

**BOND / Structural Bonding**

- Study of the adhesion mechanisms in a titanium - composite bonded joint with consideration of environmental aging

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In the aeronautical field, mass reduction of structures is a major objective. Among the wide range of possible solutions, structural bonding can be used. Hybrid bonded joints involving a thin titanium cover sheet on a lighter composite bulk appear to be a good alternative to reduce structure's weight without losing mechanical properties. In this particular type of bonded parts, titanium alloys adhesion properties are usually enhanced by chemical surface treatment and adherence promoters. Some studies have shown that in the case of the  $\alpha + \beta$  titanium Ti-6Al-4V alloy, an alkaline etching treatment leads to a selective dissolution of  $\alpha$ -phase [1]. Surface roughness and chemistry are modified, allowing good bonding properties. As for adhesive bonding, phenolic primer and epoxy adhesive seem to be standard practice. These are the solutions used in the present study. To characterize the joint properties, Thick Adherend Shear Testing (TAST) is proposed. Although nominally pure shear, this test shows failure initiation at the interface from both edges of the adhesive joint, due to development of a non-zero normal edge stress (mode I component). By shifting the load axis in the normal direction, a bending moment is created which allows increasing normal stresses at one of the two edges. Thus, failure close to the titanium-adhesive interface can be initiated from only one side, increasing sensitivity to surface microstructure modifications or to surface treatment parameters. Thus, this study focuses on the impact of surface treatment parameters upon adhesion properties. Microstructures of titanium alloy and environmental impact were also investigated. Surfaces were characterized before and after etching, and after failure, by scanning electron microscopy and X-ray Photoelectron spectroscopy, leading to a slightly Ti-microstructure dependent failure mechanism (Figure 1).

**References**

[1] M. Marín-Sánchez, A. Conde, M. García-Rubio, A. Lavia, & I. García, Durability of titanium adhesive bonds with surface pretreatments based on alkaline anodisation, *Int. J. Adhesion & Adhesives*, 70, 225-233 (2016).

Failure mechanism of TA6V microstructures

