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Preliminary study of the dry drilling process of CFRP/UNS A92024 stacks held together by adhesives

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Abstract

Currently Airship Building Industry (ABI) applies new developments of materials by stacking classics (as light alloys) and more recent (such as Carbon Fiber Reinforced Plastics) on different structural elements in order to improve the performance of the aircraft. Stacks have been usually formed by mechanical union although it provokes a weight increase. Because of this, adhesive joints have been proposed. However, this implies a third type of material, which is especially relevant in the drilling process required previously to the assembly procedure. High Performance Drilling (HPD) requires a good approximation to One Shot Drilling (OSD) and it can be affected by the presence of the adhesive in the interface CFRP-Metal, which can cause an increase of the drill defects. In this contribution, a preliminary study of the One Shot Dry Drilling (OSDD) Process of Adhesive Bound CFRP/UNS A92024 hybrid stacks have been achieved on the basis of the analysis of microgeometrical and dimensional deviations as a function of the cutting parameters applied (cutting speed and feed).

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Keywords: Dry drilling, hybrid stacks, adhesive bounding, dimensional accuracy, microgeometrical deviations

1. Introduction

At present, one of the main objectives of a productive system is the approach to the better situation of sustainability. This implies having tools that configure a system that balances its performance, at least in four of its axes: economic,

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energy, environmental and functional [1].

In this way, products of high functional performance are sought with an acceptable cost without having harmful effect on the environment in a context of energy efficiency.

Currently, thermoplastic and/or thermosetting Carbon Fiber Reinforced Plastic (CFRP) composite materials extend their use to a wide range of industrial sectors. These materials are especially attractive to the aeronautics sector given their excellent weight/mechanical properties ratio [2]. This makes them ideal components to be part of the structural elements manufactured in this sector, reducing their weight and improving the capacity/consumption ratio. The different manufacturing processes of CFRP allow to obtain from ultra-thin sheets (almost monolayers) to plates of large thickness. Both points often require a high production cost. For this reason, a tendency has begun in some industries for the use of small thicknesses elements whose application in final structures may require, in some cases, the stacking of two or more plates of small thicknesses. This stack, depending on the properties sought, can also be combined with CFRP/Metal Alloy, where the most common are aluminium or titanium alloys. In the particular case of the aeronautical industry, these stacks need to be machined prior to their intermediate or final assembly in the structure [3-7]. The presence of spatial discontinuities and/or material in the interface makes it difficult to define machining strategies that contemplate a low number of parameters, affecting the four performance axes. In addition, the tendency to automation processes require behaviour models. These models must relate the technological parameters with variables acquired during machining and evaluation on the part (surface integrity and physical-chemical properties) and/or the tool (wear) after the same [8].

To pick up on the previous part, it is necessary re-emphasize that High Performance Machining (HPM) of these structures requires to have processes where parts are obtained in accordance with functional requirements required for their use: geometry and physical-chemical properties (Surface Integrity). These processes should not adversely affect energy, economic and environmental costs, and should pay special attention to machining strategies, tool life, consumption, etc., i.e. carrying out a process monitoring (On-Line and Off-Line).

The replacement of mechanical joints by adhesive joints, mainly concerns the aeronautical sector, where their use in primary structures has been used since 70s. Fig. 1 report the evolution's publication relating to adhesive bound and stacks [9]. It is appreciated the importance of adhesive bounds in the last years. These types of joints offer a number of advantages such as weight reduction, increased life against fatigue joints and wide adaptability to materials. However, they also present some problems, mainly highlighting the formation of high residual stresses [10]. Adhesive joints may be employed between surfaces of the same or different material.

In this article, are carried out an analysis and evaluation of the OSDD Process of Adhesive Bound CFRP/UNS A92024 hybrid stacks.

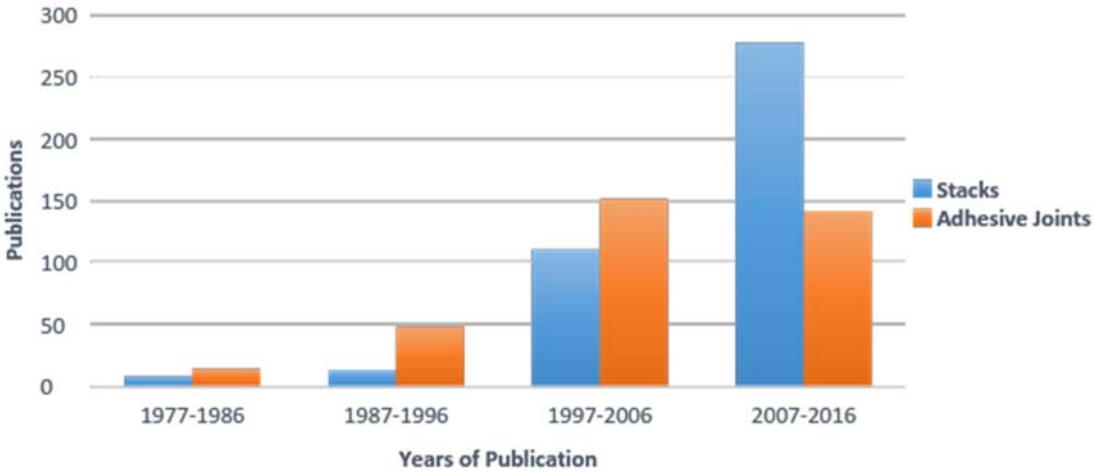

Fig. 1. Evolution's publications concerning stacks and adhesive bounds.