

Contents

1	Introduction	1
1.1	Electronics Packaging and Interconnect.....	1
1.2	Interconnection Materials.....	11
1.2.1	Lead-Free Interconnect Materials.....	12
1.2.2	Electrically Conductive Adhesives.....	15
	References.....	19
2	Nanotechnology.....	25
2.1	Introduction to Nanotechnologies and Nanopackaging	25
2.2	Nanoparticles.....	26
2.2.1	Introduction.....	26
2.2.2	Nanoparticle Fabrication.....	27
2.2.3	Nanoparticle Applications.....	28
2.3	Nano Solder Particles.....	30
2.4	Carbon Nanotubes (CNTs).....	38
2.4.1	Carbon Nanotubes for Electrical Interconnect Applications.....	39
2.5	Nanocomposites	48
2.5.1	Recent Advances in Nanocomposites	48
2.5.2	Areas of Application of Nanocomposites	51
2.6	Nano Interconnect	53
2.6.1	Carbon Nanotube Transistors.....	53
2.6.2	CNT Via.....	54
2.6.3	CNT as Flip Chip Interconnect	55
2.6.4	Nanoparticle Interlayer for Copper to Copper Bonding	56
2.6.5	Interconnection Using Inkjet Printing of Nano-ink.....	56
2.7	Nanowires and Nanobelts.....	60
2.7.1	Introduction.....	60
2.7.2	Applications of Nanowires.....	60
	References.....	65
3	Characterizations of Electrically Conductive Adhesives.....	81
3.1	Recent Advances in Polymeric Materials for Electronic Packaging	81
3.1.1	Silicones (Polyorganosiloxanes)	81
3.1.2	Epoxies.....	83
3.1.3	Polyurethanes	84
3.1.4	Polyimides.....	85

3.1.5	Silicone-Polyimide (SPI).....	86
3.1.6	Bismaleimide (BMI) Resins.....	88
3.1.7	Cyanate Ester Resins.....	89
3.2	Analytical Approaches for ECA.....	91
3.2.1	Differential Scanning Calorimeter (DSC).....	91
3.2.2	Thermogravimetry Analyzer (TGA).....	95
3.2.3	Dynamic Mechanical Analyzer (DMA).....	96
3.2.4	Thermo-mechanical Analysis (TMA).....	98
3.2.5	Viscometer and Rheometer.....	100
3.2.6	Fourier Transform Infrared (FT-IR).....	101
3.2.7	X-Ray Photoelectron Spectroscopy (XPS).....	103
3.2.8	X-Ray Diffraction (XRD).....	104
3.2.9	Transmission Electron Microscopy (TEM).....	105
3.2.10	Scanning Electron Microscopy (SEM).....	106
3.2.11	Raman Spectroscopy.....	107
3.2.12	Gas Chromatography/Mass Spectrometry.....	109
3.2.13	Electrical Characterization of ECAs.....	110
3.2.14	Mechanical Property Characterization.....	113
	References.....	117
4	Isotropically Conductive Adhesives (ICAs).....	121
4.1	Introduction.....	121
4.1.1	Percolation Theory of Conduction.....	121
4.1.2	Adhesive Matrix.....	123
4.1.3	Conductive Fillers.....	124
4.2	Processing of ICAs.....	128
4.2.1	Screen and Stencil Printing.....	129
4.2.2	Dispensing.....	130
4.2.3	Inkjet Printing.....	130
4.3	Flip Chip Applications Using ICAs.....	132
4.3.1	ICA Process for Unbumped Chips.....	132
4.3.2	Metal-Bumped Flip Chip Joints.....	138
4.4	ICAs for Surface Mount Applications.....	140
4.5	ICAs for CSP Applications.....	141
4.6	ICAs for Advanced Packaging Applications.....	142
4.6.1	Solar Cell.....	142
4.6.2	Three-Dimensional Stacking.....	143
4.6.3	Microspring.....	144
4.7	ICAs for Printed Circuit Board Applications.....	146
4.8	High-Frequency Performance of ICA Joints.....	148
4.9	Reliability of ICA Joints.....	149

4.10	Recent Advances on ICAs.....	152
4.10.1	Fundamental Understanding of the Lubricant Layer on Ag Flakes.....	152
4.10.2	Understanding of Conductivity Mechanism of ICAs.....	166
4.10.3	Improvement of Electrical Conductivity of ICAs.....	176
4.10.4	Mechanism Underlying Unstable Contact Resistance of ICA Joints.....	178
4.10.5	Improvement of Contact Resistance Stability.....	189
4.10.6	Impact Performance.....	200
4.10.7	Adhesion Strength.....	202
4.10.8	Recent Advances on Nano-ICAs.....	205
	References.....	211
5	Anisotropically Conductive Adhesives/Films (ACA/ACF).....	227
5.1	Introduction.....	227
5.2	ACA Materials and Processing.....	228
5.2.1	ACA Materials.....	228
5.2.2	Processing.....	229
5.3	Applications of ACA/ACF.....	231
5.3.1	ACAs/ACFs for Flat Panel Displays.....	231
5.3.2	ACAs/ACFs for Fine-Pitch Interconnections.....	234
5.3.3	ACA/ACF in Flip Chip Applications.....	235
5.4	Recent Advances of ACA/ACF and Nano-ACA/ACF.....	237
5.4.1	Low-Temperature Sintering of Nano-Ag- Filled ACA/ACF.....	238
5.4.2	ACA Joints with Low Melting Point (LMP) Filler.....	242
5.4.3	Self-Assembled Molecular Wires for Nano-ACA/ACF.....	244
5.4.4	Silver Migration Control in Nano-silver filled ACA.....	250
5.4.5	ACA/ACF with Ferromagnetic Conductive Fillers.....	255
5.4.6	Nanowire ACF for Ultra-fine-pitch Flip Chip Interconnection.....	259
5.4.7	Thermal Performance of ACA/ACF.....	260
5.5	ACA/ACF Reliability.....	263
5.5.1	Effects of Bonding Conditions.....	264
5.5.2	Effect of Mechanical Properties on the Reliability of ACF Joints.....	264
5.5.3	Effects of Bump Height on the Reliability of ACA Joints.....	267
5.6	Future Advances of ACA/ACF.....	268
5.6.1	Materials Development.....	268

5.6.2	High-Frequency Compatibility	268
5.6.3	Reliability	269
5.6.4	Wafer-Level Application.....	269
	References	271
6	Non-conductive Adhesives/Films (NCA/NCF)	279
6.1	Introduction	279
6.2	Electrical Properties of NCA/NCF Joints	281
6.2.1	Contact Resistance of NCA/NCF Joints	281
6.3	Reliability of NCA/NCF Joints	285
6.4	Recent Advances of NCA/NCF	288
6.4.1	Low-Temperature Assembly of NCF	288
6.4.2	Improvement of Electrical Properties of NCA/NCF Joints with π -Conjugated Molecular Wires.....	289
6.4.3	NCA/NCF with Fillers	291
6.4.4	Incorporation of Non-conductive Fillers in NCA/NCF	293
6.4.5	Multi-layer ACF/NCF	294
6.4.6	Wafer-Level NCF.....	296
	References	297
7	Conductive Nano-Inks	303
7.1	Introduction	303
7.1.1	An Overview of Conventional Patterning of Electronics	303
7.1.2	Introduction of Printed Electronics	305
7.1.3	Utility of High Volume Printing Processes in Printable Electronics	307
7.2	Conventional Conductive Inks	312
7.2.1	Metallic Ink	313
7.2.2	Conductive Carbon Ink	317
7.3	Conductive Nano-Inks.....	322
7.3.1	Metallic Nano-Inks.....	322
7.3.2	Conducting Polymer - Based Inks.....	326
7.3.3	Organometallic Ink.....	328
7.4	Processing of Nano Ink	332
7.4.1	Ink-jet Printing	332
7.4.2	Pyrolytic Printing	338
7.4.3	Gravure Printing.....	341
7.5	Applications of Conductive Inks	343
7.5.1	Die Attach for High Power Devices.....	343

7.5.2	Printed Low-resistance Metal Conductors for Printed Electronics.....	344
7.5.3	Micro-bump.....	347
7.5.4	Interconnect for System-in-Package (SiP)	349
	References	351
8	Intrinsically Conducting Polymers (ICPs).....	361
8.1	Basics of Intrinsically Conducting Polymers	361
8.1.1	Introduction	361
8.1.2	Doping.....	365
8.1.3	Polyacetylene	368
8.2	Applications of Conducting Polymers	369
8.2.1	Lithography	369
8.3	Metallization.....	376
8.4	Corrosion Protection of Metals	378
8.5	Electrostatic Discharge (ESD) Protection for Electronic Components.....	380
8.6	Field-Effect Transistors (FET)	381
8.7	Sensors	383
8.8	Microfluid Pump	390
8.9	Shielding of Electromagnetic Interference (EMI).....	392
8.10	Nanofiber-Based Nanocomposites And Devices	393
8.11	Polymer Light-Emitting Diodes (PLEDs).....	396
8.12	Solar Cells	402
8.13	Three-Dimensional Interconnect.....	404
8.14	Conducting Polymer Artificial Muscles.....	405
8.15	ICP as Interconnect Materials	406
	References	409
9	Future Trend of Conductive Adhesive Technology.....	425
9.1	Recent Advances in Conductive Adhesive Technology	425
9.2	Challenges and Opportunities of ICAs.....	426
9.2.1	Electrical Performance Improvement.....	426
9.2.2	Silver Migration	426
9.2.3	Mechanical Property Improvement.....	427
9.2.4	Manufacturability and Yields.....	427
9.2.5	Cost Reduction	427
9.2.6	ICAs Based on Intrinsically Conducting Polymers.....	428
9.2.7	ICAs for Printed Organic Electronics	429
9.3	Challenges and Opportunities for ACAs.....	430
9.3.1	Thermo-mechanical Reliability.....	430

9.3.2 High-Frequency Compatibility 430

9.3.3 Current-Carrying Capability..... 430

9.3.4 Reliability 431

9.3.5 Manufacturability 431

9.4 Challenges and Opportunities for NCAs..... 431

References 432

Index 433



<http://www.springer.com/978-0-387-88782-1>

Electrical Conductive Adhesives with Nanotechnologies

Li, Y.G.; Lu, D.; Wong, C.P.

2010, XII, 437 p., Hardcover

ISBN: 978-0-387-88782-1