Author's Accepted Manuscript

www.elsevier.com/locate/ijadhadh

Experimental analysis of Laser assisted joining of Al-Mg aluminium alloy with Polyetheretherketone (PEEK)

F. Lambiase, S. Genna

PII: S0143-7496(18)30096-4
DOI: https://doi.org/10.1016/j.ijadhadh.2018.04.004
Reference: JAAD2180

To appear in: *International Journal of Adhesion and Adhesives*

Received date: 23 December 2017
Accepted date: 29 March 2018

Cite this article as: F. Lambiase and S. Genna, Experimental analysis of Laser assisted joining of Al-Mg aluminium alloy with Polyetheretherketone (PEEK), *International Journal of Adhesion and Adhesives,* https://doi.org/10.1016/j.ijadhadh.2018.04.004

Experimental analysis of Laser assisted joining of Al-Mg aluminium alloy with Polyetheretherketone (PEEK)

F. Lambiase[a,c*], S. Genna[b,c]

[a]Dept. of Industrial and Information Engineering and Economics, University of L'Aquila, via G. Gronchi 18, Zona Industriale di Pile, 67100 (AQ), Italy

[b]Dept. of Enterprise Engineering, University of Rome Tor Vergata, Via del Politecnico 1, 00133 Rome, Italy

[c]CIRTIBS Research Centre, University of Naples Federico II, P.le Tecchio 80, 80125 Naples, Italy

[*]Corresponding author: F. Lambiase Monteluco di Roio, 67040 (AQ), Italy Tel. N.: (+39) 0862 434343 Fax N.: (+39) 0862 434303, francesco.lambiase@univaq.it

Abstract

The work is aimed at understanding the influence of process parameters of Laser Assisted Joining of Al-Mg alloy with Polyetheretherketone (PEEK) on the mechanical behavior of the joints. Experimental joining tests were performed by means of a diode laser, with maximum power of 200 W. Laser texturing was performed on the aluminium substrate before joining. These joints exploited the penetration of the aluminium teeth (produced by texturing) into the polymer surface. Laser spot joints were produced by varying the laser beam power and supplied energy. The temperature distribution was monitored during the joining process by means of IR camera. Mechanical characterization tests, based on single lap shear tests, were conducted. Fracture surface analysis was carried out by means of optical microscopy. Different fracture modes were observed depending on the amount of penetration and the presence of bubbles at the substrates interface. The maximum strength of the joints was obtained for P=200 W and E=2000 J. Under these conditions, the average strength reached 30 MPa, corresponding to 53 % of the PEEK shear strength.

Keywords: Laser assisted Joining, direct joining, polymers, hybrid joints, thermal analysis, morphology.

1. Introduction

Polymer-Metal Composite Structures (PMCS) are attracting great attention from the industry because they enable the possibility to achieve superior performances as compared to monolithic components made by metals and polymer their selves. The main problem when producing PMCS is represented by the coupling method of metals with polymers. To this end, different processes have been proposed in the recent years. Conventional joining processes between metals and polymers generally involve mechanical fastening or adhesive bonding. Both these classes of processes involve several limitations and problems. Adhesive bonding enables almost uniform distribution of stress during service life, good fatigue life, corrosion resistance, and high strength-to-weight ratio. However, the process requires specialized workers, substrate preparation and long curing time that increase the process cost, the production time and it involves high environmental impact. In addition, adhesive bonds are affected by high environmental sensitivity (like humidity and temperature) and great uncertainty regarding long-term structural integrity. Mechanical joining processes typically involve external fasteners such as rivets or bolts, which increase the structure weight and cost. In addition, high stress concentration develops around the spot joints. Furthermore, mechanical joining processes often require relatively extensive pre-processing mainly due to the hole-drilling process.

When dealing with metals and thermoplastic polymers, different solutions are available including: Friction Stir Welding, Friction Spot Welding and Friction Spot Joining, Friction Assisted Joining (FAJ), ultrasonic joining, Laser-Assisted Joining (LAJ). These processes produce spot or continuum joints between substrates of different materials within a short cycle time, without external fasteners and with high joint efficiency. Most of the aforementioned processes are based on the polymer thermoforming around the metal substrate. Herein, the polymer is directly or indirectly heated by an external source, e.g. a laser source or a rotating tool. For example, in FAJ the tool heats the material by friction, and is forced against the metal part by means of an external pressure.