhakrishnan B. In: Zacharia T ed., International Conference on Modeling and Control of Joining Process, AWS/ORNL Orlando, Florida, 1993: 10
[5] Grujicic M, Cao G, Figliola R S. Appl Surf Sci, 2001; 43: 57
[6] Lin X, Yang H O, Chen J, Huang W D. Acta Matell Sin, 2006; 42: 368
(林 鑫, 杨海欧, 陈 静, 黄卫东. 金属学报, 2006; 42: 368)
[7] Liu J C, Li L J. Opt Laser Technol, 2005; 37: 292
[8] Toyserkani E, Khajepour A, Corbin S. Opt Lasers Eng, 2004; 41: 867
[9] Jia W P, Chen J, Lin X, Zhong C W, Huang W D. Acta Metall Sin, 2007; 43: 552
(贾文鹏, 陈 静, 林 鑫, 钟诚文, 黄卫东. 金属学报, 2007; 43: 552)
[10] Lin X, Li Y M, Wang M, Feng L P, Chen J, Huang W D. Sci China, 2003; 33: 460
(林 鑫, 李延民, 王 猛, 冯丽萍, 陈 静, 黄卫东. 中国科学, 2003; 33: 460)
[11] Porter D A, Easterling K E. Phase Transformations in Metal and Alloys. 3rd Ed., London: Chapman and Hall, 1992: 168
[12] Poole W J , Weinberg F. Metall Mater, 1998; 29A: 861
[13] Kurz W, Fisher D J. Foundamentals of Solidification. 3rd Ed., Aedermansdorf, Switzerland, Trans Tech Publications, 1992: 233

本刊中的类似文章

1．杨显杰,高庆,何国求,蔡力勋.316不锈钢的非比例循环特性[J]. 金属学报, 1996,32(1): 15-22

2．乔冰 杜荣归 陈雯 朱燕峰 林昌健.NO_2^-和Cl^-对模拟混凝土孔隙液中钢筋腐蚀行为的影响[J]. 金属学报, 2010,46(02): 245-250

3．宋仁伯 项建英 侯东坡 任培东.316L不锈钢热加工硬化行为及机制[J]. 金属学报, 2010,46(01): 57-61

4．罗 键 王向杰 赵国际 王家序.CO_2+电磁搅拌复合堆焊梯度功能层的微观组织及性能研究[J]. 金属学报, 2009,45(12): 1487-1492

5．姚宗勇 刘庆 A. Godfrey 刘伟.大应变量冷轧AA1050铝合金微观组织与织构的演变[J]. 金属学报, 2009,45(6): 647-651

6．金涛 孙晓峰 赵乃仁 刘金来 张静华 胡壮麒 .单晶镍基高温合金DD8激光快速熔凝组织[J]. 金属学报, 2009,45(6): 711-716

7．徐韦锋 刘金合 栾国红 董春林.厚板铝合金搅拌摩擦焊接头不同状态微观组织与力学性能[J]. 金属学报, 2009,45(4): 490-496

8．江慧丰 陈学东 范志超 董杰 姜恒 陆守香.动态应变时效对316L不锈钢疲劳蠕变行为的影响[J]. 金属学报, 2009,45(3): 326-330

9．王荣山 侯怀宇 陈国良.非晶Cu在晶化过程中的分子动力学模拟[J]. 金属学报, 2009,45(6): 692-696

10．王旭, 张俊善, 雷明凯 .强流脉冲离子束辐照对316L不锈钢表面改性的实验研究[J]. 金属学报, 2007,43(4): 393-398