Accepted Manuscript

Title: Hybrid ultrasonic spot welding of aluminum to carbon fiber reinforced epoxy composites

Authors: Francesca Lionetto, Frank Balle, Alfonso Maffezzoli

PII: S0924-0136(17)30168-1
DOI: http://dx.doi.org/doi:10.1016/j.jmatprotec.2017.05.002
Reference: PROTEC 15210

To appear in: *Journal of Materials Processing Technology*

Received date: 12-12-2016
Revised date: 31-3-2017
Accepted date: 3-5-2017

Please cite this article as: Lionetto, Francesca, Balle, Frank, Maffezzoli, Alfonso, Hybrid ultrasonic spot welding of aluminum to carbon fiber reinforced epoxy composites.Journal of Materials Processing Technology http://dx.doi.org/10.1016/j.jmatprotec.2017.05.002

Hybrid ultrasonic spot welding of aluminum to carbon fiber reinforced epoxy composites

Francesca Lionetto[1]*, Frank Balle[2], Alfonso Maffezzoli[1]

[1]Department of Engineering for Innovation, University of Salento, via per Monteroni, 73100 Lecce, Italy

[2] Institute of Materials Science and Engineering, Hybrid Materials Engineering Group, University of Kaiserslautern, P.O. Box 3049,67653 Kaiserslautern, Germany.

*corresponding author: francesca.lionetto@unisalento.it

Abstract

Ultrasonic metal welding has been applied for joining aluminum AA5754 sheets to a thermoset matrix composite consisting in a carbon fiber reinforced epoxy resin (CF-epoxy). To overcome the limitations of thermosetting resins, that, unlike thermoplastic polymers, cannot melt due to their chemical structure, a thermoplastic film of Polyamide 6 (PA6) has been used as a surface layer of the CF/epoxy stack before curing. The functional surface created on the thermoset matrix composite enables a fast welding with a metallic sheet. By a proper selection of welding energy and force, an average adhesion strength of 34.8 MPa has been obtained on CF/epoxy-PA6-AA5754 ultrasonically welded joints.

The morphological characterization has revealed that the aluminum-composite interface is characterized by carbon fibers in a direct contact or even embedded in aluminum, whose surface presents pores and crevices due to the pronounced plastic deformation of the Al interfacial area.

Keywords: Ultrasonic welding; ; ; , Fiber reinforced composites, Joining, Dissimilar materials.

Introduction

The increasing application of lightweight and high performance materials as well as environmental-friendly technologies in automotive, aeronautic and marine industries has pushed to the use of multi-material design, where metallic and non-metallic materials are merged to hybrid components. Multi-material design is possible if an efficient joining of dissimilar materials such as metals to composite materials is performed overcoming the difficulties related to the strong dissimilar physical–chemical properties of the joining materials. Haddadi and Abu-Farha (2015) reported that reaction at the interface and material incompatibilities are the most challenging barriers in joining dissimilar materials. Traditionally, dissimilar materials are joined by adhesive bonding or mechanical fasteners, even if the latter, in the case of metal-composite joining, present several limitations in addition to the intense labor required. Graham et al. (2014) and Liu et al. (2014) have reported that the major drawbacks of mechanical fasteners derive from drilling operations which interrupt fiber