UNIVERSITI TEKNOLOGI MARA

PERFORMANCE ENHANCEMENT OF MICROWAVE ABSORBERS USING TRIANGULAR SLOT CONFIGURATIONS GEOPOLYMER CERAMIC PYRAMIDAL STRUCTURES

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ABSTRACT

A microwave absorber is essential in an anechoic chamber to simulate a free space environment by eliminating reflections, thereby enabling accurate testing of electronic devices. This project introduces a novel method for designing advanced microwave absorbers, specifically focusing on the absorption performance of geopolymer ceramic hollow pyramidal absorbers featuring triangular slots. These slots vary in size, array configuration, and pattern were found to influence absorption performance differently, indicating that geometric parameters play a crucial role in optimizing absorption. The absorbers, constructed with a square base measuring 20 cm by 20 cm and a height of 40 cm, are coated with a geopolymer ceramic material. The triangular slots are strategically integrated to improve the absorption performance compared to the original non-slotted design. The fabrication of precise triangular slot geometries remains a major challenge, as ensuring accurate alignment and material consistency. In this study, 10 microwave absorbers were developed, each incorporating variations in slot size, slot inversion, and multiple slot designs on the geopolymer ceramic hollow pyramidal structure. The design and optimization of the absorber were carried out using CST Microwave Studio software. Measurements were conducted using both simulation and the arch method, covering a frequency range from 1 GHz to 12 GHz, which includes the L, S, C, and X bands. The results demonstrated that the inclusion of triangular slots significantly enhanced the absorption performance across all frequency bands. Specifically, the highest absorption performance was observed at the C band, with a single slot achieving -68.56 dB, two slots in series reaching -76.15 dB, and a configuration with Nine slots attaining -68.87 dB. These findings clearly indicate that slotted designs substantially improve absorption capabilities compared to non-slotted configurations.

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CHAPTER 1
INTRODUCTION

1.1 Research Background

Since World War II, the telecommunications industry has seen significant technological advancements, particularly in the use of radio frequencies, including radio waves and microwaves. Both radio waves and microwaves are forms of electromagnetic radiation that propagate at the speed of light. In the electromagnetic spectrum, these frequencies range from 3 Hz to 300 GHz, with wavelengths spanning from 100,000 kilometers to 1 millimeter. Today, electromagnetic wave especially radio wave and microwave are plays an importance role in communication system, radar system, medical system and industrials. With the rapid advancement of electronic technology, more various electronic equipment is manufactured. However, certain electronic equipment that produce abnormal electromagnetic radiation can interfere the other normal operating system and can harmful the people health. Therefore, the radiation of electronic equipment must be evaluated in an anechoic chamber requiring an absorber within.

Microwave absorbers are widely used in anechoic chamber for electromagnetic compatibility (EMC) / electromagnetic interference (EMI) measurements. An anechoic chamber is a room designed to eliminate reflection of electromagnetic wave and shielded from wave outside the room. There are two types of anechoic chamber which is fully anechoic and semi anechoic chamber [1]. In fully anechoic chamber a long its wall, floor and ceiling are covered by microwave absorber while semi anechoic chamber only ceiling or upper part is covered by microwave absorber. The function of microwave absorber in the anechoic chamber is prevent any reflections of electromagnetic radiation and eliminated the unwanted radiation. Anechoic chambers are widely used to measure spacecraft, antenna and electronic systems in a variety of indoor radio frequency (RF). Other application of microwave absorber there are used in air defences military. The aircraft is designed with stealth technique to make aircraft invisible from enemy radar [2].