

Table of Contents

Preface.....	VII
Acknowledgement	IX
Abstract	XI
List of Figures.....	XV
List of Tables.....	XXI
List of Abbreviations, Acronyms and Special Terms	XXIII
1 Introduction and Motivation	1
2 Fundamentals of Flash Lamp Annealing of Shallow Boron-Doped Silicon.....	5
2.1 Electrical and Optical Characteristics of Flash Lamps	5
2.2 Absorption of Light in Single-Crystal Silicon during Flash Lamp Annealing	8
2.3 Defect Annealing and Dopant Activation in Boron-Doped Silicon.....	16
2.3.1 Types of Defects in Single-Crystal Silicon.....	16
2.3.2 Point Defects in Silicon and Defect Migration during Thermal Treatment	19
2.3.3 Enhanced Diffusion in Shallow Boron-Doped Silicon.....	23
2.4 Comparison of Flash Lamp Annealing with Furnace, Rapid Thermal and Laser Annealing	24
3 Fundamentals of Surface Temperature Measurements during Flash Lamp Annealing.....	27
3.1 Planck's Law of Thermal Radiation – a Historical Outline	27
3.2 Fundamentals of Thermal Radiation and Surface Temperature Measurements.....	29
3.3 Radiation Thermometry – Pyrometry.....	34
3.3.1 Pyrometer Formats	34
3.3.2 Limitations of Pyrometry for Flash Lamp Annealing.....	35

4	Concept of Ripple Pyrometry during Flash Lamp Annealing ...	39
4.1	Review on Temperature Measurement for Flash Lamp Annealing.....	39
4.1.1	X-ray diffraction	39
4.1.2	Interference	40
4.1.3	Recrystallisation.....	41
4.1.4	Ellipsometry.....	43
4.1.5	Polaradiometry.....	44
4.2	State of the Art [3]	45
5	Ripple Pyrometry for Flash Lamp Annealing	51
5.1	Idea and Set-up	51
5.1.1	Intrinsic Ripple	52
5.1.2	Quartz Oscillator	53
5.1.3	Mechanical Oscillator	56
5.2	Methods	58
5.2.1	Temperature Simulation.....	58
5.2.2	Secondary Ion Mass Spectrometry [76].....	59
5.2.3	Reflectometry.....	61
5.2.4	Raytracing.....	62
5.3	Technical Realisation.....	63
5.4	Amplitude Modulation of Flash Pulses	66
5.5	Analysis of Amplitude Modulation during Flash Lamp Annealing.....	70
5.6	Reflectivity Measurement during Flash Lamp Annealing.....	76
6	Experiments – Ripple Pyrometry during Flash Lamp Annealing.....	85
6.1	Proof of Concept.....	85
6.2	Low Temperature Measurement by Ripple Pyrometry.....	89
6.3	High Temperature Measurement by Ripple Pyrometry	95
6.3.1	Ripple Pyrometry on Shallow Boron-Doped Silicon.....	95
6.3.2	Temperature Control – Secondary Ion Mass Spectrometry.....	99
7	Closing Discussion and Outlook.....	103
	Bibliography	107