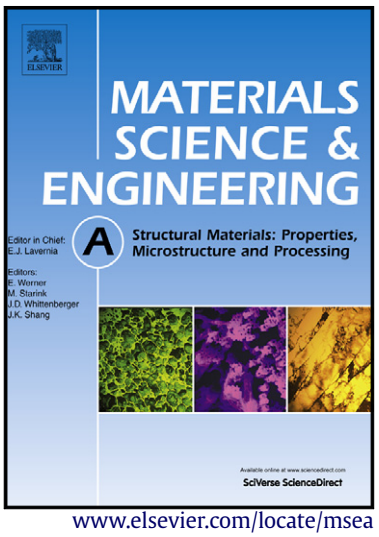

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C.B. Jagadeesha

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Dissimilar friction stir welding between aluminum alloy and magnesium alloy at a low rotational speed

C.B. Jagadeesha

Department of Mechanical Engineering, Indian Institute of Science, Bangalore, Bengaluru- 560012, India

Tel.: +91 9880 529 105; fax: +91 80 2360 0648.

E-mail address: jagscb1966@gmail.com

Abstract

A sound weld was obtained between 2024-T3 Al alloy and AZ31B-O Mg alloy dissimilar metal plates of 5 mm thickness, at a rotational speed of 300 rev min^{-1} and at a welding speed of 50 mm min^{-1}. One of the parameter studied was, the effect of interface offset variation, on the quality and properties of the welded samples and on the thickness of intermetallic layer formed in the welded samples. The intermetallic layer at the midst of the weld volume contains intermetallic compounds $Al_{12}Mg_{17}$ and Al_3Mg_2. Highest tensile strength of 106.86 MPa, corresponding tensile joint efficiency of 44.52% and corresponding elongation 1.33% were obtained for the tensile sample, with interface offset of 0.66 mm from zero interface offset in retreating side and with approximate least intermetallic thickness of 1.2 μm. Dissimilar friction stir welded joint samples had failed completely in brittle fracture mode; the position of tensile fracture was located at the midst of intermetallic layer, which had maximum hardness and minimum ductility. The nano hardness values fluctuate in the weld nugget owing to dynamic recrystallization of alloy materials and formation of brittle intermetallic compounds of alloy materials in the weld nugget; maximum hardness of 10.74 GPa occurred for the sample with least intermetallic thickness of 1.2 μm.

Keywords: Dissimilar friction stir welding; Magnesium alloy; Aluminum alloy; Intermetallic compounds; Tensile strength; Hardness distribution

1. Introduction

Compared to other alloys, Al alloys and Mg alloys have lower density and high specific strength. These are extensively used in automotive, aerospace and ship industries. Owing to the difference in chemical, physical and mechanical properties between components made up of Al, Mg or their alloys, the welding of dissimilar materials is generally more difficult than that of homogeneous materials. It is difficult to produce high quality Al, Mg dissimilar joint by fusion welding technique for the following reasons: the formation of brittle intermetallics (IMs) and formation of cracks. So dissimilar welding of Mg, Al and their alloys is a challenging technique to be developed.

Friction stir welding (FSW) is an innovative method developed by TWI in UK in 1991[1]. Sound butt and lap welds have been accomplished by FSW[2].Use of FSW to weld Al alloys [3] and Mg alloys or, to weld Al alloy to Mg alloy has increased substantially in recent years, since these are difficult to weld by fusion welding technique [4]. The side of the tool where linear velocity vector of the rotating tool is same as the welding direction vector is called advancing side (AS) and the side where both of these vectors are opposite to each other is called retreating side (RS). The front portion of the moving tool is