AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Electronics Engineering and Electrical Communications

Microwave Artificial Surfaces

A Thesis submitted in partial fulfillment of the requirements for the degree of

Master of Science in Electrical Engineering

(Electronics Engineering and Electrical Communications)

by

Mahmoud Mabrouk Eid Mostafa

Bachelor of Science in Electrical Engineering

(Electronics Engineering and Electrical Communications)

Faculty of Engineering, Ain Shams University, 2013

Supervised By

Prof. Amr Mohamed Ezzat Safwat

Prof. Tamer Mostafa Abuelfadl

Cairo - (2018)

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Examiners' Committee

Name and Affiliation	Signature
Prof. Hadia Mohamed Said EL Hennawy (Examiner) Electronics Engineering and Electrical Communications Faculty of Engineering, Ain Shams University	.....
Prof. Islam Abdelsattar Eshrah (Examiner) Electronics Engineering and Electrical Communications Faculty of Engineering, Cairo University	.....
Prof. Amr Mohamed Ezzat Safwat (Supervisor) Electronics Engineering and Electrical Communications Faculty of Engineering, Ain Shams University	.....
Prof. Tamer Mostafa Abuelfadl (Supervisor) Electronics Engineering and Electrical Communications Faculty of Engineering, Cairo University	.....

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Statement

This thesis is submitted as a partial fulfillment of Master of Science in Electrical Engineering, Faculty of Engineering, Ain Shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

Student name: Mahmoud Mabrouk Eid Mostafa

Signature

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Researcher Data

Name : Mahmoud Mabrouk Eid Mostafa

Date of birth : 9/6/1991

Place of birth : Cairo, Egypt

Last academic degree : B.Sc. in Electrical Engineering

Field of specialization: Electronics Engineering and Electrical Communications

University issued the degree : Ain Shams University

Date of issued degree : July 2013

Current job: Teaching assistant at Faculty of Engineering, Ain Shams University

Faculty of Engineering Ain Shams University

Electronics and Communication Engineering Department

Thesis title: "**Microwave Artificial Surfaces**"

Submitted by: **Mahmoud Mabrouk Eid Mostafa**

Degree: **Master of Science in Electrical Engineering**

Thesis Summary

This thesis aims to study artificial microwave surfaces and their applications in antennas. While artificial surfaces have many configurations, this thesis focuses on artificial magnetic conductors (AMCs) and their applications. Two applications are developed: an optically transparent AMC surface suitable for automotive applications and a folded dipole antenna on a near-perfect AMC surface with pseudo-omnidirectional (heart-shaped) radiation pattern.

The thesis is divided into five chapters as follows:

Chapter 1:

This chapter introduces the objectives, work contributions, and thesis organization.

Chapter 2:

This chapter presents a review of different types of artificial microwave surfaces (metasurfaces) along with their applications.

Chapter 3:

This chapter introduces a new unit cell design and an optically transparent wideband artificial magnetic conductor (AMC) surface that operates at 5 GHz. The surface is

designed on an acrylic substrate. Results show a good agreement between the proposed circuit model, EM simulations, and measurements. The ±90° BW is 1 GHz (from 4.5 to 5.5 GHz) and the optical transparency is 80 %.

Chapter 4:

This chapter presents a new pseudo-omnidirectional antenna that is appropriate for wide beam applications, e.g., handheld devices, along with a reduced back radiation that suits wearable applications as well. The design consists of a horizontal omnidirectional antenna placed on a proposed Artificial Magnetic Conductor (AMC) surface that enhances the gain in the broadside direction, reduces the back radiation, and enables good radiation in the side directions. A 5 GHz folded dipole antenna on a 2×2 AMC array surface is designed and characterized. Simulations and measurements, which are in a very good agreement, show that the radiation has a heart-shaped pattern, with a front to back ratio of more than 13 dB, a front to side ratio of less than 2.5 dB, and a half-power beam width (HPBW) of more than 230°.

Chapter 5:

This chapter draws the conclusions of the thesis and gives potential suggestions for the future work.

Key words:

Metasurfaces, Artificial magnetic conductor (AMC), 2D periodic structures, Optically transparent, Folded dipole, Heart-shaped radiation pattern

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Mahmoud Mostafa

Electronics Engineering and Electrical Communications

Faculty of Engineering

Ain Shams University

Cairo, Egypt

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