Internship Position 2019

Subject: **Characterisation of insertion of electronic type devices in laminates composite**

Location : Institut Clément Ader, 3 rue Caroline Aigle, 31400 Toulouse, France ; http://institut-clement-ader.org/ & ISAE-Supaéro, DMSM, 10 av Edouard Belin, 31055 Toulouse, France ; https://www.isae-supaero.fr/

Supervisor: Laurent MICHEL, laurent.michel@isae-supaero.fr
Preferred profile: Master of Science in mechanical or aerospace engineering with a taste for Experiments and FEM calculations. (Proficiency in abaqus© would be a plus)
Duration: 5 to 6 months starting from April 2019.
Grants : about 500€/month
Accomodation : Lodging possibility on campus , https://www.isae-supaero.fr/fr/campus/vivre-sur-le-campus/logement/

Subject:

Insertion of electronic sensors in laminated composites allows creating multi-functional materials. Consequences of this insertion on the mechanical behavior and strength of the new structures have to be measured and predicted through dedicated numerical or analytical models.

The sensor thickness is about 0.15 mm which is very close to that of an elementary ply of the laminate made out of High Performance Unidirectional prepregs plies. The integration of such a sensor in the laminate features the same problems of those found when dealing with drop-off plies in laminated composite panels of aeronautical structures, those ply arrests which allow the tailoring of composite panel thickness [1]. The mechanical approach to understand and analyze this integration should be very close to the ones used for drop-off ply zones.

The ply arrest - in our case: the edge of sensor - is the source of initiation of delamination type defects. These defects can initiate either on compressive or tensile loading, and then, propagate under static or fatigue loading of the structure. The prominent parameters of this critical zone are:

- thickness ratio of the sensor and the laminate ply,
- stiffness ratio of the adjacent ply and the electronic sensor,
- and mainly, the quality of adhesion between the sensor's outer skin and the epoxy matrix of the composite. This adhesion insures the interfacial strength between these two materials.

The work will consist in evaluating the interfacial strength between the electronic device and the laminate composite through the characterization of delamination propagation at the interface [2]. The study will be divided into 3 parts:

- Characterization of the Energy Release Rate under mode I, identification of material inputs for the numerical model of interface.
- Characterization of the Energy Release Rate under mode II, identification of material inputs for the numerical model of interface.
- Technological specimen: design and test of different specimens, comparison between experimental results and numerical models.

References:

1. A Weiss **,** « *Comportement en fatigue des zones de reprise de plis* », thèse de l'Université de Toulouse/ISAE, 2010, https://depozit.isae.fr/theses/2010/2010_Weiss_Ambrosius.pdf
2. P Prombut, « *Caractérisation de la propagation de délaminage des stratifiés composites multidirectionnels*», thèse de l'Université de Toulouse, 2007, http://thesesups.ups-tlse.fr/27/