Contents

ACKNOWLEDGEMENTS i

ABSTRACT ii

CHAPTER ONE: INTRODUCTION 1

CHAPTER TWO: LITERATURE REVIEW

2.1 Overview of copper decoration technique 4

2.1.1 Growth of silicon dioxide (SiO₂) layer 7

2.1.2 Defects in the SiO₂ layer 10

2.1.3 Electrolysis process 16

2.1.3.1 Ions transportation in electrolyte 17

2.1.3.2 Effects of ions concentration on the conductivity of electrolyte 18

2.1.3.3 Voltage drop in electrochemical cell 20

2.2 Gate oxide integrity 22

2.2.1 Oxide breakdown in Metal-Oxide-Semiconductor (MOS) structure 22

2.2.2 The mechanism of oxide breakdown 23

2.2.3 Gate Oxide Integrity (GOI) measurement 27

2.2.3.1 Time Zero Dielectric Breakdown (TZDB) method 28
CHAPTER THREE: MEASUREMENT TECHNIQUES AND EXPERIMENTAL DETAILS

3.1 Working principle of main instruments used in this project
   3.1.1 Atomic Force Microscope (AFM) 35
   3.1.2 Time Of Flight Secondary Ion Mass Spectroscopy (TOF-SIMS) 38

3.2 Experimental setup
   3.2.1 General procedures of copper decoration process 42
   3.2.2 Formation of copper dots on oxidized wafer surface 44
      3.2.2.1 Analyzing the purity of anode using Energy Dispersive X-ray Spectroscopy (EDS) 44
      3.2.2.2 Determination copper concentration in methanol using Inductive Couple Plasma – Optical Emission Spectroscopy (ICP-OES) 45
   3.2.2.3 Detection of permanent damages extended to wafer surface as a result of oxide breakdown 46
   3.2.2.4 Studying distribution of copper dots size on copper decorated wafer 48
   3.2.2.5 Studying the impact of size of D-defects on size of copper dots 48
3.2.2.6 Effect of stressed field on defect density of copper decorated wafers

3.2.2.7 Analyzing the composition of gray ring surrounded copper dots by using TOF-SIMS

3.2.3 Determination of stressed field by $V_{ox}/V_{app}$ ratio measurement

3.2.4 Effects of copper concentration in methanol on copper decoration process

3.2.4.1 Effect of copper concentration on the conductivity of methanol

3.2.4.2 Effect of copper concentration on the size (average diameter) of copper dots

CHAPTER FOUR: RESULTS AND DISCUSSIONS

4.1 Formation of copper dots on oxidized wafer surface

4.1.1 Analyzing the purity of anode using Energy Dispersive X-ray Spectroscopy (EDS)

4.1.2 Determination of copper concentration in methanol using Inductive Couple Plasma – Optical Emission Spectroscopy (ICP-OES)

4.1.3 Transportation of copper ions in methanol

4.1.4 Detection of permanent damages extended to wafer surface as a result of oxide breakdown

4.1.5 Studying distribution of copper dots size on copper decorated wafer
4.1.6 Studying the impact of size of D-defects on the size of copper dots

4.1.7 Effect of stressed field on defect density of copper decorated wafers

4.1.8 Analyzing composition of grey ring surrounded copper dots by using TOF-SIMS

4.1.9 Formation of copper dots on copper decorated wafer

4.2 Determination of stress field by $V_{ox}/V_{app}$ ratio measurement

4.3 Effects of copper concentration in methanol on copper decoration process

4.3.1 Effect of copper concentration on the conductivity of methanol

4.3.2 Effect of copper concentration on the size (average diameter) of copper dots

CHAPTER FIVE: CONCLUSION

REFERENCE

APPENDIX