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dissertation title: „*Application of planar microwave structures for non-destructive testing of composite materials*”

doctoral thesis written under the supervision of dr hab. inż. Paweł Bieńkowski

Abstract

The main scientific goal of the doctoral thesis is to solve the significant challenges related to the practical implementation of a microwave flaws detection system for composite structures made of glass fiber reinforced polymer.

The known non-destructive testing techniques used to date for the composite family of materials do not always easily enable their use as subsurface methods for assessing the condition of deep layers of composite material, especially in cases of limited access to the walls of the test object.

The paper reviewed the methods used for microwave inhomogeneity testing of composite structures, and investigations were carried out using near-field probes. As these structures were not perfect, an in-house solution was proposed in the form of planar external structures or integrated sensor structures based on the high-frequency structures known in the telecommunications field. These are adapted as structures for non-destructive testing and evaluation (NDT&E) and the tests carried out on them are described. Key parameters of the developed sensors are the low profile, minor interference with the composite support structure, ease of fabrication, and high sensitivity. The designs were supported by theoretical considerations taking into account the state of the art and verified by numerical simulations and measurements.

In the course of the research work, the thesis of the possibility of using planar metamaterials well known in the field of telecommunication as microwave sensors for the detection of defects in the dielectric composite materials was positively resolved. On the basis of a comparative analysis of simulations carried out and tests on real samples, the possibility of detecting subsurface defects with high resolution was confirmed. The lack of continuous monitoring methods for the deep layers of composite structure was a research gap that is likely to be filled by the proposed sensors.