20/05/2013

MONDAY from 10.00

Conference room ÚCHM FCH BUT
Purkyňova 118, 4th floor

COMPARTMENTED FIBRES: THE CONCEPT OF MULTIPLE SELF-HEALING IN ADVANCED FIBRE COMPOSITES

Ing. Marek Prajer, Ph.D.
CEITEC, RG2-3

BIO

Marek Prajer obtained his PhD at the BRE Centre for Innovative Construction Materials (BRE CICM) at the University of Bath, UK under the supervision of Dr. Martin P. Ansell, working on natural fibre reinforced polymer composites. Before he joined CEITEC he was a post-doctoral researcher in the Novel Aerospace Materials Group at TU Delft, The Netherlands, working on self-healing polymer composites. He's got Master degree in Materials Engineering at the Institute of Chemical Technology (ICT) in Prague. Before starting his PhD he was working in a TS&D department in polymer industry.

ABSTRACT

Polymers reinforced with high performance fibres are successfully used in many structural applications. The brittle nature of matrix cracking is the main source of composite failure initiatingply delamination and fibre to matrix debonding. Traditional composite innovation aims for stronger fibres, improved resins, improvedfibre to matrix adhesion and damage tolerant design.
An innovative approach based on bio-mimicry takes inspiration from complex and multifunctional naturally occurring materials. Biological materials like human bones, were designed to carry loads, remodel their morphology to respond the prevalent external stresses, sense and heal the damage. These structures thus apart from being load-bearing structurespossess other smart functionalities.
The idea of self-healing engineering materials is straightforward: to self-heal rather than tolerate the damage. Bio-inspired autonomous healing systems, embedded in a polymer matrix, are being developed to improve the fracture resistance of structural composites. An exemplary system can consist of fibres with individual compartments, i.e. compartmented fibres, which are filled with a healing liquid. The healing agent is distributed within the fibre in the form of long elongated compartments of ellipsoidal shape with high aspect ratio. The fibres are designed to release the liquid healing agent at multiple specific microcrack sites developed in the polymer matrix as a result ofstructural loading during its life-time.
The advantage of such a fibre as a healing agent carrier is obvious - compartmented fibres enable multiple local healing events. Neither is the whole healing agent consumed in the first damage/healing event (as for hollow fibres) nor is the functionality of remaining compartments affected by the healing event (compared to vascular networks).
Compartmented fibres were spun from an o/w emulsion of a healing agent dispersed in an aqueous solution of natural polysaccharide, sodium alginate. The encapsulation of the healing agent (σ-dichlorobenzene) was provided by the coagulation of the alginate polymer with bivalent ions during the fibre formation.
Pre-damaged model composites made of thermoplastic matrix with embedded compartmented fibres were tested for the recovery of mechanical properties. Spun fibres were embedded in polymethylmethacrylate, pre-cracked and allowed a certain period of time to self-heal before they were loaded again. Computed micro-tomography was used to visualise damage and healing sites. Test samples with the new fibres located at the likely damage sites were able to partially recover their mechanical properties. The concept of multiple release of healing agent from a compartmented fibre into the surrounding polymer matrix was demonstrated successfully.

The event has been supported by the EU Seventh Framework Programme under the„Capacities – Research Potential"
specific programme (Contract No. – 286154 SYLICA)

SEVENTH FRAMEWORK PROGRAMME