TURBO newsletter Jun-2023 (#1)

TURBO

Towards turbine blade production with zero waste

Welcome to the first TURBO project newsletter!

In this first edition we report on some of the work that has been done in the initial six months of the project, and other project news:

- A look ahead to the annual meeting in Riso, held alongside a key conference in wind turbine technology
- Resin selection for the TURBO project at DTU Wind
- Development of mid-IR OCT for NDT in TURBO at NORBLIS
- TURBO cure sensor technology from Synthesites
- Mid-IR source development for OCT at DTU Elektro.

For more info visit the website https://turboproject.eu
Or join the LinkedIn group: https://www.linkedin.com/groups/12777432

TURBO plenary to be held alongside Risø conference

The long-running international Risø Symposium on Material Science will be held in the same week as the 12M TURBO project meeting. The symposium will include a dedicated TURBO session, with eight of the 56 presentations at the conference given by TURBO partners. The symposium has attracted presentations from the US, Canada, Japan, Iran, and India as well as from many European countries.

DTU

43rd Risø International Symposium on Materials Science
Composites for wind energy: Manufacturing, Operation and End-of-life

A preliminary program will be published soon on the conference homepage, and please note that the registration deadline for attending the conference is 01-Jul-2023.

https://www.conferencemanager.dk/43rdsymposium

Consortium

DTU, SIEMENS Gamesa RENEWABLE ENERGY, NORBLIS Nordic Broadband Light Solutions, HÜBERS, NATIONAL COMPOSITES CENTRE, synthesites, ARDITEC, UNIVERSITAT POLITÈCNICA DE VALÈNCIA, SMARTIA, esi get it right, cpi, VIVID COMPONENTS

Coordinator	Ole Bang	Danish Technical University	oban@dtu.dk
Admin	Bruce Napier	Vivid Components Germany	bruce@vividcomponents.co.uk

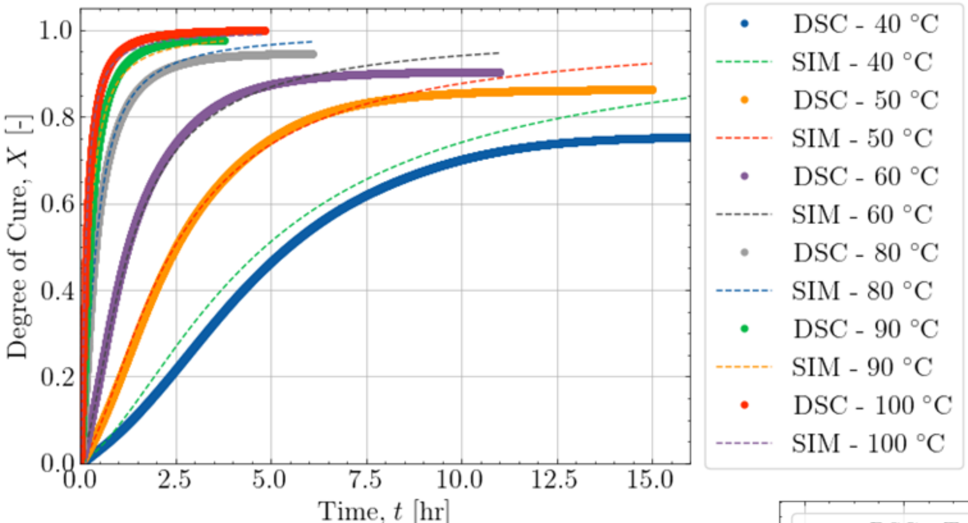
Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No. 101058054 (TURBO).This includes funds from UK Research and Innovation (UKRI) under the UK government's Horizon Europe funding guarantee [grant numbers 10037822, 10042318 and 10044756] as part of the topic ID HORIZON-CL4-2021-TWIN-TRANSITION-01-02.

Views and opinions expressed are however those of the authors only and do not necessarily reflect those of the European Union or UKRI. The European Union or UKRI cannot be held responsible for them.

Resin selection for the TURBO project

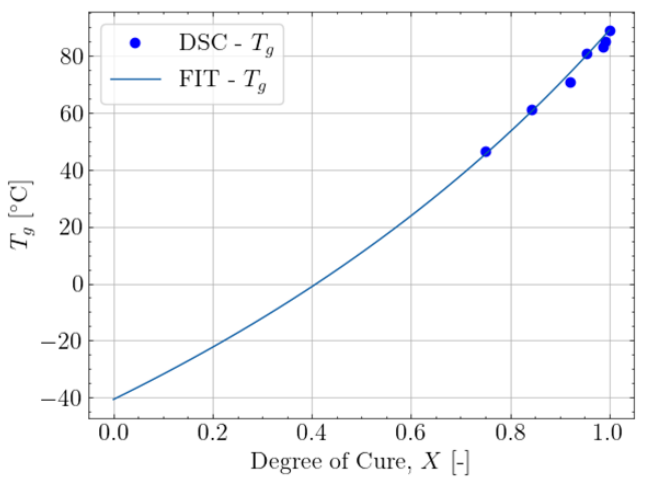
The reference resin system used in the TURBO project is a carefully selected epoxy. The system is currently being characterised regarding the cure kinetic and flow properties. A test procedure has been determined for differential scanning calorimetry (DSC) measurements, which have been used to fit a cure-kinetic model. The test procedure involved mixing a batch of base with hardener. After mixing, the resin was poured into small vials, degassed, and quenched in liquid nitrogen for storage during the test period which ran over a couple of weeks. Except for when the temperature is approaching the glass temperature, reasonable fits have been obtained using a Kamal-Sourour cure model, as shown below, where the points are the DSC measurements and the dashed lines are the fits.



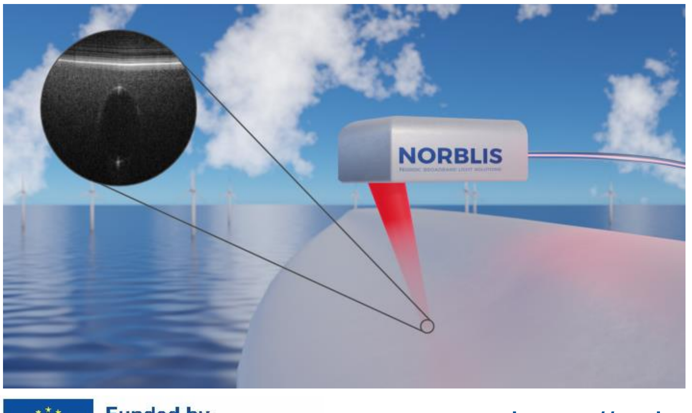
Left: Fitting of a Kamal-Sourour cure model with DSC measurements based on isotropic measurements of temperatures in the range of 40-100 °C.

For more info please contact Lars Pilgaard Mikkelsen: lapm@dtu.dk

The glass-temperature development of the resin system as a function of degree of cure are found to fit well with the Benedetto relation. More information on these experiments and parameters will be published at the 43rd International Risø Symposium on Material Science, 04-07 Sep-2023 (see previous page).

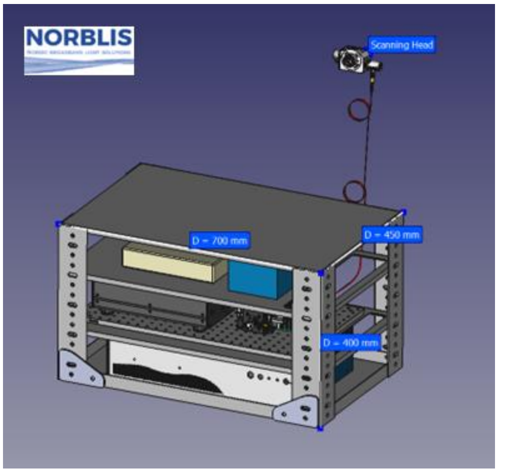


Right: Fitting of a Benedetto relation for the glass-temperature vs. degree of cure relation.

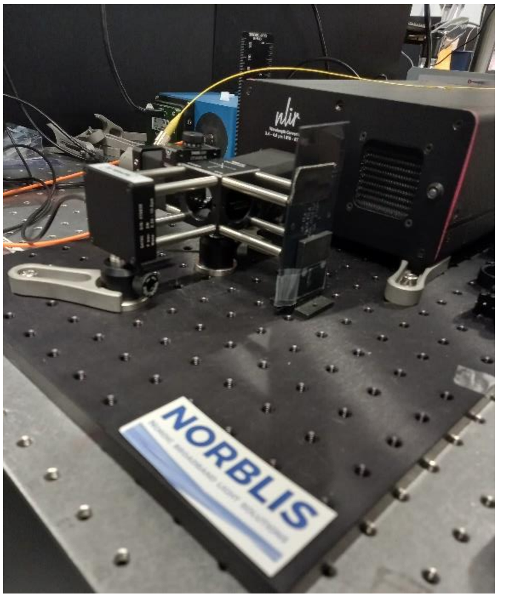


Development of mid-IR OCT for NDT in TURBO

NORBLIS ApS is a start-up spun out from Technical University of Denmark (DTU) in 2018. The image (left) illustrates the mission of NORBLIS in TURBO: to construct the first non-destructive inspection tool to discover critical defects in wind turbine blade coatings at material depths of up to 500 µm. The technology is optical coherence tomography (OCT) using mid-infrared radiation because it offers much deeper penetration of composite materials with less scattering than near-IR or visible light. The circular inset shows a real cross-sectional OCT scan detecting a void during a coating inspection.



NORBLIS has been busy designing the OCT system body and inspection probe. The latter will be mounted on a robot arm at NCC (Bristol, UK), to simulate automated and macroscopic scanning of wind turbine blades. A CAD drawing of the NORBLIS OCT system is displayed on the right. A key component is the custom designed supercontinuum laser source from DTU Electro (visible on the bottom layer of chassis). A scanning head (probe) enables swift access to the wind turbine blade surface.

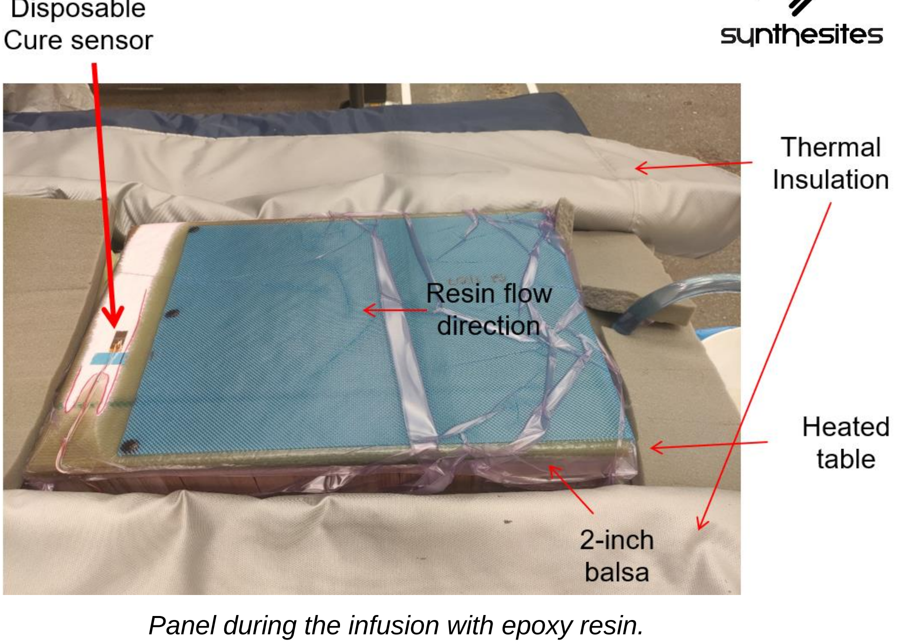


Currently, NORBLIS is developing the TURBO imaging test set-up. This will serve as the first benchmarking of the imaging performance. The photograph on the right shows the test interferometer in combination with the MIR spectrometer. A key part of the OCT system is spectrally resolved detection of the mid-infrared laser beam. This is facilitated by detection technology provided by another DTU start-up, NLIR.

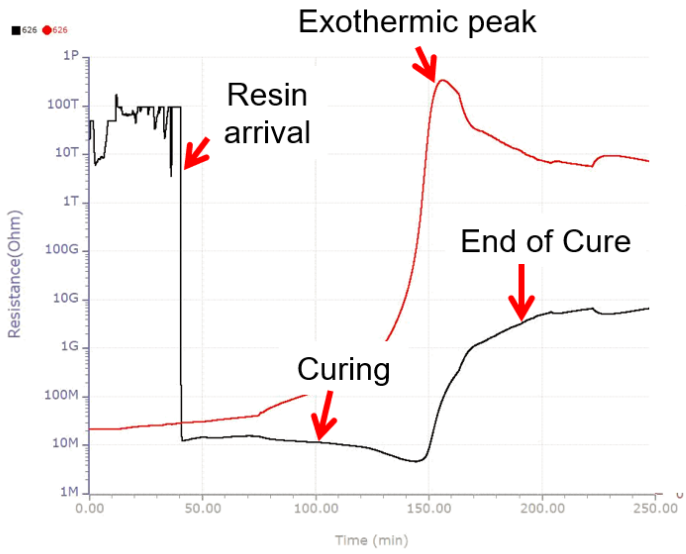
For more info please contact Niels Møller Israelsen: niels.israelsen@norblis.com

TURBO cure sensor technology from Synthesites

A first trial with Synthesites equipment and the materials that will be used in the project has been performed at Siemens Gamesa Renewable Energy (SGRE). A disposable cure sensor was introduced at the top of the thick sandwich laminate as can be seen in the image opposite. The temperature and resistance were recorded using a Synthesites Optimold unit.



Panel during the infusion with epoxy resin.



The temperature and resistance history can be seen in the graph (left), annotated with the corresponding process milestones. Due to the thermal insulation and the cure reaction, the temperature escalated quite quickly which accelerated the curing significantly.

Recorded temperature and resistance during infusion and curing.

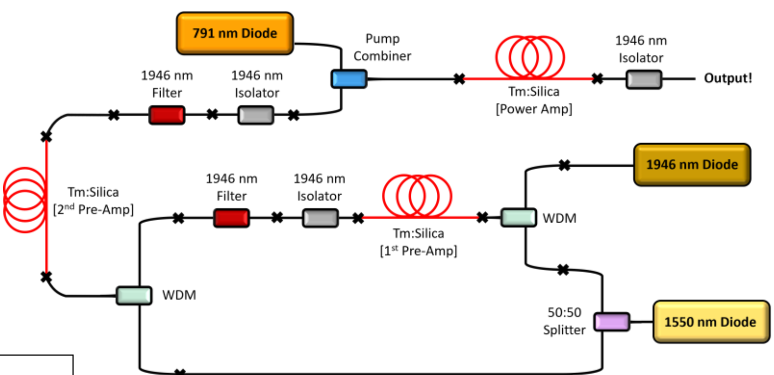
For more info please contact
Nikos Pantelelis:
be@synthesites.com

Mid-IR source development for OCT

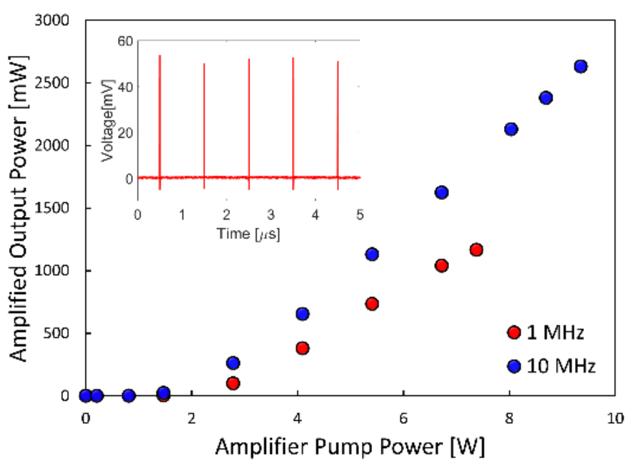
Low-noise MIR sources are desirable for OCT applications where they can exhibit reduced scattering and thus deeper sample penetration compared with conventional NIR OCT. Axial resolution in OCT is inversely proportional to the bandwidth, thus a wide bandwidth is desirable. Here we target a spectrum covering 2-5 µm. The MIR supercontinuum source will be generated through soliton dynamics resulting from pumping ZBLAN fibre in the anomalous region with pulses from a 1946 nm source.

1946 nm source architecture

The 1946 nm source architecture is shown opposite (right). This system consists of a gain-switched 1946 nm diode amplified by two thulium fibre pre-amplifier stages pumped at 1550 nm and one thulium fibre power amplifier stage pumped at 791 nm.



1946 nm source architecture



1946 nm output power at 1 MHz and 10 MHz as a function of 791 nm pump power, with recorded pulse train at 1 MHz (inset).

The amplified output power at 1946 nm as a function of 791 nm pump power is shown at 1 MHz and 10 MHz (left) with an amplified pulse train (pulse duration approx. 100 ps) at 1 MHz (inset). Initial supercontinuum results from this pump will be reported in the next newsletter.

For more info please contact
Callum Robertson Smith:
caros@dtu.dk

Funded by the European Union