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Title

Eco-efficient manufacturing of horizontal tail plane (HTP) structures for next-generation aircrafts – the role of surface pretreatment for adhesive joints

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Abstract
Reducing the CO_2 footprint is a key issue for the aero-industry in Europe. Hybrid Laminar Flow Control (HLFC) concepts allow for drag reduction arising from skin-friction. The HLFC technology aims to remove turbulent flow at the main areas of the horizontal stabilizer, the fin, or the wings by means of a suction system. Thereby high-lift performance is improved, additional engine thrust is avoided and consequently extra fuel burn and CO_2 emissions are reduced. A key technical issue is to build the HLFC structure as light and as cost-efficient as possible. This goal can be achieved by adhesive bonding of a microperforated titanium panel to a composite substructure housing the suction system. However, high demands on the structural integrity and durability of the adhesive joint exist. These requirements demand adequate surface pretreatment of the titanium panel, which today is typically achieved by chemical tank processing consuming large amounts of energy and harmful chemicals. Here we report on the study of laser treatment to improve bond strength and bond durability as an alternative for this task. In addition, manufacturing aspects of the laser pretreatment on an industrial scale are highlighted.
IR laser and UV laser were compared for pretreatment of grade 2 titanium that was subsequently bonded with RTM6 resin. We will report on chemical surface modifications by XPS and EDX measurements with focused ion beam (FIB) preparation for cross-section analysis. Changes of the topography were analyzed by electron microscopy. DCB testing was used to correlate the adhesion properties of the titanium surface with the surface modifications. Testing of aged samples for 3000 h at hot/wet conditions showed no significant decay in fracture toughness and cohesive failure mode. The results indicate that treatment with IR lasers can potentially be used successfully for pretreatment of titanium to manufacture titanium/composite adhesive joints of high quality and durability as required by the aero-industry. Furthermore, the laser pretreatment provides a « green » manufacturing technology eliminating the need of wet chemical processing of titanium.
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