Numerical Simulation on Terahertz Non-destructive Evaluation of defect in Composite Materials

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Abstract—The aim of this work is to develop a model using finite element approaches to study the absorption properties of various defect inside composite materials under terahertz excitation. In our model, defects such as weakbonds, degradation or crack in composite material were modelled.

1. INTRODUCTION

Composite material such as concrete and carbon fibre reinforced polymer (CFRP) are used extensively in many industries. These materials are formed by combining materials together via mixing or adhesive bonding to produce an overall structure with properties that differ from the sum of the individual components. Failure may occur and could initiate a threat to the efficiency of the composite material and may lead to a significant disaster if they are not detected timely. Terahertz spectroscopy is potentially viable to detect such defect. Here, our aim is to model the defect detection using terahertz spectroscopy. The absorption of various defect is detected and the variation in absorption properties of defect and non-defect area is studied. Simulation technology has proved to be crucial for providing useful guidelines and fine-tuning the experimental setup to improve the detectability and system performance.

2. TERAHERTZ SPECTROSCOPY MODELLING

The simulation model of composite material with defects under terahertz spectroscopy is developed using finite element method to predict the dependence of absorption responses to excitation conditions. The resulting absorption evolution field contain properties variation between the defect and the composite material. And, the characteristic of defect can be obtained from investigation on these field evolution. The models are developed for a spectroscopy set up for defect identification. The aim of the model is to aid the physical understanding of characteristic of various defects and to perform an optimization of the detecting system to improve the resolution and reliability of detection without time consuming and expensive preliminary experimental setup. Also, with this model, we are able to present a series of case studies of various materials, defects and configurations for future weakbond identification under terahertz region.

REFERENCES

1. Y. L., H., Szabó, Zs., Lim, H. C., Federici, J. F., Li, Er-Ping, “Terahertz Response of Microfluidic-jetted 3D Flexible Metamaterials,” Applied Optics, Vol. 49, Issue 8, pp. 1179–1184, 2010.

(1) Title of the paper:
Numerical Simulation on Terahertz Non-destructive Evaluation of defect in Composite Materials

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(6) Topic or Session organizer, if applicable:
Electromagnetic Modeling and Imaging of Composite Materials

(7) State if poster presentation is preferred:
Oral presentation is preferred