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Detection of damage in unidirectional carbon fiber composite rods using eddy current probes

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Carbon fiber composites are high performance materials, but they are very sensitive to damage. Therefore, the condition of composite structures needs monitoring to assure safe operation. However, critical flaws need to be detectable in order to develop a meaningful non-destructive testing method.

Eddy currents can be used for quality control of a laminated carbon fiber reinforced polymer (CFRP) structure. The relatively high conductivity of carbon fibers compared to a polymer matrix can be used to detect fiber orientation, laminate structure, misplaced fibers etc. A high-frequency approach that utilizes the capacitive coupling between plies has been reported [1]. That method allows the detection of delamination. In contrast, no references were found addressing damage detection in unidirectional (UD) pultruded products, i.e. structures that are not a laminate. Detection of fiber damage in pultruded UD CFRP products was shown to be difficult using commercial eddy current probes. However, a suitable probe concept and geometry for damage detection was found. The probe is a differential planar eddy current probe as shown in Figure 1 and described in detail in [2].

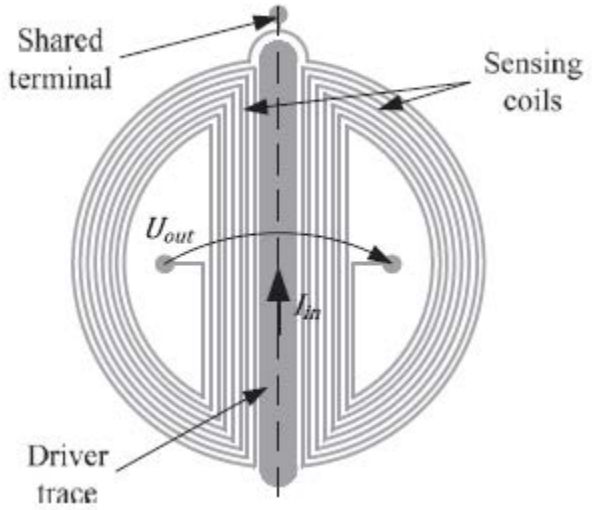

Figure 1. Configuration of the advanced probe [2]

The advanced probe geometry allows detection of fiber damage in UD CFRPs containing artificial flaws and mechanically induced defects. The tested flaw types include notches, holes, slots, voids, damage from impact, fiber breakage from flexural loading and thermal degradation. Distributed damage, such as fiber breakage due to bending, proved to be difficult to detect. Volumetric flaws, however, showed a clear signal (Figure 2).

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Damage detection of unidirectionally reinforced carbon fiber composites using eddy currents is possible with the advanced probe concept tested. However, planar and distributed damage is still a challenge for eddy current testing.

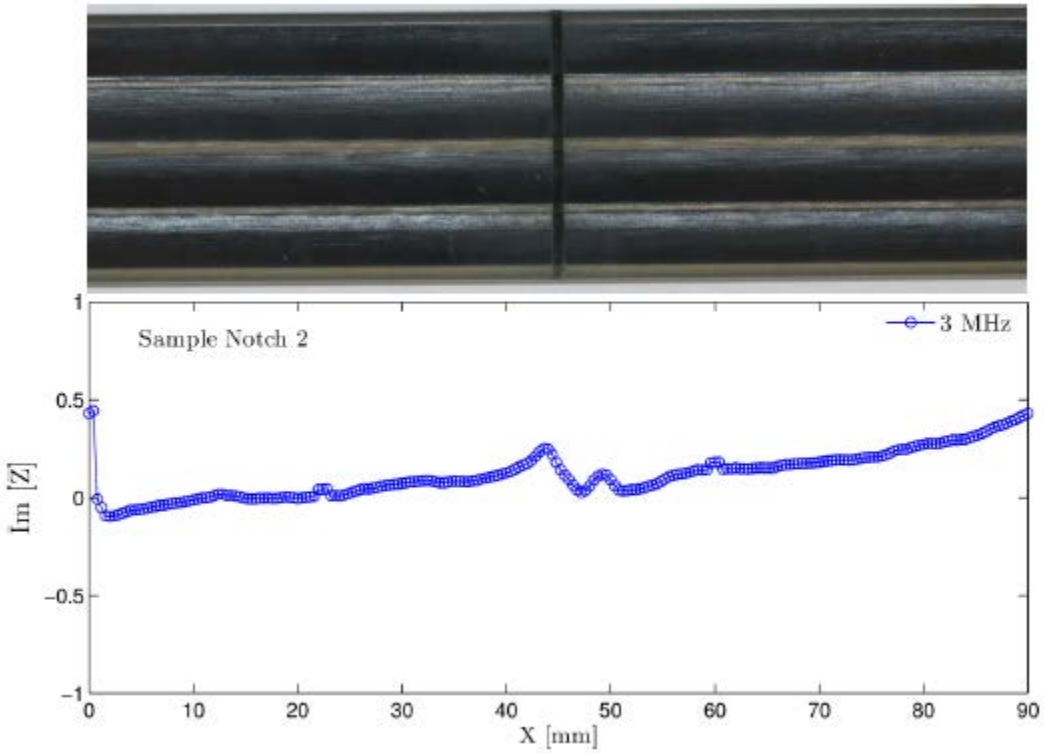

Figure 2. Impedance scan along the length of notched sample

References

[1] G. Mook, R. Lange, O. Koeser, Non-destructive characterization of carbon-fibre-reinforced plastics by means of eddy-currents, *Composites Science and Technology* 61 (2001), 865-873.

[2] L.S. Rosado, T.G. Santos, P.M. Ramos, P. Vilaça, M. Piedade, A differential planar eddy currents probe: Fundamentals, modeling and experimental evaluation, *NDT&E International* 51 (2012), 85-93.

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