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PII: S0263-2241(18)30834-0
DOI: https://doi.org/10.1016/j.measurement.2018.09.005
Reference: MEASUR 5863

To appear in: *Measurement*

Received Date: 13 March 2018
Revised Date: 29 July 2018
Accepted Date: 2 September 2018

Please cite this article as: R. Kumar, R. Singh, I. Ahuja, Friction stir welding of ABS-15Al sheets by introducing compatible semi-consumable shoulder-less pin of PA6-50Al, *Measurement* (2018), doi: https://doi.org/10.1016/j.measurement.2018.09.005

Friction stir welding of ABS-15Al sheets by introducing compatible semi-consumable shoulder-less pin of PA6-50Al

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Abstract

This study demonstrates the solution for compatibility issues between two dissimilar thermoplastic materials for friction stir welding (FSW) applications. The joints of similar thermoplastic materials possesses good mechanical strength and uniform morphological characteristics but dissimilar thermoplastic are difficult to join as they are having large variation in molecular weight, carbon chain length, melt flow index (MFI) and melting point etc. In the present study, MFI of dissimilar thermoplastics namely: acrylonitrile butadiene styrene (ABS) and polyamide (PA)6 was modeled by reinforcement of Al metal powder for enhancing the material compatibility. Reinforcement of 15% Al metal powder (by weight) to ABS (as ABS-15Al) and 50% to PA6 (as PA-50Al) resulted in the similar MFI range of 11.57g/10min and 11.97g/10 (with similar melting point range) confirmed the enhanced material compatibility with possibilities of sound FSW joints. Twin screw extrusion (TSE) and fused deposition modeling (FDM) were used to prepare the specimens of ABS-15Al and PA6-50Al and FSW was performed on conventional vertical milling setup. Further multi response optimization has been performed for establishing best settings of input process parameters.

Keywords: Friction stir welding, melt flow index, thermal properties, thermoplastics

1. Introduction

Dissimilar thermoplastics are having different mechanical, thermal, rheological, chemical and morphological characterises, which hinders its joining application; especially when thermoplastic needs to be compatible in basic nature e.g. in solid state welding [1]. ABS and PA6 are two dissimilarly characterized polymers which can be differentiated by their MFI [2].The MFI of thermoplastic material can be modified by reinforcement of micro-sized metal powder to polymer's matrix [3]. FSW as solid state welding technique is best applicable for similar material since similar materials possesses better joining compatibility [4]. Polymer compatibility is an important issue for its application in different engineering areas. It has been reported that pores and permeability of the polymeric blend is dependent upon rheological properties of polymers [5]. Sometimes blended materials result in poor mechanical strength [6]. The issue of non-compatibility occurs because thermoplastics are categorized by their unique