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DocMASE

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# Project Proposal for 2011 DocMASE Candidates

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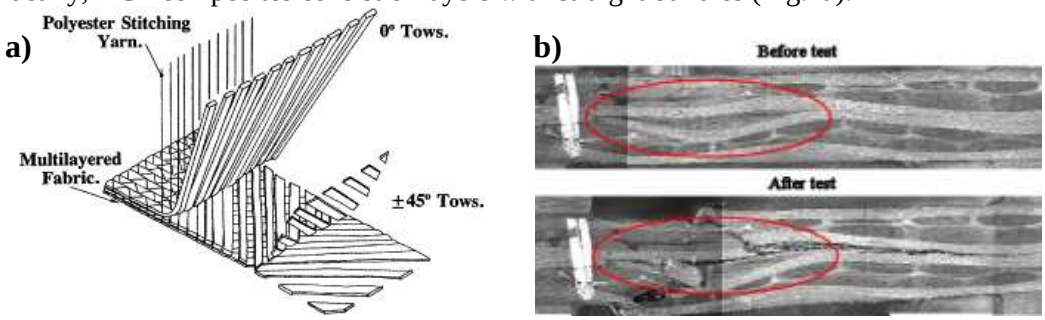
| Project Title | ***Micro-damage mechanisms and failure criteria for non-crimp fiber composites: effects of micro- and meso- architecture*** |
| Main University and Advisor | **Institut National Polytechnique de Lorraine** (Nancy, FRANCE)<br>Prof. Zoubir AYADI, Head of Mechanics of Materials Group |
| Second Univ. and Advisor | **Lulea University of Technology** (Luleå, SWEDEN)<br>Prof. Janis VARNA, Head of Polymer Engineering Division |
| Associated Partner(s) | **SICOMP**, Prof. Leif ASP<br>**LAMACOP-FSS**, Prof. Ali KALLEL and Prof. Zouhir FAKHFAKH |
| Project Description | Lightweight materials with high stiffness and damage tolerance are requested for aerospace and marine industries. Other properties can be requested for optimization, such as permeability increase due to microdamage leading to leakage can also be of importance in NASA Reusable Launch Vehicles. Composite structures are used in increasingly hostile environments, so studies of varying temperature and moisture effect on long term properties and optimization are crucial for applications in airplane engines.<br>In recent years, Non-Crimp-Fiber (NCF) reinforced composites, where cost-efficiency is reached by using dry preforms impregnated by resin infusion, resin transfer molding, etc., have made a break-through and have been widely introduced.<br>Ideally, NCF composites consist of layers with straight bundles (Fig.1a).<br>  <br><br>Fig. 1. NCF composites: a) mesostructure with expected straight fibers; b) cross-section of mesostructure.<br>However, due to manufacturing techniques the mesostructure is far from ideal (Fig.1b) with large out-of-plane waviness of fiber bundles. The mechanical performance of composites with non-straight bundles is significantly lowered and the damage modes observed are different from those in layered composites with uniform fiber distribution [1-3].<br>***The goals of this project are the following:***<br>a) Study the mesoscale related strain distributions on micro- and meso- level using Speckle Pattern Interferometry.<br>b) Observe and analyze micromechanisms of damage development in these materials using in-situ SEM and optical microscopy.<br>c) Perform FEM analysis to identify the most important material and fiber architecture related parameters for microdamage initiation and development.<br>d) Study interaction between fractures.<br>e) Develop failure criteria for damage assessment on engineering level. |
| References and Previous Publications | [1] Edgren F., D. Mattsson, L.E. Asp and J. Varna, "Formation of damage and its effects on non-crimp fabric reinforced composites loaded in tension", Composites Science and Technology, (2004); 64: 675-692.<br>[2] Joffe R., Mattsson D., Modniks J. and Varna J., "Compressive Failure Analysis of Non-Crimp Fabric Composites with Large Out-of-Plane Misalignment of Fiber Bundles", Composites Part A. Volume 36, Issue 8 , August 2005, 1030-1046.<br>[3] Mattsson D., Joffe R. and Varna J., "Methodology for characterization of internal structure parameters governing performance in NCF composites", Composites: Part B: Engineering, Volume 38, Issue 1, January 2007, Pages 44-57.<br>[4] Farge L., Ayadi Z., Varna J. "Full-Field Displacements of a Damaged Laminated Composite Using ESPI", Composites Part A : Applied Science and manufacturing, 2008. |