

- Preface p. xi
- Electronic Packaging Defined p. xiii
- Contributors p. xiv
- Part 1 Fundamental Technologies
- Chapter 1. Materials for Electronic Packaging
 - Polymers for Electronic Packaging
 - 1.1 Introduction p. 1.1
 - 1.2 Future Electronic Packaging System Needs p. 1.2
 - 1.3 Recent Advancements in Polymeric Materials for Electronic Packaging p. 1.2
 - 1.4 Polymeric Materials For Microelectronics p. 1.3
 - 1.5 Conclusions and Future Developments p. 1.15
 - Bibliography p. 1.15
 - Flip Chip Technology: Materials and Processes for the Next Generation of High-Performance Electronics
 - 1.6 Basics p. 1.22
 - 1.7 Under-Bump Metallization p. 1.24
 - 1.8 Bumping Materials p. 1.27
 - 1.9 Bumping Processes p. 1.30
 - 1.10 Joining Materials and Agents p. 1.34
 - 1.11 The Assembly Process p. 1.38
 - 1.12 Encapsulation/Underfill p. 1.41
 - 1.13 Substrates for Flip Chips p. 1.46
 - 1.14 Features and Benefits p. 1.48
 - 1.15 Limitations and Issues p. 1.49
 - 1.16 Performance and Reliability p. 1.51
 - 1.17 Applications p. 1.51
 - 1.18 Summary and Conclusions p. 1.53
 - References p. 1.54
 - Ceramic Materials
 - 1.19 Introduction p. 1.58
 - 1.20 Classes of Materials Covered p. 1.65
 - 1.21 Summary--Ceramics p. 1.93
 - References p. 1.93
- Chapter 2. Thermal Management
 - 2.1 Introduction p. 2.1
 - 2.2 Why Thermal Management? p. 2.2
 - 2.3 Heat Flow Theory p. 2.5
 - 2.4 The Thermal Design p. 2.35
 - 2.5 Heat Sinks p. 2.36
 - 2.6 Circuit Card Assembly Cooling p. 2.50
 - 2.7 High heat-load cooling p. 2.57
 - 2.8 Special cooling devices p. 2.66
 - 2.9 Computer-Based Thermal Analysis p. 2.75
 - 2.10 Thermal Measurements p. 2.79
 - References p. 2.90
- Chapter 3. Thermal and Mechanical Stress Behavior in Electronic Packaging

- 3.1 Introduction p. 3.1
- 3.2 Stress Generation and Fatigue p. 3.2
- 3.3 Stress Environments p. 3.5
- 3.4 Material Mechanical Properties p. 3.8
- 3.5 Soft Solder Fatigue p. 3.12
- 3.6 Mechanical and Thermomechanical Models p. 3.13
- 3.7 Modified Coffin-Manson Equations p. 3.18
- 3.8 Miner's Rule p. 3.20
- 3.9 FEM Package Representation p. 3.22
- 3.10 Thermal Analysis Using FEM p. 3.24
- 3.11 Total Inelastic Strain Energy p. 3.25
- 3.12 Crack Growth Theory p. 3.25
- 3.13 Temperature Dependence of Properties p. 3.27
- 3.14 Packaging Fatigue p. 3.28
- 3.15 Die Cracking and Delamination p. 3.28
- 3.16 Flip Chips p. 3.31
- 3.17 Ball Grid Arrays p. 3.36
- 3.18 Chip on Board p. 3.37
- 3.19 Level-Two Packaging--Pin-in-Hole p. 3.39
- 3.20 Leadless and Leaded Quad Packages p. 3.40
- 3.21 FEM Stress Analysis of Temperature-Cycled LCCC Solder Joints p. 3.42
- 3.22 Leaded Chip Carriers (Quad Flat Packages) p. 3.45
- 3.23 Summary p. 3.46
- References p. 3.47
- Chapter 4. Connector and Interconnection Technology
- 4.1 Connector Overview p. 4.1
- 4.2 The Contact Interface p. 4.6
- 4.3 The Contact Finish p. 4.10
- 4.4 Contact Springs p. 4.17
- 4.5 Connector Housings p. 4.21
- 4.6 Separable Connections p. 4.27
- 4.7 Permanent Connections p. 4.33
- 4.8 Connector Applications p. 4.49
- 4.9 Connector Types p. 4.55
- 4.10 Connector Testing p. 4.72
- References p. 4.80
- Chapter 5. Wiring and Cabling
- 5.1 Introduction p. 5.1
- 5.2 Cabling Types p. 5.2
- 5.3 Basic Construction p. 5.4
- 5.4 Connector Characteristics p. 5.45
- 5.5 Electromagnetic Interference and Shielding p. 5.47
- References p. 5.55
- Chapter 6. Solder Technologies for Electronic Packaging and Assembly
- 6.1 Introduction p. 6.1
- 6.2 Solder Materials p. 6.6

- 6.3 Solder Paste p. 6.23
- 6.4 Soldering Methodology p. 6.31
- 6.5 Solderability p. 6.50
- 6.6 Cleaning p. 6.52
- 6.7 Fine-Pitch Application p. 6.53
- 6.8 Soldering-Related Issues p. 6.57
- 6.9 Solder-Joint Appearance and Microstructure p. 6.66
- 6.10 Solder-Joint Integrity p. 6.71
- 6.11 Lead-Free Solders p. 6.78
- References p. 6.82
- Part 2 Interconnection Technologies
- Chapter 7. Packaging and Interconnection of Integrated Circuits
- 7.1 Introduction p. 7.1
- 7.2 Conventional Package Technologies p. 7.20
- 7.3 Advanced Package Technologies p. 7.45
- 7.4 Comparison of Technologies p. 7.59
- 7.5 Package Families p. 7.61
- 7.6 Package Design Considerations p. 7.67
- 7.7 Package IC Assembly Processes p. 7.77
- 7.8 Outsourcing--Subcontract Assembly p. 7.91
- 7.9 Package to Second-Level Interconnection p. 7.94
- 7.10 Summary and Future Trends p. 7.95
- References p. 7.97
- Chapter 8. Surface Mount Technologies
- 8.1 Introduction p. 8.1
- 8.2 The Challenges of SMT p. 8.2
- 8.3 Engineering Skills p. 8.8
- 8.4 Electronics Packaging Families p. 8.12
- 8.5 SMT Design for Manufacture p. 8.26
- 8.6 Materials Impact on Process p. 8.34
- 8.7 Process Guidelines for SMT Manufacturing p. 8.41
- 8.8 Inspection and Quality Assurance p. 8.72
- 8.9 Reliability p. 8.78
- References p. 8.87
- Chapter 9. The Hybrid Microelectronics and Multichip Module Technologies
- 9.1 Introduction p. 9.1
- 9.2 Ceramic Substrates for Microelectronic Applications p. 9.2
- 9.3 Composite Materials p. 9.9
- 9.4 Thick Film Technology p. 9.11
- 9.5 Cermet Thick Film Conductor Materials p. 9.18
- 9.6 Thick Film Resistor Materials p. 9.20
- 9.7 Thick Film Dielectric Materials p. 9.28
- 9.8 Overglaze Materials p. 9.29
- 9.9 Conclusions p. 9.30
- 9.10 Thin Film Technology p. 9.30
- 9.11 Thin Film Materials p. 9.35

- 9.12 Comparison of Thick and Thin Film p. 9.37
- 9.13 Copper Metallization Technologies p. 9.37
- 9.14 Summary of Substrate Metallization Technologies p. 9.46
- 9.15 Resistor Trimming p. 9.46
- 9.16 Assembly of Hybrid Circuits p. 9.51
- 9.17 Packaging p. 9.62
- 9.18 Design of Hybrid Circuits p. 9.68
- 9.19 Multichip Modules p. 9.71
- References p. 9.75
- Chapter 10. Chip Scale Packaging and Direct Chip Attach Technologies
- 10.1 Introduction p. 10.1
- 10.2 Background and History p. 10.2
- 10.3 Electronic Interconnection Regime p. 10.5
- 10.4 Early Minimalist IC Packaging Solution p. 10.6
- 10.5 Current Interconnection Trends p. 10.7
- 10.6 Important Shared Issues p. 10.7
- 10.7 Markets for CSP and DCA p. 10.15
- 10.8 Direct Chip Attach Technologies p. 10.19
- 10.9 Chip scale Packages p. 10.26
- 10.10 Testing CSPs and Direct Attach Assemblies p. 10.48
- 10.11 Summary p. 10.58
- References p. 10.58
- Chapter 11. Rigid and Flexible Printed Wiring Boards and Microvia Technology
- 11.1 Introduction p. 11.1
- 11.2 Printed Circuit Board System Types p. 11.2
- 11.3 Printed Circuit Board Materials p. 11.6
- 11.4 Design Considerations p. 11.19
- 11.5 Manufacturing Considerations p. 11.54
- 11.6 Microvias p. 11.65
- 11.7 Industry Standards p. 11.84
- Suggested Reading p. 11.86
- Acknowledgment p. 11.88
- Part 3 System Packaging Technologies
- Chapter 12. Packaging of High-Speed and Microwave Electronic Systems
- 12.1 Introduction p. 12.1
- 12.2 Types of Circuit Media for Modern Microwave Packaging p. 12.4
- 12.3 Limitations of Microwave Integrated Circuits p. 12.9
- 12.4 Technology of Microwave Integrated Circuits p. 12.13
- 12.5 Planar Waveguides p. 12.21
- 12.6 Lumped-Element Circuits for Microwave Packages p. 12.29
- 12.7 High-Speed Digital Packaging p. 12.34
- 12.8 Electrical Design Inputs p. 12.37
- 12.9 Netlist Analysis p. 12.40
- 12.10 Design Restrictions p. 12.42
- 12.11 PWB Layout Considerations p. 12.52
- 12.12 Preferred Redesign Options p. 12.54

- 12.13 CAD Interface p. 12.57
- References p. 12.59
- Chapter 13. Packaging of High-Voltage Systems
- 13.1 Introduction p. 13.1
- 13.2 Properties of Insulating Materials p. 13.1
- 13.3 Field Stress and Configurations p. 13.21
- 13.4 Aerospace Design Considerations p. 13.29
- 13.5 Design and Manufacturing Guidelines p. 13.37
- 13.6 Tests p. 13.48
- 13.7 Problems and Suggested Solutions p. 13.53
- 13.8 Conclusions p. 13.54
- References p. 13.55
- Chapter 14. Electrical Characterization and Modeling of IC Packaging
- 14.1 Introduction p. 14.1
- 14.2 Package Electrical Analysis p. 14.2
- 14.3 Package Modeling p. 14.23
- 14.4 Package Modeling Program p. 14.34
- 14.5 Verification Method for Modeling Programs p. 14.41
- 14.6 Summary p. 14.52
- References p. 14.53
- Appendix Electronic Packaging Terms and Abbreviations p. 1
- Index p. 1
- About the Editor p. 1