



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم

بسم الله الرحمن الرحيم



MONA MAGHRABY



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم



شبكة المعلومات الجامعية التوثيق الإلكتروني والميكروفيلم



MONA MAGHRABY



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات



يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار



MONA MAGHRABY



MANUFACTURING OF COMPOSITE MATERIALS USED FOR CAMOUFLAGING AND CONCEALMENT FOR UAV (STEALTH)

By
Ahmed Mamdouh Azab

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Chemical Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2020

**MANUFACTURING OF COMPOSITE MATERIALS
USED FOR CAMOUFLAGING AND CONCEALMENT
FOR UAV (STEALTH)**

By
Ahmed Mamdouh Azab

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Chemical Engineering

Under the Supervision of

Prof. Dr. Nabil M. Abdelmonem

Dr. Hesham Tantawy

.....
Professor of chemical engineering
Chemical engineering department
Faculty of Engineering, Cairo University

.....
Associate Professor
Chemical engineering department
Military Technical College

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2020

**MANUFACTURING OF COMPOSITE MATERIALS
USED FOR CAMOUFLAGING AND CONCEALMENT
FOR UAV (STEALTH)**

By
Ahmed Mamdouh Azab

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Chemical Engineering

Approved by the
Examining Committee

Prof. Dr. **Nabil M. Abdelmonem**

Thesis Main Advisor

Prof. Dr. **Mohammed. H.Mahmoud**

Internal Examiner

Prof. Dr. **Mohammed. A.Gobara**

External Examiner

(Head of Chemical engineering department, Military Technical College)

Engineer's Name: Ahmed Mamdouh Azab
Date of Birth: 8 /12 /1980
Nationality: Egyptian
E-mail: ahmedazabelkanawaty@gmail.com
Phone: 01027459877
Address: Nasr City, Egypt
Registration Date: 1 /10 /2014
Awarding Date: / /2020
Degree: (Master of Science)
Department: Chemical Engineering



Supervisors:

Prof. Dr. Nabil M. Abdelmonem
Dr. Hesham. Ramzy Tantawy
Chemical engineering department, Military Technical
College

Examiners:

Prof. Dr. Nabil. M. Abdelmonem (Thesis main advisor)

Prof. Dr Mohammed. Mahmoud (Internal examiner)

Prof.Dr Mohammed Ahmed Gobara (External examiner)
Head of Chemical engineering department,
Military Technical College

Title of Thesis:

Manufacturing of composite materials used for camouflaging and concealment for UAV (stealth).

Key Words:

Stealth; Composites; Preparation; Characterization; measurements.

Summary:

composite materials used for camouflaging and concealment for unmanned aerial vehicles UAV from radar waves are prepared by using Graphene / polyethylene matrix. Graphene used in the matrix are in the form of chemically reduced graphene oxide RGO or thermally reduced graphene intercalated GI-Th. Characterization are done for both pure graphite G, RGO and GI-Th. Composite polymer matrix is prepared utilizing 0.7 g sample of 10, 20 and 30% mass loading of G, RGO and GI-Th. EM measurements are done by using Network Analyzer device under the frequency range (8-12)GHz to obtain RL and TL of the composites.

Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

Name: Ahmed Mamdouh Azab

Date: .././...

Signature:

Dedication

I would like to dedicate the present work to my family, my parents and my brothers, who have been supporting me in all steps of my life

Acknowledgments

Praise to "Allah", the Most Gracious and the Most Merciful Who Guides Us to the Right Way

All praises and thanks to Allah, the lord of the Words, the sustainer of the universe, and the rule of the day of resurrection. He provided me with all means of support, guidance, patience and ability to complete this work.

No words can adequately express my deepest gratitude to:

1. Prof. Dr. Nabil Mahmoud Abdelmonem.

2. Dr. Hesham Ramzy Tantawy

for their moral support, valuable instructions, priceless advices, continuous supervision, and encouragement.

Thanks for Chemical Engineering Department in **Cairo University, Military Technical College, Central Labs of Chemical Warfare Institution** for great efforts in the experimental work, it would have been difficult indeed to have made such progress without their assistance.

Special Thanks to **Dr. Magdi Darwish** for helping me in the electromagnetic measurements.

Thanks to all my family for their continuous help and encouragement.

Finally, my thanks to all people who helped and gave me a hand to carry out this work.

Table of Content

TABLE OF CONTENTS	IV
LIST OF TABLES	VII
LIST OF FIGURES	VIII
NOMENCLATURE	X
ABSTRACT	XII
CHAPTER 1 : INTRODUCTION	1
CHAPTER 2 : LITERATURE REVIE	3
2.1. BACKGROUND ON THE STEALTH TECHNOLOGY	3
2.2. UAV SIGNIFICANCE	3
2.3. STEALTH CHALLENGE	5
2.3.1. Infra- red stealth	5
2.3.2. Acoustic Stealth	6
2.3.3. Visual Stealth	6
2.3.4. Radar Stealth	6
2.4. THEORY OF RADAR STEALTH	7
2.4.1. Radar Principals:	7
2.4.2. Radar Cross Section:	8
2.4.3. Interaction Of Radar Wave With Matter:	10
2.4.4. Electromagnetism	11
2.4.4.1 Permittivity	11
2.4.4.2 Permeability	12
2.4.4.3 Reflectivity Minimization	13
2.5. RADAR ABSORBING MATERIALS (RAMS)	15
2.5.1 Nanostructured Radar Absorbing Materials	15
2.6 GRAPHENE	15
2.6.1 Graphene Synthesis	19
2.6.1.1 Chemical Vapor Deposition (CVD)	19
2.6.1.2 Graphene Synthesis by Mechanical Cleavage	19
2.6.1.3 Graphite Chemical Intercalation	20
2.6.1.4 Graphite Chemical Oxidation	21
2.6.2 polymer Based Composites	22

2.7.	GRAPHENE NANO COMPOSITES CHARACTERIZATION.....	22
2.7.1.	Graphene Nano Composites Instrumental Characterization.....	22
2.7.2	.Electromagnetic Measurement.....	22
CHAPTER 3: EXPERIMENTAL WORK.....		26
3.1.	MATERIALS AND CHEMICALS.....	26
3.2.	SYNTHESIS PROCEDEURE.....	27
3.2.1	Preparation of Thermal Reduced Graphite Intercalated.....	27
3.2.2	Preparation of Reduced Graphene Oxide RGO.....	27
3.2.2.1	Preparation of Graphite Oxide GO by Using Improved Hummer Method.....	27
3.2.2.2.	Reduction of Graphite Oxide.....	29
3.2.3	Preparation of Graphene- Polyethylene Matrix	30
3.3.	Instrumentations AND Characterization.....	31
3.3.1.	Dispersive Raman spectroscopy	31
3.3.2.	X-Ray Diffraction Analysis (XRD).....	31
3.3.3	Scanning Electron Microscope (SEM).....	32
3.3.4.	Electromagnetic Measurement.....	33
CHAPTER 4: RESULTS AND DISCUSSIONS.....		36
4.1	RAMAN SPECTROSCOPY	36
4.2.	THE X RAY DIFFRACTION ANALYSIS XRD.....	40
4.3.	MORPHOLOGICAL ANALYSIS	41
4.3.1	Scanning Electron Microscope (SEM).....	41
4.3.2	EDAX Analysis.....	44
4.3.3	TEM Analysis.....	44
4.4.	ELECTROMAGNETIC MEASURMENTS.....	45
4.4.1	Electromagnetic Measurements For G, GI-Th and RGO.....	48
4.4.2	Electromagnetic Measurements For G, GI-Th and RGO Composite....	48
4.4.2.1	Reflection Loss Measurements	48
4.4.2.2	Transmission Loss Measurements	50
4.4.2.3	Mass loading percentage impact reflection loss and transmission loss	52
CONCLUSIONS AND RECOMMENDTIOS.....		55
REFERENCES.....		56

List of Tables

Table (2.1) Radar bands and usage.....	10
Table (3.1) Chemical used in preparation.....	26
Table (3.2) Preparation of G, RGO and GI-Th / Polyethylene composites	30
Table (4.1) Peak table relative peak intensity for G, GI, GI-Th and GI-MW...	38
Table (4.2) The relative peak intensity values of both G-NICE and RGO.....	39
Table (4.3) EDX analysis of G-NICE, GI and GI-Th.....	44
Table (4.4) average transmission loss and reflection loss of 0.7 gm. of G, RGO and GI-Th at X band range.....	48
Table (4.5) mass loading percentage impact on RL.....	53
Table (4.6) mass loading percentage impact on TL.....	54

List of Figures

Figure (2.1) The RQ-3 UAV.....	4
Figure (2.2) X-47A UAV.....	4
Figure (2.3) Wing-Long UAV.....	5
Figure (2.4) Electromagnetic waves.....	8
Figure (2.5) Electromagnetic radiation spectrum.....	8
Figure (2.6) Radar cross section of different targets.....	9
Figure (2.7) reflection- transmission-absorption of EMW.....	11
Figure (2.8) Dielectric polarization.....	12
Figure (2.9) Polarized and un-polarize dielectric material.....	12
Figure (2.10) Different types of permeability.....	13
Figure (2.11) Sp ¹ hybridization (a), sp ² hybridization(b).....	16
Figure (2.12) The physical structure of graphene.....	17
Figure (2.13) Piece of natural graphite (a), layered structure of graphite(b).....	17
Figure (2.14) Dimensional structure of grapheme, graphite, nanotube and fullerene...18	
Figure (2.15) The graphite sheets an intercalates.....	20
Figure (2.16) The intercalation process of graphite.....	21
Figure (2.17) The physical structure of graphite oxide.....	21
Figure (2.18) Classification of electromagnetic Characterization methods.....	23
Figure (2.19) Transmission /Reflection Characterization methods.....	23
Figure (2.20) The setting of the two-port analyzer.....	24
Figure (3.1) Preparation of GI-Th from pure graphite.....	27
Figure (3.2) Improved Hummer Method.....	29
Figure (3.3) The preparation of RGO.....	29
Figure (3.4) Preparation of RGO Polyethylene composite.....	30
Figure (3.5) Bruker Raman Spectroscopy.....	31
Figure (3.6) X-Ray diffractometer.....	32
Figure (3.7) Scanning Electron Microscope.....	33
Figure (3.8) The Network Analyzer.....	34
Figure (3.9) Waveguide Samples (a) Before heating (b) After heating.....	35
Figure (4.1) Raman analysis for G, GI, GI-Th and GI-MW.....	37
Figure (4.2) Raman analysis for graphite and reduced graphene oxide.....	39
Figure (4.3) ... Figure (4.3) XRD analysis of G-NICE, GI, GI-Th and GI-MW.....	40
Figure (4.4) The XRD analysis of RGO with respect to G-NICE.....	41
Figure (4.5) SEM and corresponding EDX of G-NICE, GI and GI-Th.....	42
Figure (4.6) SEM of 10% G, RGO and GI-Th /Polyethylene composites.....	43
Figure (4.7) TEM for GO, RGO.....	45
Figure (4.8) Reflection losses of Graphite (G), (RGO), and (GI-Th).....	46
Figure (4.9) Transmission losses of Graphite (G), (RGO), and (GI-Th).....	47
Figure (4.10) Reflection loss of 10, 20 and 30% G /PE composite.....	49
Figure (4.11) Reflection loss losses of 10, 20 and 30% of RGO-Polyethylene.....	49
Figure (4.12) Reflection loss losses of 10, 20 and 30% of GI-Th-Polyethylene.....	50
Figure (4.13) Transmission losses of 10, 20 and 30% of graphite-Polyethylene.....	51
Figure (4.14) Transmission losses by 0.7g of 10, 20 and 30% of RGO-Polyethylene.....	51

Figure (4.15) Transmission losses by 0.7g of 10, 20 and 30% of GITH-Polyethylene.	52
Figure (4.16) Impact of mass loading percentage of G, RGO, and GITH utilized in polyethylene composite average RL.....	52
Figure (4.17) Impact of mass loading percentage of G, RGO, and GI-Th utilized in polyethylene composite on average TL.....	54