Wind Blade Using Cost-Effective Advanced Lightweight Design

Issue 3 September 2015

The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under Grant Agreement no.309985

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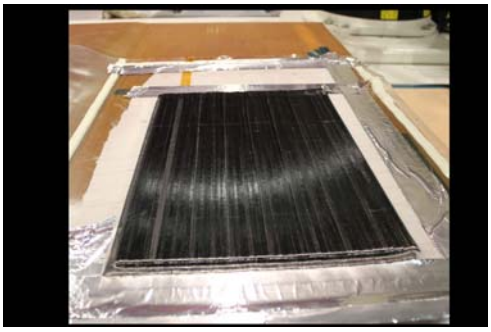
Project Progress

Automated Fibre Placement Layup Trials take place

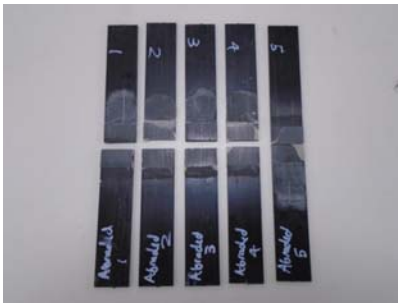
Coriolis Composites have been carrying out trials at COMPOSITADOUR/ESTIA facilities in Biarritz, France on a 16fiber Automated Fiber Placement Machine by Coriolis Composites. A heatable GFRP-mould from LOIRETECH was used as well as carbon fiber reinforced tapes which were produced by COMFIL with specific resins according to the WALID consortium specification. Different surface preparations and erosion protection films were used and results from these trials determined the best process parameters such as speed and laser power and compaction pressure. Test plates were produced and will be analyzed by Fraunhofer ICT and Smithers Rapra regarding mechanical properties and inner quality.

Compositadour 16 fibre laser automated Fibre placement cell



Test plate used for mechanical testing and analysis

Solutions are currently being sought to use paste adhesives with the new materials developed in the project and benchmarking of different adhesive suppliers is taking place to determine the best solutions for bonding thermoplastic fiber reinforced materials.



TNO Publish Paper

TNO published a paper on "Leading edge erosion of coating wind turbine blades: review of coating life models".

One of the items covered in this paper is the reduction in machine power output caused by erosion on the leading edge of turbine blades due to droplet impingement. It also includes details on the reduction of the impact pressure or enlargement of the safe area with respect to fatigue which will enhance the life of the coatings.

This paper can be purchased from the August 2015 edition of the 'Renewable Energy' journal.

Partner's Feature

TNO Netherlands Organisation for Applied Scientific Research

TNO is an independent research organisation that employs some 3,000 specialists. They believe in the joint creation of economic and social values and focus on transitions or changes in five social themes: Industry; Healthy Living; Defense, Safety & Security; Urbanisation and Energy.

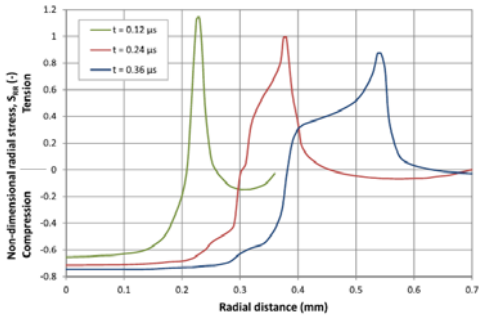
Trends in the high-tech industry are pushing towards miniaturization, the creation of products with complex shapes, and multi-functional materials, preferably based on renewable materials or in compliance with circular economy. To keep up with ever-increasing demands, companies must focus on developments and improvements in production, processing and performance qualifications. TNO assists companies by combining its required competencies to enable and enhance the development of complex, reliable, safe and cost-effective products.

The group Responsive Material and Coating technology focuses on materials and processes for wet-chemical coatings, nano-structuring - in terms of design, synthesis, characterization of nanoparticles and nano-imprint lithography - and responsive polymers. They develop materials for integrated products that focus on the combination of materials performance and materials processing, using unique physical experiments and computer-aided modelling and simulation for innovative product development with built-in reliability.

Main tasks of TNO within WALiD

TNO is developing thermoplastic coatings with good resistance against droplet and particle erosion. A predictive model has been developed to benchmark required properties (Slot *et al.* , 2015). This model is composed of experimentally validated droplet erosion model blocks to predict the lifetime of the leading edge of coated wind turbine blades. From the work carried out it can be seen that surface fatigue, as a nucleating wear mechanism for erosion damage, can explain erosive wear and failure of the coatings. An engineering approach to surface fatigue, using the Palmgren–Miner rule for cumulative damage, allows for the construction of a rain erosion incubation period equation. Coating life was described as a function of the rain intensity, the droplet diameter, the fatigue properties of the coating and the severity of the conditions. The recommendation is to focus coating development on reduction of the impact pressure, e.g. by developing surfaces with a low modulus of elasticity; and/or on enhancing the fatigue endurance strength through developing coatings without defects and impurities.

Partner's Feature continued ....



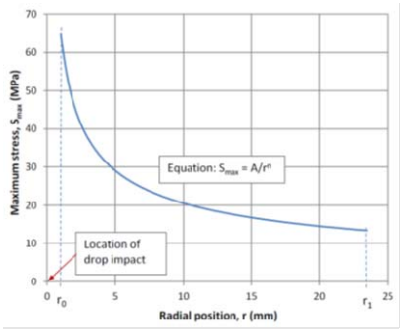
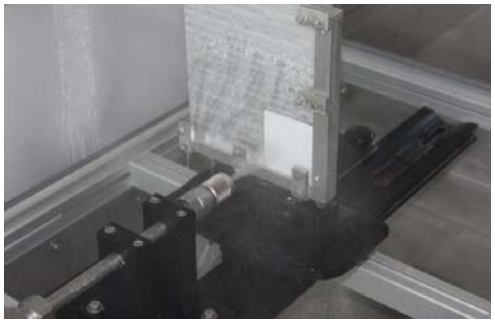


Figure 1a *Figure 1b*

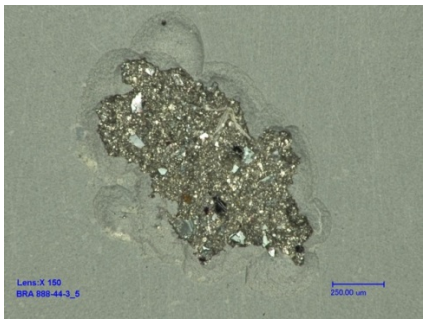
Figure 1a - Variation of normalized radial stress due to the Rayleigh surface wave as a function of time in PMMA at a depth of 5 µm (water drop diameter d_d = 1.8 mm, impact velocity v_d = 222 m/s).

Figure 1b -The attenuation of the maximum stress of the fatigue stress cycle as a function of the distance (r) to point of drop impact. It is assumed that the Rayleigh surface wave starts at r = r_0 and only causes damage within the area with a radius r = r_1.

Based on this model coatings are selected and developed. A two way approach is chosen: improve the performance of a typical thermoplast; give a thermoset coating thermoplastic feature. In the second approach, thermo-reversible Diels-Alder bindings are incorporated into wind blade protection coatings. The bindings are opened at elevated temperatures resulting in a viscosity drop making the coatings recyclable. When the temperature drops the viscosity increases again and a solid coating is formed that shows sufficient erosion protection. To enhance the impingement resistance and generate anisotropic behavior (hard properties along the coating and soft properties within the coating) nanoparticles are added to the coating. The coatings are tested for particle erosion and droplet erosion resistance. To determine droplet erosion a bespoke set-up has been built for the WALiD project. The images above show the droplet erosion test set up and a typical erosion result. These results were disseminated at COSI the 11th Coatings Science International Conference (COSI) in June 2015.



Droplet Erosion resistance



Microscope image of damage caused by impingement

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Forthcoming Events

Composites Europe—22nd-24th September 2015 (Stuttgart, Gemany).

Offshore Energy—13th-14th October 2015 (Amsterdam, Netherlands).

4th Annual Future Offshore Foundations 21st—23rd October 2015 (Hamburg, Germany)

EWEA Annual Event 17th-20 November 2015 (Paris, France)

Exploitation Strategy

An Exploitation Strategy Seminar was held on 24th February 2015 in conjunction with a General Assembly meeting which was hosted by PPG at their site in Wigan.

The seminar which was attended by all partners was run by an expert from the EC in order to assist in the development of the foreground in the project and to create an exploitation plan beyond the life of the project.

Following discussions of the key exploitable results, a report was produced and circulated to the consortium partners.

Project Partners:

Fraunhofer Institute for Chemical Technology (Germany), Smithers Rapra & Smithers Pira (UK), TNO (Netherlands), PPG (Netherlands), Norner (Norway), Comfil APS (Denmark),Loiretech (France), Coriolis Composites (France), NEN (Netherlands), WPS Windrad Power Systems (Germany)

Key Facts:

Project acronym: WALiD

Project Title: Wind Blade Using Cost-Effective Advanced Composite Lightweight Design

Project Duration: 01.02.13—31.01.17

Website: www.eu-walid.com