Aerospace Europe Conference 2023
Joint 10th EUCASS – 9th CEAS Conference

Abstract #XXX *(to be filled by the organizers)*
Preferred Topics: STRMAT / SUSTAV / CFDMPS
Corresponding author: Laura Mainini
e-mail of corresponding author: laura.mainini@collins.com
Type: Oral
Status of corresponding author: Regular
For student corresponding author: student member of one of the following:

Title

Thermoplastic Induction Welding for Sustainable Aircraft: an Industrial Perspective

Authors

Rémy Garcia[1], Igor Kiyanitsyn[2], Milan Mitrovic[2], Hajer Saada[1], Alfred Tang[2], Michel van Tooren[2], Laura Mainini[1]*

** Corresponding author*
[1] Collins Aerospace Applied Research & Technology, Cork, Ireland
[2] Collins Aerospace Advanced Structures, Chula Vista, CA, USA

Abstract

Thermoplastics components are of interest for the next generation of structures in the aerospace industry. One key property is their weldability that allows a reduction of manufacturing times and costs while also enabling broader opportunities for recyclability. In particular, thermoplastic induction welding [1] is an efficient way to join components together without the use of additional fasteners which would lead to lighter weight structures. All these elements can be pivotal to the development of more sustainable aircraft, which motivates the interest in scaling the adoption of thermoplastic induction welding to manufacture a broader family of structural components.

During the induction process eddy-currents are generated in composites to provide heating in specific areas and weld components together. To enable tailoring and scaling, different design variables characterizing inductor (coil) and welding process need to be considered: the coil shape, the amperage supplied to the coil, the speed and the distance of the coil from the component. These variables can be adjusted to achieve high precision welding [2,3]. Optimizing these variables has a direct impact on the quality of welding: minimizing time and energy, in turn making thermoplastics more affordable. The material composition and associated properties need also to be considered as it impacts the welding process. Manual tailoring is an import part of the thermoplastic induction welding recipe process. Automating these steps leads to more efficient experimental campaigns while improving the overall welding process.

These considerations motivate the interest in multidisciplinary design optimization (MDO) methodologies to broaden and scale the use of this welding technique [4,5]. The small amount of data available drives the use of physics-constrained learning [6] combined with efficient experimental testing campaign on use-cases of interest. Multiphysics modelling permits to capture complex and coupled physics phenomena [7,8], and is used to complement testing and support optimization by evaluation. This work provides an overview of the main research challenges associated with the use of induction welding of thermoplastic composites at scale. A framework of methods and approaches to address these challenges will be discussed together with ongoing projects and international partnerships. The goal is to automate and accelerate tailoring of welding recipes and inductors scaling over different families of aerospace structures

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