Int J Adv Manuf Technol
DOI 10.1007/s00170-016-9225-9

ORIGINAL ARTICLE

A review on resistance spot welding of aluminum alloys

S. M. Manladan [1,2] · F. Yusof [1,3] · S. Ramesh [1,3] · M. Fadzil [3] · Z. Luo [4,5] · S. Ao [4]

Received: 3 May 2016 / Accepted: 25 July 2016

Abstract This paper presents a review on the resistance spot welding (RSW) of Al/Al alloys, Al alloys/steel, Al/Mg alloys, and Al/Ti alloys, with focus on structure, properties, and performance relationships. It also includes weld bonding, effect of welding parameters on joint quality, main metallurgical defects in Al spot welds, and electrode degradation. The high contact resistance, induced by the presence of oxide layer on the surface of Al alloys, and the need for application of high welding current during RSW of Al alloys result in rapid electrode tip wear and inconsistency in weld quality. Studies have shown that cleaning the oxide layer, sliding of a few microns between sheets, enhancing the electrode force, and the application of a low-current pre-heating can significantly reduce the contact resistance and improve joint quality. For Al/steel dissimilar RSW, the technique of resistance element welding, the use of optimized electrode morphology, the technique of RSW with cover plates, and the use of interlayers such as Al-Mg, AlSi12, and AlCu28 alloys were found to suppress the formation of brittle intermetallic compounds (IMC) and improve the joint quality. The employment of pure Ni foil, Au-coated Ni foil, Sn-coated steel, and Zn-coated steel interlayers was also found to restrict the formation of brittle IMCs during RSW of Al/Mg alloys. Furthermore, the techniques of RSW with cover plates and RSW under the influence of electromagnetic stirring effect were found to improve the weldability of Al/Ti dissimilar alloys.

Keywords Resistance spot welding · Aluminum alloys · Magnesium alloys · Titanium alloys · Microstructure · Intermetallic compounds · Failure mode · Weld bonding · Metallurgical defects · Electrode degradation · Welding parameters

✉ F. Yusof
farazila@um.edu.my

S. M. Manladan
smmanladan.mec@buk.edu.ng

S. Ramesh
ramesh79@um.edu.my

M. Fadzil
ibnjamaludin@um.edu.my

Z. Luo
lz@tj.edu.cn

S. Ao
aosanmick@163.com

[1] Department of Mechanical Engineering, Faculty of Engineering, University of Malaya, 50603 Kuala Lumpur, Malaysia

[2] Department of Mechanical Engineering, Faculty of Engineering, Bayero University, Kano, 3011 Kano, Nigeria

[3] Center for Advanced Manufacturing and Materials Processing (AMMP), Faculty of Engineering, University of Malaya, 50603 Kuala Lumpur, Malaysia

[4] School of Materials Science and Engineering, Tianjin University, Tianjin 300072, China

[5] Collaborative Innovation Center of Advanced Ship and Deep-Sea Exploration, Shanghai 200240, China

1 Introduction

Fossil fuel combustion is one of the largest sources of anthropogenic greenhouse gas emission [1, 2]. Thus, the transportation industry, the largest consumer of fossil fuel, is continuously exploring strategies to improve fuel efficiency and reduce greenhouse gas emission. These strategies include weight reduction, improving conventional engine efficiency, developing new and more energy efficient powertrains, such

Published online: 05 September 2016