

TABLE OF CONTENTS

Declaration	i
Preface	ii
Acknowledgment	iii
 1. INTRODUCTION	 1
1.1 Introduction on Silicon Wastage	1
1.2 Silicon Wafer Technology in MEMC KL	3
1.2.1 Slicing	5
1.2.2 Edge Profiling	6
1.2.3 Lapping	7
1.2.4 Etching	9
1.2.5 Annealing	9
1.2.6 Polishing	10
1.2.7 Cleaning and Inspection	11
1.3 Typical Defects in Wafer Manufacturing Processes	12
1.3.1 Process induced defects	12
1.3.1.1 Oxidation-induced Stacking Fault	12
1.3.1.2 Saucer pits	13
1.3.2 Slicing defects	14
1.3.2.1 Chip	14
1.3.2.2 Saw mark	14
1.3.2.3 Thickness rejects	14
1.3.3 Edge profiling defects	15
1.3.3.1 Nick mark	15
1.3.3.2 Bad grind	15
1.3.3.3 Dings	15

1.3.4	Lapping defects	15
1.3.4.1	Lapping scratches	15
1.3.4.2	Fractures	16
1.3.5	Etching defects	16
1.3.5.1	Bad etch	16
1.3.5.2	Dull center	16
1.3.5.3	Roller mark	16
1.3.5.4	White stain	17
1.3.6	Polishing defects	17
1.3.6.1	Polishing scratches	17
1.3.6.2	Dimple	17
1.3.6.3	Streaks	18
1.3.6.4	Syton Spots	18
1.3.7	Light point defects	18
1.3.7.1	Particles	18
1.3.7.2	Haze	18
1.3.7.3	Microscratches	19
1.3.8	Flatness defects	19
1.3.9	Metallic Contamination	19
1.4	Some Schematics of Various Defects on Silicon Wafers	20

2.	EXPERIMENTAL TECHNIQUES	24
2.1	Introduction	24
2.2	Measurement Techniques by Microscan ADE8100	28
2.2.1	Functional Description on Microscan	28
2.2.2	Microscan System Description	29
2.2.2.1	Prealigner station	29
2.2.2.2	Flatness station	32
2.2.2.3	Resistivity station	33
2.2.3	Thickness/Flatness Station Measurements	34

2.3 Measurement Techniques by ESTEK CR80	42
2.3.1 Functional description on ESTEK CR80	42
2.3.1.1 <i>Dark channel theory</i>	45
2.3.1.2 <i>Light channel theory</i>	46
2.3.2 Measurement procedures on particles, scratches and haze	47
2.3.2.1 <i>Particle measurement</i>	47
2.3.2.2 <i>Scratches measurement</i>	48
2.3.2.3 <i>Haze measurement</i>	49
2.4 Visual inspection techniques	51
2.4.1 Visual inspection in Modifications area	52
2.4.2 Visual inspection at Polishing area	53
2.4.3 Visual inspection at the Clean room	54
3. RESULTS AND DISCUSSIONS	55
3.1 Introduction	55
3.2 Analysis on MEMC 1995 4th quarter performance	57
3.2.1 Production summary	57
3.2.2 Silicon wastage analysis for performance losses and removal losses	59
3.2.2.1 <i>Performance losses analysis</i>	59
3.2.2.2 <i>Removal losses analysis</i>	63
3.2.3 Pareto analysis on performance losses	65
3.2.3.1 <i>Performance losses in Modifications processes</i>	65
3.2.3.1 <i>Performance losses in Polishing and Clean Room processes</i>	67
3.3 Measurement results from Microscan ADE8100	70
3.3.1 Measurement results for etched wafers	70
3.3.2 Measurement results for polished wafers	71
3.4 Measurement results from ESTEK CR80	77
4. RECOMMENDATIONS AND CONCLUSION	84
4.1 Introduction	84

4.2 Reduction on silicon wastage	85
4.2.1 The SPC approach	85
4.2.1.1 Control chart	87
4.2.2 Process improvement with designed experiments	89
4.2.2.1 Guidelines for DOE	90
4.2.3 Contamination free manufacturing	92
4.2.3.1 Getting to the root cause of contamination	92
4.2.3.2 Defect reduction in process equipment	92
4.2.3.3 Contamination sensors for fluid and vacuum applications	93
4.2.3.4 Analytical techniques for on-line ultra-trace contamination detection	93
4.2.3.5 Wafer surface preparation	93
4.2.3.6 Wafer environment control	94
4.2.3.7 Chemical, gas and water purity	94
4.2.3.8 Ultraclean gas delivery system	94
4.3 Recycling and utilization of silicon wastage	95
4.3.1 Rework on off-specifications wafers	95
4.3.2 Utilization of scrap wafers	98
4.4 Conclusion	99
References	100