

# **41<sup>st</sup> Risø International Symposium on Materials Science**

**Materials and design for next generation wind turbine blades**

**7 - 10 September 2020**

**Department of Wind Energy  
Technical University of Denmark  
Risø Campus, Roskilde**

**Programme**

*Update: 10 August 2020*

## Monday, 7 September

<b>08:30 – 09:00</b>	<b>Opening</b>
09:00 – 09:30	A critical review of damage and failure of composite wind turbine blade structures (Invited) <i>X. Chen, M.A. Eder</i>
09:30 – 09:50	A material perspective on digitalization for wind turbine blades from the ReliaBlade project <i>F. Sayer, K. Branner, A. Antouniou, S. Goutianos, I. Gebauer, T.L. Andersen, F. Klaenfoth, P. Berring</i>
09:50 – 10:10	Proof of concept: elliptical biaxial rotor blade fatigue test with resonant excitation <i>D. Melcher, H. Rosemann, B. Haller, S. Nesslinger, E. Petersen, M. Rosemeier</i>
<b>10:10 – 10:30</b>	<b>Discussion single papers</b>
<b>10:30 – 10:40</b>	<b>Break</b>
10:40 – 11:00	On the composite design of wood branches leading to improved bending strength <i>M. Hartwig, E. K. Gamstedt</i>
11:00 – 11:20	Mechanical properties characterization of the lchu fibers composites <i>S. Charca, S. Candiotti</i>
11:20 – 11:40	The influence of different glass fiber/epoxy matrix combinations on the durability under severe moisture impact <i>D. Gibhardt, C. Fleschhut, B. Fiedler</i>
<b>11:40 – 12:00</b>	<b>Discussion single papers</b>
<b>12:00 – 13:00</b>	<b>Break, lunch time</b>
13:00 – 13:30	Through life management and life extension of wind farms (Invited) <i>M. Spring</i>
13:30 – 13:50	Blade materials selection influence on sustainability: a case study through LCA <i>G. Chiesura, H. Stecher, J. Pagh Jensen</i>
13:50 – 14:10	A comparison of surface preparation techniques for wind turbine field repairs <i>A. Lusty, D. Cairns, D. Miller, D. Samborsky</i>
<b>14:10 – 14:30</b>	<b>Discussion single papers</b>
<b>14:30 – 14:40</b>	<b>Break</b>
14:40 – 15:10	Upgrading and reuse of glass fibre recycled from end-of-life composites (Invited) <i>J.L. Thomason, L. Yang, K. Pender</i>
15:10 – 15:30	Chemical recycling of End-of-Life wind turbine blades by solvolysis/HTL <i>C. Mattsson, A. André, M. Juntikka, T. Tränkle, R. Sott</i>
15:30 – 15:50	Recyclable epoxy systems for rotor blades <i>P.K. Dubey, S.K. Mahanth, A. Dixit, S. Changmongkol</i>
<b>15:50 – 16:10</b>	<b>Discussion single papers</b>

- 16:10 – 16:20**                    **Break**
- 16:20 – 16:40                    Re-use of wind turbine blade for construction and infrastructure applications  
*A. André, J. Kullberg, D. Nygren, C. Mattsson, G. Nedev, R. Haghani*
- 16:40 – 17:00                    Composite wind turbine blade recycling - value creation through Industry 4.0 to enable circularity in repurposing of composites  
*R. Geiger, Y. Hannan, W. Travia, R. Naboni, C. Schlette*
- 17:00 – 17:20                    Optimization of chemical degradation of polyester and epoxy-based composites used for manufacturing wind turbine blades through combinations of various solvolysis techniques  
*J.H.H. Henriksen*
- 17:20 – 17:40**                    **Discussion single papers**

**Tuesday, 8 September**

- 09:00 – 09:30                    Numerical and experimental analyses in composites processing: heat transfer, resin cure and residual stresses (Invited)  
*J. Hattel*
- 09:30 – 09:50                    Constrained and un-constrained load transferring shrinkage of an epoxy resin system  
*L.P. Mikkelsen*
- 09:50 – 10:10                    Influence of the glass non-crimp fabric intrinsic undulation on the stiffness of the composite ply: a micromechanical approach.  
*A. Antoniou, L.P. Mikkelsen, S. Goutianos, O. Bagemiel, I. Gebauer, R. Flindt, F. Sayer*
- 10:10 – 10:30**                    **Discussion single papers**
- 10:30 – 10:40**                    **Break**
- 10:40 – 11:00                    Exploration of irreversible residual stresses in a carbon/epoxy composite  
*J. Jakobsen, F. Shakibapour*
- 11:00 – 11:20                    Micromechanical and spectroscopic characterisation of the curing performance of epoxy resins in the microbond test  
*D. Bryce, J. Thomason, L. Yang*
- 11:20 – 11:40                    Modelling of chemical shrinkage evolution with curing degree of a filled epoxy adhesive  
*T. Holst, F. Sayer, A. Antoniou*
- 11:40 – 12:00**                    **Discussion single papers**
- 12:00 – 13:00**                    **Break, lunch time**

13:00 – 13:30	Unidirectional strength: “global” and “local” load sharing models and implications on size-scaling, fatigue, and hybridization (Invited) <i>W. Curtin</i>
13:30 – 13:50	A basic orthotropic viscoelastic model for composite and wood materials considering available experimental data and time-dependent Poisson's ratios <i>R. Bengtsson, R. Afshar, E.K. Gamstedt</i>
13:50 – 14:10	Multiaxial stress and strain analysis on laminated plates under different flexural loading rates <i>S. Horta Muñoz, M.C. Serna Moreno</i>
<b>14:10 – 14:30</b>	<b>Discussion single papers</b>
<b>14:30 – 14:40</b>	<b>Break</b>
14:40 – 15:10	Challenges in preventing leading edge erosion (Invited) <i>S. Laustsen</i>
15:10 – 15:30	Rain droplet erosion behavior of a thermoplastic based leading edge protection system for wind turbine blades <i>T.H. Hoksbergen, I. Baran, R. Akkerman</i>
15:30 – 15:50	Combatting rain erosion of offshore wind turbine blades by co-bonded thermoplastic-thermoset hybrid composites <i>J.S.M. Zanjani, I. Baran, R. Akkerman</i>
<b>15:50 – 16:10</b>	<b>Discussion single papers</b>
<b>16:10 – 16:20</b>	<b>Break</b>
16:20 – 16:40	Mechanisms and computational analysis of leading edge erosion of wind turbine blades <i>L. Mishnaevsky Jr., S. Fæster, S.D. Rad</i>
16:40 – 17:00	A practical approach for the peel stress prediction in the trailing-edge adhesive joint of wind turbine blades <i>M. Rosemeier, T. Gebauer, A. Antoniou</i>
17:00 – 17:20	On the potential of particle engineered anti-erosion coatings for the leading edge protection of wind turbine blades: Computational studies <i>K.M. Jespersen, G. Monastyreckis, L. Mishnaevsky Jr</i>
<b>17:20 – 17:40</b>	<b>Discussion single papers</b>

### **Wednesday, 9 September**

09:00 – 09:30	Micromechanics testing and modelling to enhance the damage tolerance of composite structures (Invited) <i>B.F. Sørensen</i>
09:30 – 09:50	Micro-mechanical investigation of glass fibre/resin interface failure in mode I and mode II <i>P.G. Jenkins, D. Bryce, G. Xypolias, J.L. Thomason</i>

09:50 – 10:10	Determination of fibre/matrix interfacial toughness using the single fibre peel test <i>D.J.H. Cederløf, B.F. Sørensen</i>
<b>10:10 – 10:30</b>	<b>Discussion single papers</b>
<b>10:30 – 10:40</b>	<b>Break</b>
10:40 – 11:00	Air-to-air atmospheric pressure plasma treatment – perspective for composite manufacturing <i>C. Fang, D.J.H. Cederløf, A. Bardenshtein, Y. Kusano</i>
11:00 – 11:20	The effect of environmental ageing in the interphase of a glass fibre/vinyl ester composite designed for wind turbine applications <i>G. Xypolias, J.L. Thomason, L. Yang</i>
11:20 – 11:40	Design of lamina orientation for biaxially loaded off-axis tunneling cracks <i>A.K. Bangaru, L.P. Mikkelsen, B.F. Sørensen</i>
<b>11:40 – 12:00</b>	<b>Discussion single papers</b>
<b>12:00 – 13:00</b>	<b>Break, lunch time</b>
13:00 – 13:30	Structural battery composites - what are they and can they be used in wind turbines? (Invited) <i>L. Asp</i>
13:30 – 13:50	Understanding the mechanical response of glass and carbon fibres: engineering and true stress-strain analysis and modulus determination <i>R. Kumar, L.P. Mikkelsen, H. Lilholt, B. Madsen</i>
13:50 – 14:10	Investigations of the carbon fibre cross-sectional areas and their non-circularities by means of laser diffraction <i>J.J. Huether, W.V. Liebig</i>
<b>14:10 – 14:30</b>	<b>Discussion single papers</b>
<b>14:30 – 14:40</b>	<b>Break</b>
14:40 – 15:10	State-of-the-art models for mechanical performance of carbon-glass hybrid composites in wind turbine blades (Invited) <i>Y. Swolfs, B. Fazlali, A. Melnikov, F. Mesquita, V. Feyen, C. Breite, L. Gorbatikh, S.V. Lomov</i>
15:10 – 15:30	Evolution of CFRP stress cracks observed by in-situ X-ray refractive imaging <i>A. Kupsch, V. Trappe, B.R. Müller, G. Bruno</i>
15:30 – 15:50	Comparison of the damage evolution in glass fiber-reinforced polyurethane and epoxy in the HCF and VHCF regimes investigated by intermittent in situ X-ray computed tomography <i>D. Hülsbusch, R. Helwing, S. Mrzljak, F. Walther</i>
<b>15:50 – 16:10</b>	<b>Discussion single papers</b>
<b>16:10 – 16:20</b>	<b>Break</b>

- 16:20 – 16:40 Characterization of the fiber orientations in non-crimp glass fiber reinforced composites using structure tensor  
*N. Jeppesen, V.A. Dahl, A.N. Christensen, A.B. Dahl, L.P. Mikkelsen*
- 16:40 – 17:00 X-ray tomography based numerical analysis of stress concentrations in non-crimp fabric reinforced composites - assessment of segmentation methods  
*R.M. Auenhammer, L.P. Mikkelsen, L.E. Asp, B.J. Blinzler*
- 17:00 – 17:20 Observing the evolution of fatigue damage and associated strain fields in a correlative, multiscale 3D time-lapse study of quasi-unidirectional glass fibre composites  
*A. Prajapati, A. Chirazi, L.P. Mikkelsen, T. Burnett, P.J. Withers*
- 17:20 – 17:40 Discussion single papers**

#### Thursday, 10 September

- 09:00 – 09:20 Effect of backing fibers on the thermoelastic stress analysis of multi-directional glass/epoxy laminates during fatigue loading  
*A. Quinlan, J.M. Dulieu-Barton, O. Castro*
- 09:20 – 09:40 Effect of maximum load on cyclic crack growth in UD E-glass/vinyl ester composites with constant and alternating stitch density  
*R.I.E. Anchondo, S. Goutianos*
- 09:40 – 10:00 Does age matter? Impact on fire safety properties of composite materials from ageing  
*A. Sandinge, P. Blomqvist, A. Dederichs*
- 10:00 – 10:20 Discussion single papers**
- 10:20 – 10:30 Break**
- 10:30 – 10:50 Blade research and demonstration platform  
*P.U. Haselbach, F. Zahle, P. Berring, S. Semenov, L.V.I. Roqueta, D.R. Verelst*
- 10:50 – 11:10 How representative are current fatigue testing methods for wind turbine blades?  
*O. Castro, K. Branner*
- 11:10 – 11:30 Strength analysis of a 5-m composite wind turbine blade under static and fatigue loading conditions  
*C. Muyan, D. Coker*
- 11:30 – 11:50 Discussion single papers**
- 11:50 – 12:00 Break**
- 12:00 – 12:30 Advancing blade performance through applied composite material science (Invited)  
*L. Overgaard*
- 12:30 – 12:50 Discussion single paper**
- 12:50 – 13:00 Closing**