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Refill Friction Stir Spot Welding of 7075-T6 aluminium alloy single-lap joints with polymer sealant interlayer

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Abstract

With the addition of a sealant interlayer, 7075-T6 aluminium alloy sheets were refill friction stir spot welded (RFSSW). Two sealants were used in the investigations: phenol-formaldehyde resin-based adhesive and epoxy resin-based tape. Single-lap RFSSW joints were made in 0.8- and 1.6-mm-thick sheets, which corresponds to the actual thicknesses of welded stringer of aircraft skin. The welding of the sheets with polymeric interlayer lowered the tensile pure/shear load capacity of the joint from approximately 9% to 28%, according to the variant of sealant application. However, the polymer interlayer increases considerably the protection of the weld against the corrosion environment. Considering that the main indicator of joint quality is a tight interlayer of sealant between the faces of joined sheets and simultaneously a minimum degree of imperfection induced in the joint microstructure by sealant material, it can be concluded that the most advantageous joint variant is that with a single interlayer of epoxy-based tape.

Key words: 7075-T6 aluminium alloy, aircraft skin, fuselage, RFSSW, sealant

1. Introduction

Efforts to reduce aircraft weight have resulted in the increased use of light-weight aluminium alloys in elements of airframes. Under the structural fuselage attached to the aircraft skin there are many components that support airframe function. Several fasteners are used to join the entire airframe and its components, i.e. bolts, screws, rivets. Among the many methods used to join airframe structural components which are constructed from a wide variety of materials, the greatest number involve welding, adhesive bonding and special hybrid bonding techniques. In the last two decades, the Friction Stir Spot Welding (FSSW) technique has had widespread application in joining unweldable materials such as aluminium alloys [1, 2]. FSSW is a non-fusion solid state welding method which was developed as a novel technique suited for joining lightweight alloys.

During FSSW, the frictional heat generated at the tool-workpiece interface softens the joined materials, and the rotating and moving pin causes material flow. The forging pressure and stirring of the plasticised material result in the formation of a solid bond region [3]. The Refill Friction Stir Spot Welding (RFSSW) process, developed in 1999 by GKSS GmbH [4], involves four stages, including the plunge and refill stages. A detailed description of the welding procedure (friction heating, plunging, refilling and joint formation) using a 3-piece

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