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A literature review of Ti-6Al-4V linear friction welding

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ABSTRACT

Linear friction welding (LFW) is a solid-state joining process that is an established technology for the fabrication of titanium alloy bladed disks (blisks) in aero-engines. Owing to the economic benefits, LFW has been identified as a technology capable of manufacturing Ti-6Al-4V aircraft structural components. However, LFW of Ti-6Al-4V has seen limited industrial implementation outside of blisk manufacture, which is partly due to the knowledge and benefits of the process being widely unknown. This article provides a review of the published works up-to-date on the subject to identify the "state-of-the-art". First, the background, fundamentals, advantages and industrial applications of the process are described. This is followed by a description of the microstructure, mechanical properties, flash morphology, interface contaminant removal, residual stresses and energy usage of Ti-6Al-4V linear friction welds. A brief discussion on the machine tooling effects is also included. Next, the work on analytical and numerical modelling is discussed. Finally, the conclusions of the review are presented, which include practical implications for the manufacturing sector and recommendations for further research and development. The purpose of this article is to inform industry and academia of the benefits of LFW so that the process may be better exploited.

Contents

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1. Introduction

Linear friction welding (LFW) is a solid-state joining process that works by oscillating one workpiece relative to another while under a large, compressive force; see Fig. 1(a). The friction between the oscillating surfaces produces heat which causes the interface material to plasticise. The plasticised material is then expelled from the interface causing the workpieces to shorten (burn-off) in the direction of the compressive force [1–4]. During the burn-off the interface contaminants, such as oxides and foreign particles, which can affect the properties [5,6] and possibly the service life of a weld [7], are expelled from

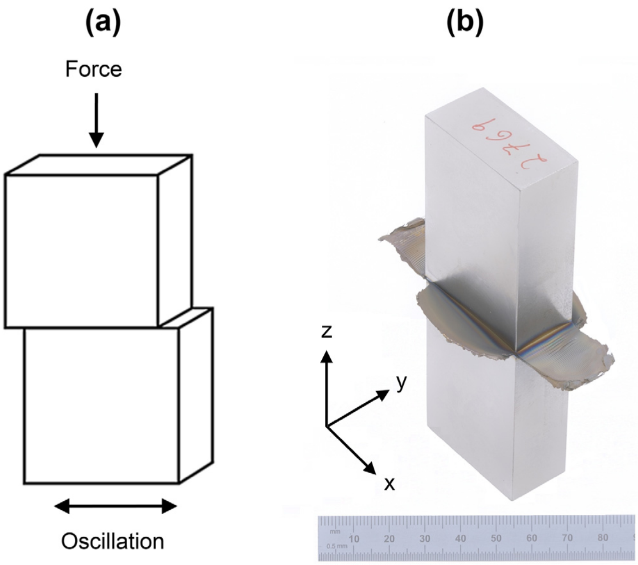

Fig. 1. (a) **LFW process schematic and (b) a completed Ti-6Al-4V weldment showing the expelled interface material (flash), where the oscillatory motion occurred in the 'x' direction** [16].