

Contents

1	Introduction	1
1.1	Characterisation of Surface Passivation	1
1.2	Al_2O_3 as a Passivating Dielectric	3
1.3	Industrial Application of Al_2O_3	6
1.4	Outline of This Work	7
	References	8
2	Surface Recombination Theory	15
2.1	The Semiconductor Surface	15
2.2	Definition of Energies and Potentials	18
2.3	Surface Charge and Band-Bending	19
2.4	Recombination Through Defect States	21
2.5	Surface Recombination	22
2.6	Relationship to Experimental Parameters	25
	References	27
3	Al_2O_3 Deposition and Characterisation	29
3.1	Al_2O_3 Deposition by APCVD	29
3.1.1	Deposition System	30
3.1.2	Process Parameters	30
3.1.3	Chemical Precursors	31
3.1.4	Temperature Profiles	35
3.2	Sample Preparation	37
3.3	Characterisation	37
	References	39
4	Electrical Properties of the Si-Al_2O_3 Interface	41
4.1	Interface State Distribution	42
4.2	Capture Cross-Sections	45
4.2.1	The Conductance Method	45
4.2.2	Previous Work	47
4.2.3	Real and Apparent Capture Cross-Sections	48

4.2.4	Determination of σ_p and σ_n	51
4.2.5	Information from Temperature-Dependent Measurements	56
4.3	Comparison of Model and Experiment	59
4.4	Conclusions	62
	References	63
5	Influence of Deposition Parameters	67
5.1	Substrate Temperature	67
5.1.1	H ₂ O	68
5.1.2	O ₂	70
5.2	Reactant Concentration	71
5.2.1	H ₂ O	71
5.2.2	O ₂	72
5.3	Chemical Precursor	73
5.4	Conclusions	76
	References	77
6	Effect of Post-Deposition Thermal Processing	79
6.1	Firing	80
6.2	Rapid Thermal Annealing	89
6.3	Conclusions	95
	References	95
7	Effect of Surface Dopant Concentration	97
7.1	Introduction	97
7.2	Boron-Doped Surfaces	98
7.3	Phosphorus-Doped Surfaces	109
7.3.1	Undiffused Surfaces	110
7.3.2	Diffused Surfaces	116
7.4	Consequences for Device Design	133
7.5	Conclusions	135
	References	136
8	Effect of Surface Orientation and Morphology	141
8.1	Recombination at $\langle 100 \rangle$, $\langle 111 \rangle$, and Textured Surfaces	142
8.2	Electrical Properties of the $\langle 100 \rangle$ and $\langle 111 \rangle$ Interfaces	145
8.3	Conclusions	151
	References	152
9	Relationship Between Al₂O₃ Bulk and Interface Properties	155
9.1	Structure and Composition	155
9.1.1	Infrared Absorption Measurements	156
9.1.2	Band Assignments	156
9.1.3	Trends and Discussion	161
9.2	Dielectric Properties	166

Contents	xix
9.3 Optical Properties	169
9.4 Conclusions	172
References	173
10 Conclusion.	177
References	179
Appendix A: Capacitance–Voltage Measurements	181
Appendix B: The Conductance Method	199

<http://www.springer.com/978-3-319-32520-0>

New Perspectives on Surface Passivation:

Understanding the Si-Al₂O₃ Interface

Black, L.E.

2016, XXVIII, 204 p. 100 illus., 17 illus. in color.,

Hardcover

ISBN: 978-3-319-32520-0