

# **AUTOMATED JOINING PROCESSES FOR HIGH-PERFORMANCE THERMOPLASTIC COMPOSITES**

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## **ABSTRACT**

Thermoplastic composites offer the advantage of automated joining by welding. Eurocopter in Germany has started to investigate and develop an automated welding technology based on inductive heating. This paper describes the first efforts based on screening tests, to identify materials and process constraints as well as design limitations.

Preliminary investigations on coupon level comprise induction heating of aerospace thermoplastic composites. The tests showed significant effects of the carbon fiber morphology, inductor-coil distance and edge effects on the time-temperature profile of the specimens investigated. For example, edge effects were found responsible for halving the heating time. These results will be used to further optimize the technologies and process parameters for joining of thermoplastic composite structures.

## **1. INTRODUCTION**

### **1.1 Background**

Carbon fiber reinforced thermoplastics offer several advantages compared to thermoset based composites. Besides the lower storage costs (no freezer and long storage life) and enhanced possibilities for recycling, a significant benefit is presented by the possibility of automated joining (welding) of thermoplastic composite parts. This can lead to a significant drop in lead time and reduction in number of fasteners resulting in more light-weight products.

Possible joining processes include welding technologies based on local heating by induction, electrical resistance or ultrasonic vibrations, as well as diffusion bonding by, for example, co-consolidation in a heated tool, hot press or autoclave. Together with partners, Eurocopter is currently investigating these technologies to produce and join helicopter and aircraft composite parts. Possible applications include stiffened skin structures, as well as assembly and integration of multiple parts. Therefore, automated joining resulting in a continuous bond line is aimed, which can be achieved by using robots or gantry systems with a dedicated functional robot head.

### **1.2 Aims**

One of the technologies that show great promise for industrialization is induction welding, as shown for the Gulfstream 650 [1]. Eurocopter Germany is currently investigating the automated induction welding technology for application into stiffened skin structures and integration of structures. One of the goals is to develop a continuous, but flexible automated process, such that a variety of parts can benefit from this technology. In order to learn more about the possibilities