ABSTRACT – *Non-destructive testing of gaps in high performance fiber-reinforced composites with eddy current sensors*

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Abstract: Gaps in non-crimp fabrics for high performance composites such as carbon fiber-reinforced plastics (CFRP) are a regularly occurring source of weakness and make the composite prone to damage. These gaps can occur both during textile production and preforming processes. However, the fabrics used in CFRP are most often multi-layered materials where only the top layer is visible. Consequently, defects in the lower layers cannot be detected reliably by visual checks or computer vision. Eddy current testing is a non-destructive method, which leverages the electric conductivity of carbon fibers to image the fiber structure of the whole layer stack. But due to the underlying principle, the actual size of the gap that is important to assess the degree and impact of the defect cannot be measured. The gap usually seems larger in eddy current images than it is, which leads to unnecessary waste of still usable materials and components. In this work we explore the use of reconstruction methods based on inverse point spread functions to estimate the gap width. Therefore, textiles with gaps in different depths and with different gap sizes were produced. Afterwards these were scanned with eddy current sensors and the data divided into test and validation sets to be able to verify the feasibility of our approach.

Keywords: *Fiber-reinforced composites, non-crimp fabrics, non-destructive testing, eddy current testing.*

Eddy current testing is an established method for non-destructively evaluating carbon fiber reinforced textiles and composites made of those textiles [1]. One important type of defect, especially in non-crimp fabrics (NCF) are gaps, which can either be a result of torn rovings or preforming and can drastically lower the local strength of the composite. Nonetheless, most fabrics used in CFRP are made of several layers, of which only the top layer is visible. Consequently, computer vision or optical inspections cannot consistently uncover flaws in the lower layers.

A large drawback of eddy current testing, however, is that the true defect size is hard to determine because the eddy current sensor spatially spreads the information. To be able to judge the “effect of defect” (EoD) either based on simulations or experience.

An exemplary measurement result of carbon fiber NCF with gaps with width of 25 and 30 mm are shown in Figure 1.

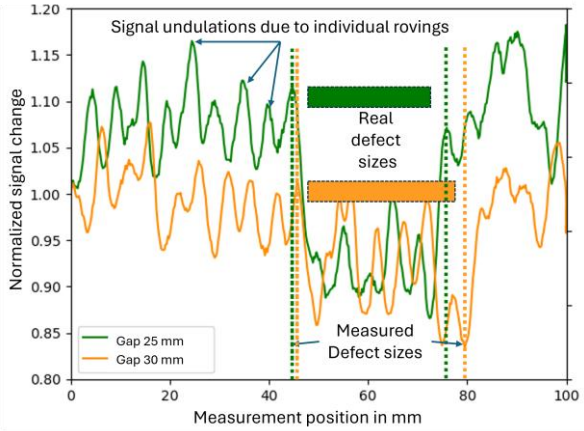

Figure 1 Eddy current sensor signals for gap sizes of 25 and 30 mm with visualization of the true defect size and the overestimated one without reconstruction

In this work we explore a reconstruction approach to more accurately predict the actual gap sizes from eddy current imaging. The approach is based on the deconvolution of the signal based on an inverse point spread function with the Richardson-Lucy method. The point spread function is calibrated for each eddy current sensor with an experimental procedure and point source dummies.

Acknowledgement*: This research was funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) – 461706052. Gefördert durch die Deutsche Forschungsgemeinschaft (DFG) – 461706052. We are grateful for the financial support..*

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