PhD. Dissertation Defend Examination

Presented by

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Enhancing Sustainable IoT Communication: Transparent Antenna on Glass for Smart Building Applications

Highlight Summary

Optically transparent antennas are essential for seamlessly integrating Internet of Things (IoT) connectivity into smart buildings and vehicles without compromising aesthetics. Simultaneously, the rapid expansion of IoT emphasizes the need for sustainable electronics to mitigate e-waste. This research addresses the critical challenge of low gain and poor efficiency, which typically hinders transparent antennas due to the high sheet resistance of conductive materials like Indium Tin Oxide (ITO). This dissertation presents a complete design framework and validation of high-performance, sustainable antenna systems on glass. A foundational database of substrate properties was established by characterizing architectural glass using a dielectric probe and biodegradable polymers (PLA, PBAT) using a novel hybrid microstrip (MTR/ML) method. First, a high-performance baseline was established by designing and validating a wideband (1.53-2.63 GHz) bidirectional antenna using opaque copper on glass, which achieved ~3 dBi gain. To achieve unidirectional performance and higher gain, a conventional copper-on-glass Artificial Magnetic Conductor (AMC) was designed, providing 0° in-phase reflection at both 2.1 GHz and 2.4 GHz. The low-profile integration of this AMC with the antenna was successfully fabricated and measured, dramatically enhancing the forward gain to 8.41 dBi while suppressing back radiation. Having validated the design with opaque conductors, the study then addressed the final goal of full transparency. Various transparent conductive materials (TCMs), including ITO and MXene, were characterized using a custom 3D-printed fixture with an LCR Meter. The validated high-gain, unidirectional antenna and AMC system was then successfully realized using the most promising TCM. This work culminates in a complete, validated design pathway for an all-transparent, low-profile, high-gain antenna system, demonstrating a viable solution to the transparency-efficiency trade-off and advancing the scalable integration of aesthetic, sustainable antennas into smart infrastructure.

Date	Time	Venue
December 2nd, 2025	14:00	Room: 407, TGGS Building, KMUTNB