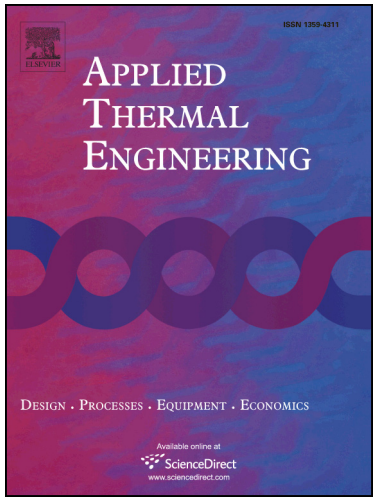

Research Paper

The prediction of the whole weld in fiber laser keyhole welding based on numerical simulation

Yuewei Ai, Ping Jiang, Xinyu Shao, Peigen Li, Chunming Wang, Gaoyang Mi, Shaoning Geng, Yang Liu, Wei Liu

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The prediction of the whole weld in fiber laser keyhole welding based on numerical simulation

Yuewei Ai[a], Ping Jiang[a,] *, Xinyu Shao[a], Peigen Li[a], Chunming Wang[b], Gaoyang Mi[b], Shaoning Geng [a], Yang Liu[a], Wei Liu[a]

[a]The State Key Laboratory of Digital Manufacturing Equipment and Technology, School of Mechanical Science and Engineering, Huazhong University of Science & Technology, 430074 Wuhan, P.R. China

[b]School of Materials Science and Engineering, Huazhong University of Science & Technology, 430074 Wuhan, P.R. China

Abstract

The quality of the welded joints is greatly affected by the appearance and geometry of the weld bead. Understanding the formation mechanism of whole weld bead has great theoretical significance and engineering value. This paper proposes a novel three-dimensional model considering the heat transfer, keyhole free surface, surface tension and recoil pressure for simulating the formation process of the weld bead and predicting its full sizes in the fiber laser keyhole welding. To improve the simulation accuracy, the relationship between the weld geometry and welding process parameters is established and taken into consideration in the numerical modeling. Based on the model, the keyhole phenomena and weld bead formation process have been revealed. During the numerical simulation, the weld shape including the width, reinforcement and penetration are all calculated, as well as the corresponding size. The validity of the proposed model is confirmed by experiments, and the calculated results show good agreement with the experimental values. Additionally, the changing tendency of the weld geometry affected by the welding process parameters is analyzed by simulation and the results are found to be consistent with the theoretical and experimental data. Therefore, the proposed method is very effective for improving the weld shape and welded joints quality.

Keywords: Weld formation; Laser welding; keyhole; Numerical simulation

1 Introduction

Laser welding has been widely used in a variety of industrial applications due to the advantages of high power intensity, high productivity, high penetration and narrow heat affected zone. With the high energy density from the input heat source loading on the workpiece, the region evaporated materials forms the keyhole rapidly. During the laser keyhole welding, the involved complex multiphase flows and the frequently instable keyhole behavior in the laser keyhole welding may greatly influence the formation of the weld bead and the welding quality. Weld shape size is as one of the most significant factors result from which is critical to judge the quality of welded joints [1]. The welded joints quality can be defined in terms of properties like the weld bead geometry, mechanical properties, and distortion [2-3]. Therefore, how to accurately predict the weld shape under different process

*Corresponding author.

E-mail address: jiangping@mail.hust.edu.cn