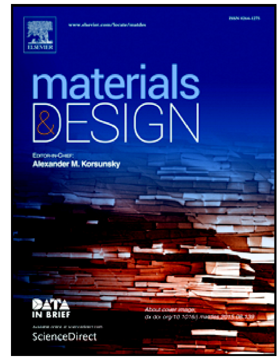

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Finite element modeling of continuous induction welding of thermoplastic matrix composites

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Abstract

Continuous induction welding for thermoplastic matrix composites requires an accurate modeling of the temperature distribution in the laminates, depending on the electromagnetic field. In this work, a transient three-dimensional finite element (FE) model was developed in order to study the heat transfer phenomena, and melting and crystallization in the welding area during the continuous induction welding of carbon fiber reinforced Poly(ether ether ketone) (CF/PEEK) laminates. The multiphysics problem was solved by coupling electromagnetic and heat transfer equations considering matrix melting and crystallization behavior. The model was able to simulate the continuous process along a linear path at a constant speed. The computed temperatures were in good agreement with experimental measurements. Several numerical simulation were used for selecting a processing window as a function of coil speed and current, for the welding of CF/PEEK joints. The results of welding experiments were evaluated by single lap shear tests and morphology characterization of the welded interfaces and fracture surfaces.

1. Introduction

Recently, thermoplastic matrix composites (TPCs) are replacing thermosetting matrix composites in many different applications, thanks to their easy processing, which does not need curing, long shelf life, lower storage costs, enhanced possibilities for recycling, high impact resistance, higher repair potential and the possibility of automated joining by welding [1],[2],[3],[4]. Composite welding leads to additional significant advantages given by reduced assembly time, number of fasteners and weight. Welding is able to overcome the limitations related to adhesive bonding avoiding the weight increase of a structure assembled by mechanical fastening [5],[6],[7]. Among the several fusion-bonding techniques available for joining thermoplastic matrix composites, which are based on different heating mechanisms, ultrasonic, resistance and induction welding reached an adequately high technology readiness level, being used to join large parts in different industrial applications [8], [9], [10], [11], [12], [13], [14], [15], [16].

Induction welding of metals has been recognized to be a very efficient technology, characterized by high production rates and selectivity of the heated area [17]. In the last three decades, induction welding has been studied for high speed