The University of Texas Rio Grande Valley

Center for Multidisciplinary Research Excellence in Cyber-Physical Infrastructure Systems (MECIS)

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THESIS DEFENSE

Development and Testing of a Prototype Erbium-Doped Lithium Tantalate Based Sensor for UAV Infrastructure Crack Detection

Alejandro Barrera

Center for Multidisciplinary Research Excellence in Cyber-Physical Infrastructure Systems

Department of Mechanical Engineering

Committee

Chairs:

Dr. Constantine Tarawneh

Dr. Farid Ahmed

Members:

Dr. Horacio Vasquez

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Abstract

Ensuring the safety and longevity of infrastructure is crucial to safeguarding communities and preserving economic stability. In this study, we present the development of a novel sensor for detecting and characterizing cracks in infrastructure, particularly suited for deployment on Unmanned Aerial Vehicles (UAVs). The device utilizes a laser (operating at 980 nm) for triangulation-based excitation of an erbium-doped lithium tantalate sensing electrode that emits lights at 1550 nm. This emitted light stimulates a photodiode which in turn changes impedance across it. The changes in impedance across the photodiode have been utilized in this study to collect, process, and reconstruct topological information on surfaces. The synthesized lithium tantalate nanoparticle samples vary in erbium doping percentages of 0.5%, 3%, and 10%. Experimental evaluation of these nanoparticles across the near-infrared spectrum has been conducted to optimize their absorption and emission properties, which are crucial for enhancing sensor performance. Our investigation encompasses various crack characterization methods, identifying these anomalies by width and depth. The results also show an improvement in the design and construction of sensing electrodes to augment sensing capabilities. This research represents a significant step forward in advancing infrastructure health monitoring through innovative remote sensor technology.