

论文

搅拌头机械载荷在搅拌摩擦焊接中的作用的数值分析

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摘要:

利用数值模拟技术分析搅拌头机械载荷在焊接过程中的作用, 通过对比只考虑热载荷, 考虑热载荷和搅拌头的下压力, 综合考虑热载荷、搅拌头下压力和工作扭矩三种条件下的应力、应变和变形, 结果发现, 搅拌头下压力使焊后残余应力值大幅下降; 搅拌头的工作扭矩是焊后残余应力、应变不对称分布的重要影响因素; 并且搅拌头机械载荷使得薄板焊后残余变形的模式发生了完全相反的变化, 由不考虑搅拌头载荷时的马鞍状变成了反马鞍状。

关键词: 搅拌摩擦焊 数值模拟 残余应力 残余应变 残余变形

NUMERICAL ANALYSIS ON THE FUNCTIONS OF STIR TOOL'S MECHANICAL LOADS DURING FRICTION STIR WELDING

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Abstract:

Besides lower welding temperature and solid phase welding process, another significant difference between friction stir welding and conventional fusion welding (FSW) is that the forming of weld seam in FSW is effected by both thermal load and mechanical loads of stir tool. However, the definite functions of mechanical loads of stir tool in FSW process are not clearly described. With FSW experiments, only the material flow around stir tool can be observed, from which the results were obtained that the mechanical loads of stir tool gave birth to the plastic flow, a key factor of weld formation, of intermetallic metal around the tool. In the simulation of FSW process, mechanical loads are always neglected in most analysis models, which can't describe the unique characteristic of FSW. Although the mechanical loads have been considered in FSW simulation by some researchers, the loads are greatly simplified and the analysis is only localized in the asymmetric distribution of residual stress. In this paper, numerical simulation was applied to investigate the functions of mechanical loads during FSW process. Based on experiments of FSW aluminium alloy sheets, three simulation models were established with different conditions of considering thermal load only, considering both thermal load and down force, and considering thermal load, down force and working torque synthetically. The results show that the down force significantly reduces residual stress and the torque leads to the unsymmetrical distribution of residual stress. On the other hand, mechanical loads absolutely change the residual distortion pattern from saddle state into anti-saddle state. Mechanical loads strengthen the mechanical restriction on sheet, forge and extrude the materials around tool, so the residual strain in weld zone is reduced, which leads to the eduction of residual stress. Furthermore, the mechanical loads change the correlaton of strain on top surface and bottom surface of sheet, which resultes in the change of distortion pattern.

Keywords: friction stir welding numerical simulation residual stress residual strain residual distortion

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