WIM VAN PAEPEGEM-GHENT UNIVERSITY, BELGIUM

MULTI-SCALE MODELLING

OF DAMAGE MECHANICS OF FIBRE-REINFORCED POLYMER COMPOSITES FROM MICRO-TO MACRO-SCALE: THE (VIRTUAL) REALITY AND CHALLENGES AHEAD

May 12, 2022 at 11:00 AM US Eastern Daylight Time

ABSTRACT

Multi-scale modelling of composites is a very active topic in composites science. This is illustrated by the numerous sessions in the recent European and International Conferences on Composite Materials, but also by the fast developments in multi-scale modelling software tools, developed by large industrial players such as Siemens, MSC/e-Xstream, Simulia, HyperSizer, Altair,...

Over the past years, the elastic property prediction of composites has become quite established through a variety of multi-scale modelling approaches. When it comes to the nonlinear and damage behaviour of composites, multi-scale modelling becomes much more challenging. Experimental input data on the different scales are not always easy to obtain, in-situ observation of damage mechanisms like fibre/matrix debonding and fibre failure is difficult, anisotropic damage models that take into account effects of temperature and strain-rate are complex and computational efficiency is needed.

Based on our recent research, the lecture will cover the three most important scales in multi-scale modelling of composites: (i) micro-scale, (ii) meso-scale and (iii) macro-scale. The nano-scale and related atomistic and molecular modelling approaches are not covered. A strong focus is put on physics-based damage modelling and the need for experimental validation, hence the link in the title to virtual reality and reality.

The lecture will not only discuss the finite element based approaches for multi-scale modelling, but also much faster methods, such as Mean Field Homogenization methods and variational methods. Examples will be given for unidirectional composites, textile composites and short fibre-reinforced composites, and advanced experimental testing techniques will be illustrated.

PROFESSOR WIM VAN PAEPEGEM

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B I O

Professor Wim VAN PAEPEGEM (°1975) is full professor and head of the research group "Mechanics of Materials and Structures" (UGent-MMS) at Ghent University. The research group counts 3 professors and about 30 doctoral and postdoctoral researchers. The research itself is focussed on experimental and computational mechanics of fibre-reinforced composites, polymers, foams and additively manufactured polymers and metals, as well as nondestructive testing of those materials.

Wim Van Paepegem defended his own PhD on fatigue of composites in 2002 and ever since, has been working on the experimental testing and numerical modelling of fibre-reinforced composites. So far, he published 280 Science Citation Index (SCI) papers in these research domains and he is Editor of the very recent book "Multi-Scale Continuum Mechanics Modelling of Fibre-Reinforced Polymer Composites" (November 2020, Elsevier).

He also received 5 personal awards for his academic achievements, including the "Best Young Researcher" award from the European Society for Composite Materials and the Laureate prize of the Royal Flemish Academy of Belgium for Science and Arts. Since 2013, four spin-off companies have been founded by postdoctoral fellows of the research group.

He is mentor and supervisor of 33 defended PhD theses and 12 running PhD theses. Further, he is serving as an Editorial Board Member for the international journals "Composites Part B" and "Polymer Testing" and former Editorial Board Member of "Composites Science and Technology" and "Fatigue and Fracture of Engineering Materials and Structures".