UNIVERSITI TEKNOLOGI MARA

HEAT DISTRIBUTION SIMULATION OF A PHASE CHANGE MEMORY WITH SEPARATED HEATER STRUCTURE

MOHD SHARIMAN BIN A. AZIZ

Thesis submitted in fulfillment
of the requirements for the degree of
Master of Science (Electrical Engineering)

Faculty of Electrical Engineering

July 2019

ABSTRACT

Phase change memory (PCM) is a type of the non-volatile memory. A PCM structure with the heater layer was more efficient in heating up the PCM material. Typically, the heater needs to maintain in a fairly high temperature because enough power were enquired in ensuring the melting temperature to be reached. Therefore, the Silicon Carbide (SiC) was proposed as the heater layer. SiC's advantages was low thermal expansion, high thermal conductivity, excellent thermal shock resistance and wide band gap material. The objective of this study were to determine the optimum temperature for the changes in the memory layer using SiC as the heater layer by simulation method, to investigate the ability of SiC as a heater layer in separate-heater PCM structure to change the phase change material properties from amorphous to crystalline state by simulation method and to determine the power consumption for the phase change memory (PCM) and investigated multilevel storage of the phase change memory (PCM) by calculating the resistance changes of the memory layer. The PCM with a separated hater structure was design by using COMSOL Mutiphysic Software to control the power and to achieve multilevel storage. Joule heating elements in COMSOL Mutiphysic Software were applied. Simulation with different structure, properties, thickness, channel and the different heater material of SiC were done in this study. Finding from this study, SiC were most suitable material for heater layer compared with other material (CNT and TiSi3) . The optimum temperature of this design was 450K and the power consumption was 0.9V with 100ns pulse width.

ACKNOWLEDGEMENT

First and foremost, all praises to Almighty ALLAH for delivering me the patience, strength and guidance in completing my Master research at Universiti Teknologi Mara (UiTM). I owe my deepest to my supervisor, Dr. Rosalena Irma Alip and my co-supervisor Dr. Zulfakri Mohamad for their encouragement and great support. Their guidance and dedicated time had inspired me to gain confidence in achieving the objective of this project. Without their efforts, I would not be able to bring this research to a completion.

I would like to acknowledge and thank the assistance and help provided by staffs of NANO-Electronic Centre and NANO-SciTech Centre specifically Mr. Azwan, Mr. Suhaimi, Mr. Danial, Mr. Azrul, Mrs. Nurul, Mr. Salifairus and Mr. Azlan. Other notable staffs are Mr. Hayub, Mr. Abul, Mrs. Anisda and Mr. Zulhelmi.

A token of appreciation goes to all my colleagues especially Ms. Rohanieza, Mrs. Shafaq Mardhiana, Mrs. Bazilah, Mrs. Dalila, Ms. Azira, Mrs. Aimi, Mrs. Raudah, Mr. Hasliadi, Mr. AlHadi, Mr. Izaidi, Mr Hasif, Ms. Farhaniza, Mrs. Shakina, Ms. Najwa, Mrs. Nurbaya, Ms. Shafura, Mr. Syakirin, Mr. Marmizi, Mr. Amer and Mr. Azman. Their cooperation and aid given are deeply appreciated.

My warmest feeling is addressed to my family especially to my beloved parents, Mr. A.Aziz Bin A.Razak and Mrs. [redacted] for their support, prayers and understandings. To my elder brother Mohd Shahril Aswani, my younger brothers Mohd Syafiq, Muhammad Hafiz, Muhammad Tariq Jamil, and Muhammad Muaz and last but not least to my lovely sister Shahliza Azreen, thank you for always be there when I needed of any kind of support. I do not think I will be able to give them back what they did to me, but I will do my best to draw the smile on their faces, make them proud of their son and brother. My special gratitude goes to my wife Farah Hanim and my children Muhammad Uwais Al-Qorni and Naeilah Al Farafisya for their endurance, support and encouragement during this study. Special thank goes to my in-laws Mr. Mohd Fauzi Razali and Mrs. Safiah Ramli for their best understanding all this while.

I also place on record, my sense of gratitude to one and all who directly and indirectly have lent their helping hand in this research.

TABLE OF CONTENTS