Project Proposal for 2011 DocMASE Candidates

Project Title	***Mechanical and Environmental Durability of High Performance Bio-based Cellulosic Composites***
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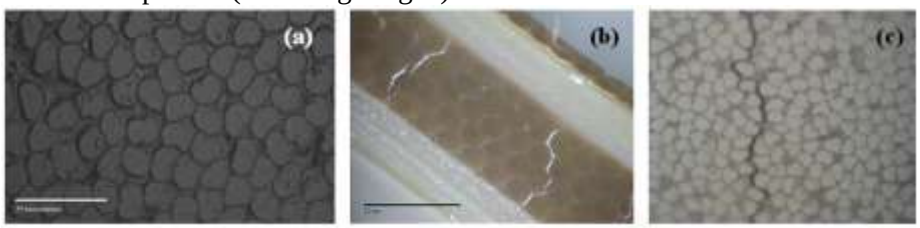
Project Description	***The general objective of the project is to develop novel high performance composite material based on fibers with high cellulose content and bio-based matrix (resin made of material derived from plants). The fibers considered for this project are not only natural fibers such as flax and hemp but also regenerated cellulose fibers.*** Regenerated cellulose fibers (RCF) are manmade fibers made out of the natural polymer directly. These fibers are continuous and it is easy to arrange them into fabrics with stable orientation and geometry. Preliminary results [1,2] show that morphology and damage modes of the composites made out of RCF are very similar to that of synthetic fibers – reinforcement is well dispersed in the matrix and micro-structure is very regular (Fig. 1). However, mechanical behaviour of regenerated cellulose fibers is highly non-linear and therefore performance of the composite is also non-linear with presence of very significant vicscoelastic component. In order to achieve the main objective of the proposed project, the ***following research sub-topics are proposed for study***: 1. Optimization of morphology of composites with respect to fiber content, alignment and orientation (natural fiber/RCF hybrid composites will also be studied); 2. Optimization of fiber/matrix adhesion by use of bio-based resins compatible with cellulosic fibers; 3. Failure modes and sequence will be studied in order to fully understand sources of damage initiation; 4. Mechanical durability of composites will be studied with respect to the accumulation of damage and fatigue; 5. Environmental durability of materials will be investigated (performance at elevated temperature and humidity); 6. Non-linear behavior (damage, viscoelasticity, plasticity) of composite constituents will be studied and accounted for in models to be able to accurately describe the mechanical behaviour of composites (including fatigue).  Fig. 1. Composite structure with RCF (a) and damage in cross-ply laminate (b), (c). The main part of the project will be carried out at LTU and activities will involve optimization and characterization of composites as well as development and verification of new material models. The activities concerning the fracture properties (including fatigue) will be performed at UPC. The annual time distribution between LTU and UPC is planned in proportion of 75%/25%.
References and Previous Publications	[1] Nyström B, Joffe R., "*Mechanical performance and damage tolerance of bio-based polymer composites with man made cellulose fiber reinforcement.*", 21st Conference on Manufacturing and Design of Composites, Piteå (SWEDEN), June 3-4, 2010. [2] Joffe R., Nyström B, "*Suitability of man made cellulose fibers as reinforcement for bio-based polymer composites*", 21st Conference on Manufacturing and Design of Composites, Piteå (SWEDEN), June 3-4, 2010.