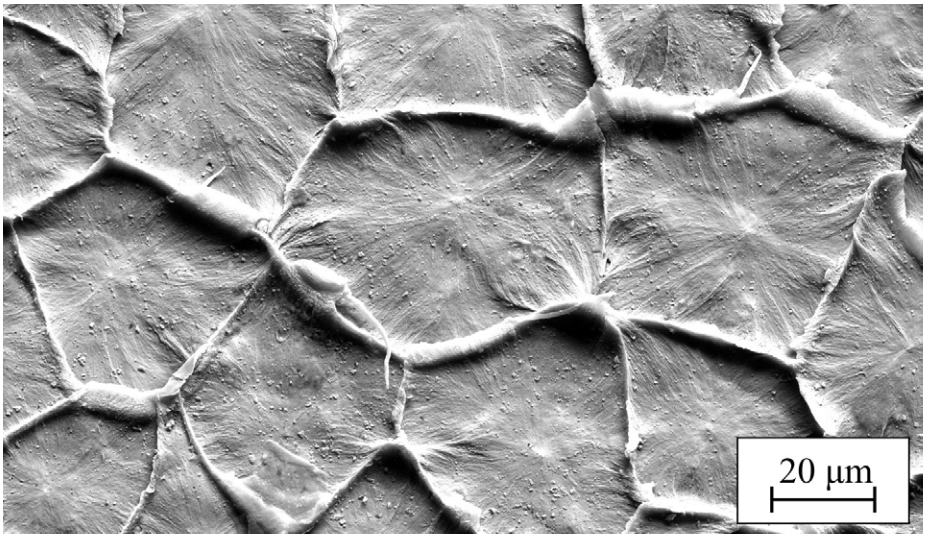
# Co-Consolidated Titanium-Thermoplastic Composite Joints: a study on the mechanisms governing adhesion and durability

The main drivers for technological innovation in the aviation industry are the reduction of the $CO_2$ emissions along with the reduction of operating costs. Multimaterial design that joins advanced metals, such as titanium, to high-performance thermoplastic composites represents an appealing solution, as metal inserts are often required for load introduction purposes. Besides, composites and metals can be combined to form hybrid materials called Fibre Metal Laminates, typically used in fuselage panels.
The moldability of the thermoplastic matrix allows for a cost-efficient joining method, known as co-consolidation, where composite consolidation and joining to the metal are achieved simultaneously during a standard composite consolidation or forming process.

**Vanessa Marinosci with one of the samples (Photo: Gijs van Ouwerkerk)**

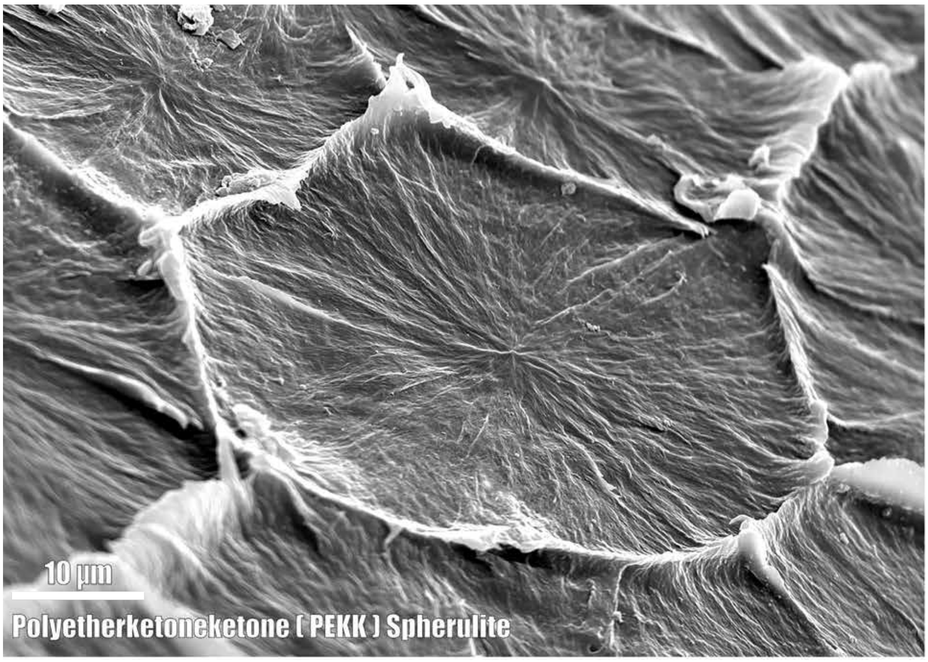
For the implementation of the co-consolidation technology, it is essential to develop guidelines which ensure reliable and predictable metal-thermoplastic composite interfaces. Therefore, the objective of this research is to understand and optimize the interfacial bonding mechanisms between metal and thermoplastic composites, more specifically, between the titanium alloy Ti6Al4V and C/PEKK composites.




**Scanning Electron Microscopy picture showing the crystalline phase of the polymer (called PEKK) on the crack surface of a titanium-PEKK joint (Picture by Nick Helthuis)**

Video

It has been demonstrated that the attraction between Ti6Al4V and PEKK relies on physical interactions. As evidence, the loss of adhesion in the presence of water is recovered when redrying. Additionally, it has been found that the mechanical interlocking, promoted by the titanium surface roughness, has a beneficial effect on the fracture toughness in dry conditions. The metal surface irregularities alter the local stress state at the crack tip and may cause a transition from adhesive to cohesive failure. A stable Ti6Al4V-C/PEKK interface in both dry and humid conditions has been obtained by combining the toughening effect of the surface roughness and the moisture barrier provided by a silane-based coating. Altogether, this work constitutes a fundamental basis towards reliable titanium-thermoplastic composite joints manufactured via a co-consolidation process.




**Scanning Electron Microscopy picture showing the crystalline phase of the polymer (called PEKK) on the crack surface of a titanium-PEKK joint (Picture by Nick Helthuis)**

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**The dissertation can be found online>**