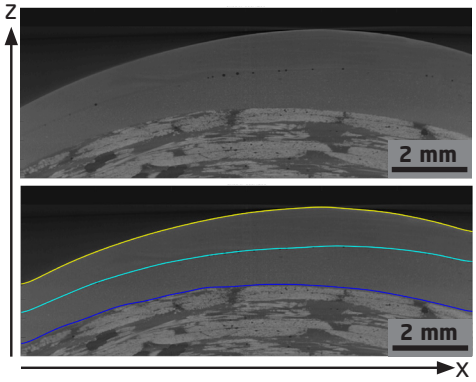
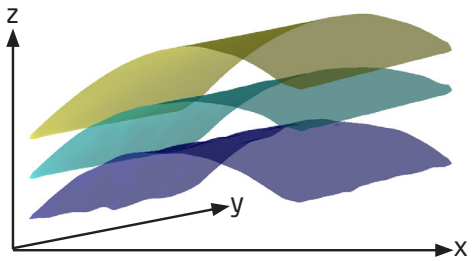
LM WIND POWER a GE Renewable Energy business
LINX
Innovation Fund Denmark

Thickness determination of coating layers

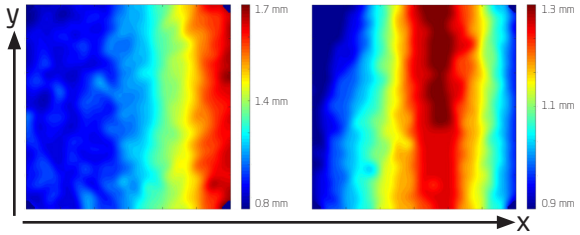
With the need to reduce CO_2 emissions, the use of renewable energy sources, e.g. wind power, is highly important in the fight against climate change. The company LM wind power is the world's leading supplier of components and services to the wind turbine industry and produces blades since 1978. Though the fundamental blade composition has not been changed, a number of developments and improvements were taken in order to meet advanced requirements, e.g. for ultra long blades. For protecting the blades against sand, sunlight, salt, water and insects, the blades' outer layer is covered with a gelcoat. In this project, the aim was to examine X-ray Computed Tomography as a method to study the thickness of different gelcoat layers on wind turbine blades.



2D slices, taken from 3D CT data of the wind turbine blade samples, cutting the sample perpendicularly to the blade length. The top image shows the two gelcoat layers on the outside and fibre bundles on the inside. However, it is difficulte to differentiate between the coating layers. The bottom image shows the interfaces identified by using a surface detection algorithm including the middle interface which is difficult to find.



3D visualisations of the extracted layers.



Thickness maps of the inner (left) and outer (right) layer indicating that the thickness is relatively constant along the blade (y direction) but varies in the perpendicular direction (x direction).

Challenge

X-ray micro Computed Tomography (CT) can be used to study the thickness of the gelcoat in a volume rather than by cutting individual slices. The obtained 3D images clearly show fibres and the coating, but it is challenging to discern the two coating layers due to their similar X-ray absorption properties. Thus, the challenge in this project was to separate the coating layers and to determine their thickness along the curved geometry of the samples to produce a thickness map.

Collaboration

Through the collaboration between LM wind power and the 3D Imaging Centre at DTU, the materials were charactersed using micro X-ray CT scans and in-house developed analysis tools. This collaboration was part of the LINX project in which researchers at leading Danish universities collaborate with scientists in industry to solve industry relevant problems using advanced neutron and X-ray techniques.

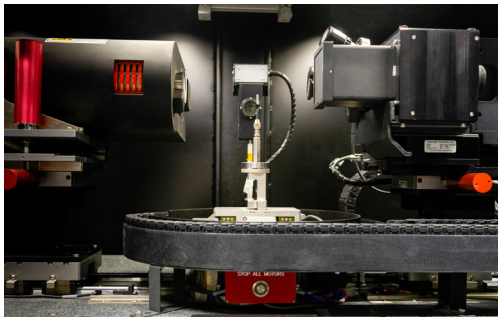
Results

Two different sample types were studied using a Nikon XT H 225 industrial CT scanner at the 3D Imaging Centre at DTU. One sample type had two gelcoat layers on top of each other, while the other one had an aluminium layer inbetween to enhance the visibility of the interface between the coating layers. Incorporating the aluminium layer facilitated the image analysis such that simple automatic analysis tools could be used to separate the two layers, but this material composition does not represent a real blade. When the realistic samples without aluminium were analysed, a slight difference between the gelcoat layers was visible to the human eye, but simple automatic analysis tools failed to differentiate between the layers. However, an automated detection of the layers is necessary in order to perform statistically valid analysis on a whole 3D volume. We therefore used more complex analysis tools developed in-house, which are based on surface detection algorithms. Using these tools, we could identify the different layers and determine the distance between the interfaces, corresponding to the coating layer thickness. With this procedure, we could show that CT imaging followed by dedicated image analysis can be applied to generate thickness maps along curved geometries, which can be used to study the thickness of gelcoat layers on wind turbine blades.

Imaging Industry Portal

The Imaging Industry Portal is a part of the 3D Imaging Centre at DTU and assists companies in using and implementing 3D Imaging in research, development and production. The portal offers research-based 3D Imaging services and provides companies with the latest equipment and the most advanced knowledge within 3D Imaging and data analysis. The Imaging Industry Portal works as a gateway to ESS and MAX IV, as well as other large scale facilities.

www.imaging.dtu.dk/Industry-Portal



DTU 3D Imaging Centre