UNIVERSITI TEKNOLOGI MARA

ANALYSIS ON THE PERFORMANCE OF DUAL STACK TRANSPARENT ANTENNA MADE OF AZO TRANSPARENT CONDUCTIVE MATERIALS

MARDHIAH BINTI AWALLUDIN

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

Name of Student	:	Mardhiah binti Awalludin
Student I.D. No.	:	2013456572
Programme	:	Doctor of Philosophy (Electrical Engineering) – EE950
Faculty	:	Electrical Engineering
Thesis Title	:	Analysis on the Performance of Dual Stack Transparent Antenna Made of AZO Transparent Conductive Materials
Signature of Student	:	……..
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ABSTRACT

The demand for multi-function application in modern wireless communication system has created a growing interest of incorporating optically transparent and electrically conductive material in antenna designs. Over two decades, the microstrip patch antenna (MPA) due to its low profile, small size, low cost and easy fabrication process has gained numerous research attention for such wireless application systems. However, despite the advantages MPA offers, narrowband issues remain to be solved for the antenna to reach its full potential, especially if it is to be integrated with transparent materials. Wideband technology become one of the promising technology to fulfill the demand on providing wide bandwidth and high data transmission in the latest and future portable home and office devices for audio and video streaming. This thesis presents dual-stacked transparent microstrip patch antenna development for future wireless communication system as solution for narrowband problem. Instead of using copper as the conductive patch like in conventional MPAs, the proposed antennas utilised transparent substrates and transparent conductive thin films as an alternative solution. As a preliminary study, single Aluminium Doped Zinc Oxide (AZO) microstrip patch antenna using three different transparent dielectric substrates (glass, quartz or Polymethyl methacrylate (PMMA)/Perspex) were simulated at 2.4 GHz. The antenna based on PMMA/Perspex substrate showed higher impedance bandwidth and directivity than the antenna based on quartz and glass substrates. Therefore, PMMA/Perspex was chosen as the transparent substrate for the next investigation besides physical properties of the substrate, which are flexible and non-fragile, also provided advantages for this research. The chosen PMMA/Perspex was used to further investigate a single MPA resonating at 5 GHz based on three different transparent conductive films such as AZO, Indium Tin Oxide (ITO) and Silver Coated Polyester (AgHT-8). In this second investigation, a narrow bandwidth of 0.135 GHz (2.7%), 0.21 GHz (4.2%), and 0.21 GHz (4.2%), were achieved for AZO, ITO and AgHT-8 single MPA, respectively. Therefore, these simulation results have led to the development of dual-stacked transparent MPAs. The stacking technique was subsequently employed, introducing an air gap in the antenna structure. The dual-stacked antennas were simulated, fabricated and experimentally verified. All designs were simulated using CST Microwave Studio Software. AZO thin film was deposited on PMMA/Perspex substrate using RF magnetron sputtering technique, whilst ITO and AgHT-8 thin films were ready-made commercial films available in the market. All measured S11 were slightly varied compared to simulation results due to fabrication tolerances. Adding an air-gap to the structure was proven with the impedance bandwidth that increased up to 160% for AZO dual-stacked MPA compared to its corresponding single MPA. However, the characteristic of film material used affected the performance of all antennas, where the antennas exhibited negative gain values and also low efficiency.

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TABLE OF CONTENTS