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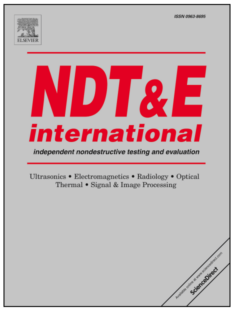

A wireless shortwave near-field probe for monitoring structural integrity of dielectric composites and polymers

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A wireless shortwave near-field probe for monitoring structural integrity of dielectric composites and polymers

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Abstract

In this paper, a passive wireless sensor is presented for monitoring structural integrity of wind turbine blades manufactured using reinforced glass fibers. The sensor developed is an Inductor Capacitor (LC) based resonant tank that detects the defects in the near-field region. The sensor is designed such that, strong electric fields exist along the near-field region of the capacitor allowing detection of very small change in effective dielectric constant of the target. The sensitivity of the developed RF sensor is verified by shortwave imaging of the target. The designed sensor has multiple reuse capability and is used in the real-time monitoring of defects along the manufacturing supply chain. A path to two-dimensional simultaneous scanning of target is shown by demonstrating a multiple LC tank array probe. The details of single and array probes for detection of fiber defects are outlined in the paper.

Keywords: Non-destructive Evaluation, Passive Wireless Sensor, Shortwave Imaging, Structural Health Monitoring (SHM), GFRP, Polymers, Wind turbines

1. Introduction

Wind power is one of the world's fastest growing renewable energy sources, leading to a rapid increase in the number of wind turbines [1]. Due to increase in size of the turbine blades and number of commercial installations, there has been a growing interest in monitoring structural integrity to keep the manufacturing and operational cost of wind turbines affordable [2, 3]. The blades are the most critical components of the wind turbines that are commonly manufactured using glass or carbon fibers [3, 4]. Quality analysis of the blades is critical during manufacturing to prevent higher maintenance and repair costs. Some of the common manufacturing defects of the turbine blades includes surface and sub-surface defects such as delamination, voids, cracks, fiber breakage, improper bonding and misalignment, and defects due to impact damage during the manufacturing process [5]. There is a growing demand for developing rapid, low cost, non-destructive evaluation (NDE) techniques to identify and quantify defects to prevent economic and structural loss.

In recent years, the advancement in sensing technology has fueled the development of different probing techniques to evaluate the structural integrity of the target under test. In literature,

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