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EXPERIMENTAL STUDY AND ANALYSIS OF THE WEAR PROPERTIES OF FRICTION-STIR-WELDED AA7075-T6 AND A384.0-T6 DISSIMILAR ALUMINIUM ALLOYS OF BUTT JOINTS

EKSPERIMENTALNA ŠTUDIJA IN ANALIZA OBRABE ZVAROV, IZDELANIH Z ROTACIJSKIM TORNIM VARJENJEM RAZNOVRSTNIH ZLITIN AA7075-T6 IN A384.0-T6

Karuppannan Anganan[1], Subramaniam Prabagaran[2], Mayakrishnan Muthukrishnan[3]

[1]Karpagam Academy of Higher Education, Coimbatore, Department of Mechanical Engineering, 641 021 Tamil Nadu, India
[2]Karpagam Academy of Higher Education, Department of Mechanical Engineering, Coimbatore, 641 021 Tamil Nadu, India
[3]Kalaignar Karunanidhi Institute of Technology, Department of Mechanical Engineering, Coimbatore, 641 402 Tamil Nadu, India
anganan09@gmail.com

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The wear is one of the main issues in friction-stir welding (FSW) of dissimilar aluminium alloys. Two dissimilar metals welded with FSW have different mechanical, metallurgical and chemical properties compared to the parent materials. Therefore, the wear resistance is an important property in an FSW process. In this research, AA7075-T6 and A384.0-T6 aluminium alloys with a thickness of 6.35 mm were selected and a design matrix was developed to produce FSW welds using the MINITAB-17 software. Friction-stir-welded pieces were made as test specimens and their ultimate tensile strengths (UTSs) were tested. In these experiments, the maximum- and minimum-UTS specimens were used for a wear-resistance analysis and its results were compared with the wear resistance of the parent metals. The results were obtained by keeping the revolutions per minute (min^{-1}), time and sliding velocity as constants, while varying the load applied. The rpm, time and sliding velocity were 500, 300 s and 3.141 m/s, respectively. The loads applied were (20, 40 and 60) N. The conclusion is that, under all the applied loads, the wear of the friction-stir weld produced is lower than that of the A384.0-T6 aluminium base metal. On the other hand, the wear of the weld is higher than the AA7075-T6 aluminium base metal.

Keywords: wear resistance, dissimilar aluminium alloys, friction-stir welding, base metals, wear-resistance parameters

Obraba raznovrstnih aluminijevih zlitin je ena od glavnih tem v raziskavah na področju rotacijskega tornega varjenja (FSW; angl.: Friction Stir Welding). Dve različni kovini, ki ju varimo, imata med FSW različne mehanske, metalurške in kemične lastnosti v primerjavi s sorodnimi materiali. Odpornost proti obrabi je pomembna lastnost v FSW-procesu. V tej raziskavi so avtorji izbrali dve Al zlitini AA7075-T6 in A384.0-T6 debeline 6,35 mm in z njima oblikovali matrico za FSW-zvare z uporabo programske opreme MINITAB-17. Izdelali so vzorce varjene s postopkom FSW in določili natezno trdnost zvarov. Nato so za nadaljnje preiskave obrabe izbrali vzorce z najmanjšo in največjo natezno trdnostjo in jih primerjali z FSW-zvari, izdelanimi iz sorodnih materialov. Med eksperimenti so držali konstantne naslednje procesne parametre varjenja: število obratov na minuto (500 min^{-1}), čas (300 s) in hitrost drsenja (3,141 m/s); spreminjali pa so obremenitev (20, 40 in 60) N. Avtorji so v tej raziskavi ugotovili, da je obrabna obstojnost zvarov, izdelanih z FSW drugačna od obrabe zvarov izdelanih iz osnovne Al zlitine A384.0-T6 pri vseh obremenitvah. Obrabna obstojnost izdelanih zvarov iz izbranih nesorodnih zlitin pa je primerljiva z zvari izdelanimi iz Al zlitine AA7075-T6.

Ključne besede: odpornost proti obrabi, raznovrstne Al zlitine, rotacijsko torno varjenje, osnovne kovine, parametri obrabne odpornosti

1 INTRODUCTION

FSW is one of the solid-state fumeless welding techniques. It was invented, developed and patented in 1991 by Wayne Thomas, The Welding Institute, United Kingdom.[1] For our experiment, the plates to be welded were placed adjacent to each other and tightly clamped by a specially made fixture. A tool was fitted to a chuck and that was then fitted to the spindle of an FSW machine. **Figure 1** depicts the FSW machine. A rotating tool with an axial pressure force and longitudinal movement was inserted between the two plates. Hence, as a stirring action takes place between the plates, heat is developed and the metals are plastically deformed and joined together.[2] The concept of an FSW process is shown in **Figure 2**. After the FSW process, the mechanical, metallurgical, thermal and chemical properties are changed compared to the parent-material properties. In this research, the wear properties were analysed.

L. Guo et al.[3] investigated the lubrication effect of annealed Fe78Si9B13 glass particles in the FSW of the AA6061 metal and found that the particles play an important role in improving the wear resistance. S. K. Naimuddin et al.[4] conducted an experimental study analysis of similar and dissimilar joints of the materials of (AA6061-AA6061), (AA6082-AA6082) & (AA6061-AA6082) under T6 conditions to find the wear behaviours. They found low wear and low wear resistance in the FSW welds. A. M. Hassan et al.[5] experimentally studied the wear characteristics of aluminium-