



THERMOELECTRIC BEHAVIOR OF NON CONDUCTING / CONDUCTING POLYMERIC MATERIALS

By

Hussein Osama Mohamed Badr

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
METALLURGICAL ENGINEERING

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Key Words:

Thermoelectricity; Seebeck Coefficient; Insulating and Conducting Polymers;
Polyaniline; Carbon nanotubes.

Summary:

As on the increasing energy crisis, large amount of heat are reported to be lost at low temperatures (up to 250 °C), that can reach more than 70 % of the total waste heat, the market is motivated for seeking of new materials for low temperature thermoelectric applications (LTTE). Organic materials, with their well-known properties of light weight, abundance, versatility, low cost, ease of synthesis and processing, low thermal conductivity, in addition to eco-friendly and sustainability, show large findings in LTTE with their additional superior adjustment to be semiconducting / conducting moderate temperature stable materials (up to 300 °C). However all of these advantages, lower values of figure of merit were recorded for polymers and polymer composite that motivates for deep study of thermoelectric properties of polymers for the aim of understanding and developing new methodologies for organic thermoelectric materials.

Disclaimer

I hereby declare that this thesis is my 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:

Date:

Signature:

Dedication

I dedicate this thesis to my parents. I dedicate this thesis to my mother (Mrs Amira Elsayad) that Dedicated all her life as an investment in growing her sons to be two successful and remarkable persons and hope this thesis to one step toward her dream. I deeply dedicated this thesis to my father (Colonel / Osama Badr) that passed away in 2003. He wishes to see me with the primary school certificate before going to the afterlife; sure he is proud of me now obtaining my primary graduate school step (Masters degree) to be a scientist.

Acknowledgments

This thesis marks the end of a research period that has been fruitful, successful and valuable for me at Department of Mining, Petroleum and metallurgical Engineering, Faculty of Engineering, Cairo University. I cannot express the possible thanks to all generous individuals, whose support have been greatly appreciated.

I thank Allah -subhanhahu w ta'lla- for all the blessings he gave me. I thank Allah of awarding me a loving family and I really appreciate their support, especially my mother (Mrs. Amira Elsayad), my brother (Eng. Mohamed Osama) and my uncle (Dr. Badr Mohamed). I could not have done that without their care and guidance and I kindly ask Allah to reward them in and afterlife.

I would like to express my sincere gratitude to Prof. Iman Elmahallawi, not just for being my master's advisor, but also for awarding me the initial steps in the academia career. The first proposal, grant, Prize, Poster and research paper were just dreams for me before achieving them under Prof. Iman supervision. Thanks for her consistent guidance and mentorship over the period of this research. I would like also to express my pleasing to join the academic school of Prof. Fawzi Elrefaei. Prof. Elrefaei is the scientist and the father that has been professionally establishing well defined borders for my career and personality. Additionally, I am so grateful to Prof. Saad Elraghy for recommending me for a real and great research opportunity to one of the top ranked "ceramics research group" all over the world. I would like to let Prof.Saad Elraghy know that I can perfectly meet all MPM morning tours advices and tips through my entire journey.

I would like to express my gratitude to Prof. Nageh Allam and his talented EML group from AUC for providing me with their scientific experience and advanced characterization instruments and tools for my research. I would also thank Dr Ahmed Abdel Azim for proposing the main idea of this work (Thermoelectricity) to start it in Egypt from scratch. Also I would like to show many thanks to Prof. Samia Sobhy and her PhD student Dr Abd Elrahman Gadallah from Department of Chemical Engineering, Faculty of Engineering, Cairo University for providing me by their thesis and experience in synthesis and characterization of conducting polymers; especially polyaniline.

Finally, I have to show my pleasing to all my instructors/ colleagues especially Dr Lamia Zaki, Dr Mohamed Mohsen and Eng. Mohamed Hafez for being my mentors and friends through my bachelor and masters studies. I have also the deepest gratitude to my school, my teachers and all my professors who taught me one day.

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Nomenclature

Abbreviation	Name
GDP	gross domestic product
EIA	energy information administration
PV	Photovoltaic
TE	Thermoelectricity
ZT	thermoelectric figure of merit
S	Seebeck Coefficient
σ	Electricacal Conductivity
K	Thermal Conductivity
PF	Power Factor
η	Power Conversion Efficiency
PGEC	phonon glass electron-crystal
HH	Half Heusler
VEC	the valence electron count
CNTs	Carbon nanotubes
MWNTs	Multi wall Carbon nanotubes
SWNTs	Single wall Carbon nanotubes
dppp	bidentate phosphine ligands, 1, 3-bis(diphenylphosphino) propane
CPs	conducting polymers
P3T	polymethylthiophenes
PEDOT	poly (3,4-ethylenedioxythiophene)
PANI	polyanilines
HCl	hydrochloric acid
CH ₃ SO ₃ H	methansulphonic acid
CSA	camphor sulfonic acid
PSB	poly-Schiff bases
PS	Polystyrene
PVAc	Poly (vinyl acetate)
DOC	sodium deoxycholate
TCP	meso-tetra (4-carboxyphenyl) porphine