

Contents

1 Interconnects	1
1.1 Introduction	1
1.2 Types of Interconnects	3
1.3 Evolution of Interconnects	4
1.3.1 Aluminum Interconnects	4
1.3.2 Reason Behind the Replacement of Al by Cu	5
1.3.3 Demerits of Cu Interconnects.	6
1.3.4 Demands in Future Interconnects.	6
1.4 Carbon Nanotubes: The Ultimate Choice	14
2 Carbon Nanotube: Properties and Applications	17
2.1 Introduction	17
2.2 Structure and Types of Carbon Nanotubes.	18
2.3 Electronic Band Structure of CNTs	20
2.3.1 Band Structure of CNTs from Graphene	22
2.3.2 Metallicity and Semiconducting Properties of Zigzag CNTs	25
2.4 Properties of CNTs.	26
2.4.1 Electrical Conductivity	26
2.4.2 Strength and Elasticity	26
2.4.3 Thermal Conductivity and Expansion	27
2.4.4 Field Emission	27
2.4.5 Aspect Ratio.	27
2.4.6 Absorbent	28
2.5 Production of CNTs	28
2.5.1 Arc Discharge Method	28
2.5.2 Laser Method	29
2.5.3 Chemical Vapor Deposition	29
2.5.4 Ball Milling	30
2.5.5 Other Methods	30

2.6	Purification of CNTs	30
2.6.1	Gas Phase	31
2.6.2	Liquid Phase	31
2.6.3	Intercalation	31
2.7	Application of CNTs	32
2.7.1	Structural	32
2.7.2	Electromagnetic	33
2.7.3	Electroacoustic	33
2.7.4	Chemical	34
2.7.5	Mechanical	35
2.7.6	Optical	35
2.7.7	Electrical Circuits	36
2.7.8	Interconnects	36
2.7.9	Transistors	36
3	Modeling of Carbon Nanotube Interconnects	39
3.1	Introduction	39
3.2	Analytical Models: A Technical Review	39
3.2.1	Lüttinger Liquid Theory Based Model	40
3.2.2	Electron Transport Theory Based Model	40
3.2.3	Models Based on Physical Parameters of CNTs	42
3.2.4	Diameter Dependent Modeling of CNT Interconnects	43
3.2.5	Models Based on Process Induced Parameters	44
3.2.6	Compact Physical Models of SWNT and MWNT Interconnects	44
3.2.7	Performance Comparison of SWNT Bundles and MWNT Interconnect Models	46
3.2.8	CNT Interconnect Models for FPGA Applications	46
3.2.9	CNT Interconnect Models for Crosstalk Analysis	47
3.2.10	Modeling of Mixed CNT Bundle Interconnects	49
3.3	Geometry and Equivalent <i>RLC</i> Model of CNT Interconnect	49
3.3.1	SWNT Interconnect	49
3.3.2	DWNT Interconnect	51
3.3.3	MWNT Interconnect	52
3.3.4	SWNT Bundle Interconnect	53
3.3.5	DWNT Bundle Interconnect	55
4	Crosstalk and Delay Analysis	57
4.1	Introduction	57
4.2	Simulation Setup	58
4.2.1	Motivation Behind Using CMOS Driver	58
4.2.2	Simulation Setup Using Capacitively Coupled Three-Line Bus Architecture	59
4.3	Crosstalk Induced Delay of Bundled SWNT and DWNT Interconnects	60

- 4.4 Crosstalk Induced Delay of Bundled SWNT and Single MWNT Interconnects. 62
- 4.5 Crosstalk Induced Delay of Bundled SWNT, Bundled DWNT, and Single MWNT Interconnects. 66
- 5 Mixed Carbon Nanotube Bundle. 69**
 - 5.1 Introduction 69
 - 5.2 Proposed MCB Topologies. 70
 - 5.3 ESC Model of MCB Interconnects 71
 - 5.4 Performance Analysis of MCB Based Interconnects 73
 - 5.4.1 Propagation Delay and Power Dissipation of MCB Topologies 73
 - 5.4.2 Crosstalk Induced Delay of MCB Topologies 75
- References 79**



<http://www.springer.com/978-81-322-2046-6>

Carbon Nanotube Based VLSI Interconnects
Analysis and Design

Kaushik, B.K.; Majumder, M.K.

2015, XI, 86 p. 57 illus., Softcover

ISBN: 978-81-322-2046-6