VIETNAM NATIONAL UNIVERSITY – HCMC
Ho Chi Minh City University of Technology

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INFORMATION OF THE DISSERTATION

Title: **INVESTIGATION OF MECHANICAL PROPERTIES OF ROTARY FRICTION WELDED TITANIUM ALLOYS AND OPTIMIZATION**

Major: Machanical Engineering

Major code: 62.52.01.03

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1. Abstract

Titanium alloy Ti6Al4V is a lightweight, high-strength material that is widely used in the aerospace industry. Titanium alloys are also very important materials in other manufacturing fields, such as the automotive and medical device industries. Components manufactured from an original block of material are expensive due to the proportionally large amount of material that is purchased compared to the amount that remains after machining. However, conventional fusion welding of high-strength titanium alloys is generally conducive to poor mechanical properties. Friction welding is a potential method for intensifying the mechanical properties of suitable geometry components. In this dissertation, the rotary friction welding (RFW) method is used to study the feasibility of producing similar metal joints of high-strength titanium alloys. To predict the upset and

temperature and identify the safe and suitable range of parameters, a thermomechanical model was developed. The upset predicted by the finite element simulations was compared with the upset obtained by the experimental results. The numerical results are consistent with the experimental results. Particularly, high upset rates due to generated power density and forging pressure overload that occurred during the welding process were investigated. The performances of the welded joints are evaluated by conducting microstructure studies and Vickers hardness at the joints. The titanium rotary friction welds achieve a higher tensile strength than the base material. The friction welding parameters, such as speed, axial pressure and friction time, have a great influence on the quality of the joint strength. In addition, the microhardness and tensile strength at different locations in the welded area are not homogeneous, so it is necessary to determine the trend for the hardness distribution to find the weakest positions in a rotating friction weld. The experimental results show that the weld quality, in terms of the tensile strength and hardness, decreases radially. Therefore, the radius of the welded parts that are viable for rotating friction welding is limited because the areas located far from the centre of the axis have poor mechanical properties. The parameter that impacts the tensile strength and microhardness the most during rotary friction welding of Ti6Al4V is the axial pressure, which includes the friction pressure and forging pressure. A high forging pressure produces fine, equiaxed, and recrystallized grain structures in the welded joint, resulting in a high tensile strength and microhardness. In addition, an increased forging pressure can be used in rotary friction welding to reduce the radial differences in the mechanical properties of the welded joints.

2. Objectives of the dissertation

Studying the characteristics and properties of Ti6Al4V alloy rotary friction weld, the influence of the main technological parameters on the quality of the weld, and thereby finding the suitable working parameters ranges to ensure the quality of the weld.

3. Contribution of dissertation

The quality of the friction weld is closely related to the welding technology parameters. The change of one of these welding technology parameters can lead to different results of the weld. Suitable welding technology parameters are usually determined through many experiments. The experimental method is effective but expensive, especially in the case of welding high-cost superalloy materials. Ti6Al4V titanium alloy material is a material with many typical applications and high cost. Therefore, to study the rotational friction welding process of titanium alloy Ti6Al4V, the dissertation has conducted numerical simulation studies combined with experimental analysis to provide suitable technological parameters for this alloy. The research contents of the dissertation are as follows:

Content 1, the dissertation studies and builds a thermomechanical numerical model used to simulate the rotational friction welding process to predict temperature, stress, and heat-affected area width. The numerical simulation results given in the content are the basis for selecting welding technology parameters for the rotational friction welding process.

Content 2, the dissertation empirically researches and analyzes the micro-organization of the rotational friction weld and checks the mechanical properties of the friction weld, such as the hardness, tensile strength, and impact toughness of the weld. From this experimental result, the dissertation will determine the influence of welding technology parameters on the mechanical properties of Ti6Al4V titanium alloy rotary friction weld.

Content 3, the dissertation provides a suitable set of technological parameters for the rotational friction welding process for Ti6Al4V determined through the experimental planning method.

Science advisors

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