2011 PLASTICS RESEARCH REVIEW XXI
INTRODUCTION XXI

CHAPTER ONE: CONDUCTIVE POLYMERS: TECHNOLOGIES AND GLOBAL MARKETS (PLS043C) 1
INTRODUCTION 1
STUDY GOALS AND OBJECTIVES 1
REASONS FOR DOING THE STUDY 1
SCOPE OF THE STUDY 2
METHODOLOGY 3
ANALYST CREDENTIALS 3
RELATED BCC REPORTS 3
BCC ONLINE SERVICES 4
DISCLAIMER 4
SUMMARY 4
TABLE 1 GLOBAL MARKET FOR ELECTROACTIVE POLYMERS, THROUGH 2016 (MILLION LBS/$ MILLIONS) 5
FIGURE 1 GLOBAL MARKET FOR ELECTROACTIVE POLYMERS, 2010–2016 ($ MILLIONS) 6
ELECTROACTIVE POLYMERS 7
BACKGROUND 7
INHERENTLY CONDUCTIVE POLYMERS 8
INHERENTLY DISSIPATIVE POLYMERS (IDPS) 8
CONDUCTIVE PLASTICS 9
ADDITIONAL TECHNICAL DETAILS 9
SYNTHESIZING CONJUGATED POLYMERS 10
TECHNIQUES FOR MAKING PLASTICS CONDUCTIVE 10
TABLE 2 HOW TO MAKE PLASTICS CONDUCTIVE 11
CONCEPT OF RESISTIVITIES 11
OVERVIEW 11
TABLE 3 RESISTANCE SPECTRUM FOR METHODS OF MAKING PLASTICS CONDUCTIVE 11
CONCEPTS AND NOMENCLATURE 12
BARRIERS TO APPLICATIONS 13
CATEGORIZING ICPS 13
TABLE 4 CATEGORIZING INHERENTLY CONDUCTIVE POLYMERS 13
ICP HISTORICAL PERSPECTIVE 13
PRIOR TO 1990 13
POST-1990 PERIOD 14
BY 2010 15
TECHNOLOGIES 16
OVERVIEW 16
PREPARATION OF ICPS 16
ENERGY BAND STRUCTURE 16

CHAIN STRUCTURE 17
COMPARISON OF CONDUCTIVITIES OF ICPS WITH METALS, SEMICONDUCTORS, AND INSULATORS 18
TABLE 5 CONDUCTIVITIES OF DOPED ICPS COMPARED WITH METALS, SEMICONDUCTORS, AND INSULATORS 18
TABLE 5 (CONTINUED) 19
DOPING DETAILS 19
Background 19
Overview 19
Chemical and Electrochemical Methods 20
Reversal of Doping Process 20
Types of Dopants 20
Goal of Narrow Band Gaps 21
Effect on Color and Optical Properties 21
TABLE 6 COLOR OF DOPED AND UNDOPED CONDUCTIVE POLYMERS 21
IMPORTANCE OF MOLECULAR WEIGHT AND DISTRIBUTION IN CONDUCTIVE POLYMERS 22
IMPROVING HIGH TEMPERATURE CONDUCTIVITY AND TEMPERATURE STABILITY 22
ALLOYING AND BLENDING CONDUCTIVE POLYMERS WITH CONVENTIONAL RESINS 22
PERFORMANCE ENHANCEMENTS SOUGHT THROUGH ICPS 23
Conductivity 23
Electrochromic Effects 23
Electroluminescence 24
Photoconductivity 24
Thermochromic Effects 24
PROCESSING CONDUCTIVE POLYMERS 25
Background 25
Problems and Challenges 25
Processing Options for ICPs 26
TABLE 7 ICP PROCESSING TECHNIQUES 26
TABLE 8 STABILITY AND PROCESSING ATTRIBUTES OF KEY ICPS 26

CHAPTER TWO: WOOD-PLASTIC COMPOSITES: TECHNOLOGIES AND GLOBAL MARKETS (PLS034B) 27
INTRODUCTION 27
REASONS FOR DOING THE STUDY 27
SCOPE OF THE STUDY 27
METHODOLOGY AND INFORMATION SOURCES 28
AUTHOR CREDENTIALS 28
RELATED BCC REPORTS 28
EXECUTIVE SUMMARY 28

TABLE 9 GLOBAL MARKET FOR APPLICATIONS OF WPCS, CELLULOSICS, PLASTIC LUMBER, AND NATURAL FIBER COMPOSITES, THROUGH 2016 (METRIC TONS) *29*
FIGURE 2 GLOBAL MARKET FOR APPLICATIONS OF WPCS, CELLULOSICS, PLASTIC LUMBER, AND NATURAL FIBER COMPOSITES, 2008–2016 (METRIC TONS) *30*
INDUSTRY OVERVIEW 30
DEFINITIONS 30
DEFINITIONS (Continued) 31
WOOD PLASTIC COMPOSITES 32
OVERVIEW 32
INTERACTION OF TWO DIFFERENT INDUSTRIES 32
THE BEGINNING 33
1990 ACTIVITIES 33
IMPACT OF USDA AND FOREST PRODUCT COMPANIES 33
CONTRAST WITH PLASTIC LUMBER 34
CELLULOSICS 34
NATURAL FIBER COMPOSITES 35
BACKGROUND 35
TYPES OF FIBERS 36
OUTLOOK 36
TECHNIQUES 36
PLASTIC LUMBER 37

CHAPTER THREE: COMPOSITES: RESINS, FILLERS, REINFORCEMENTS, NATURAL FIBERS AND NANOCOMPOSITES (PLS029C) 38
INTRODUCTION 38
REASONS FOR DOING THE STUDY 38
SCOPE OF THE STUDY 38
METHODOLOGY 39
ABOUT THE AUTHOR 40
RELATED BCC REPORTS 40
SUMMARY 40
TABLE 10 NORTH AMERICAN FIBER REINFORCED PLASTIC MARKET BY APPLICATION, THROUGH 2015 (MILLION LBS) *40*
FIGURE 3 NORTH AMERICAN FIBER REINFORCED PLASTIC MARKET BY APPLICATION, 2009–2015 (MILLION LBS) *41*
FILLERS AND REINFORCEMENTS 42
BACKGROUND 42
PROPERTY PROFILES 43
CHARACTERISTICS OF FILLERS/REINFORCEMENTS 43
TABLE 11 PROFILE OF CHARACTERISTICS OF FILLERS/REINFORCEMENTS *43*

TABLE 12 OVERVIEW OF CHARACTERISTICS AND APPLICATIONS OF FILLERS/REINFORCEMENTS *44*
FILLER/REINFORCEMENT USAGE WITH SPECIFIC RESINS 45
TABLE 13 FILLER/REINFORCEMENT USAGE WITH SPECIFIC RESINS *45*
TABLE 13 (CONTINUED) *46*
FILLERS 46
OVERVIEW 46
ALUMINA TRIHYDRATE (ATH) 46
Background 46
Properties 47
Grades 47
A Recent Development 47
BARIUM SULFATE 47
CALCIUM CARBONATE 48
Background 48
Grades 48
As Plastic Fillers 48
Automotive Applications 49
CALCIUM SULFATE 49
Background 49
Applications 49
KAOLINS 49
Background 49
Grades 50
Automotive Applications 50
REINFORCEMENTS 50
OVERVIEW 50
NON-FIBROUS 51
Talcs 51
Background 51
Grades 52
Applications 52
Mica 52
Background 52
Properties 53
Applications 53
Thermosets 53
Thermoplastics 53
Wollastonite 54
Background 54
Applications 54
Silicas 55

FIBROUS 55
Background 55
Reinforcement Types 55
Overview 55
Mats 56
Woven Fabrics 56
Knitted Fabrics 56
Braids 56
Preforms 56
Glass-Fiber Reinforcements 56
Production 56
Types of Fiberglass 57
Background 57
Types of Glass Fibers 57
Sizing 58
Microspheres 58
Background 58
Solid Microspheres 58
Hollow Microspheres 59
TABLE 14 ADVANTAGES OF SOLID GLASS MICROSPHERES 59
Applications 59
New Development 59
Glass Fiber Suppliers 60
TABLE 15 GLASS FIBER SUPPLIERS 60
Carbon Fibers 60
Background 60
Manufacture 61
Product Types 62
Applications 62
Largest Users of Carbon Fiber Reinforced Plastics 62
The Military 62
Commercial Aircraft 63
Producers 63
Recent Developments 63
Usage in Non-Sports Cars 63
BMG Developments 63
Metallized Carbon Fibers 64
End-of-Life Recycling 64
Aramid Fibers 64
Background 64
Production 65
Properties 65
Usage 65
Ceramic Fibers 65

Background 65
Applications 66
Suppliers 66
Boron Fibers 66
Stainless Steel Fibers 67
Natural Fibers 67
Background 67
Background (Continued) 68
Types of Natural Fibers 69
Overview 69
Flax Fibers 69
Jute Fibers 69
Kenaf Fibers 69
Hemp Fibers 70
Global Cultivation of Selected Natural Fibers 70
TABLE 16 GLOBAL PRODUCTION OF SELECTED NATURAL FIBERS 70
Processing 71
Comparison with Glass Fibers 71
Pricing 72
Review of Possible Stumbling Blocks to Natural Fiber Reinforcements 72
Suppliers of Natural Fibers 72
Composite Products 72
Flexform Technologies 72
Quadrant Plastic Composites 73
Automotive Applications 73
Overview 73
Recent Developments 73
Other Potential Applications 74
New Advances 74
Sabic IP 74
In-Line Compounding and Molding of Biocomposites 74
Use of Sunflower Hull Fibers 74
Bamboo Fiber Reinforcement Usage 75
RheTech Introduces Biocomposite 75
Market Estimates and Forecasts 75
NANOCOMPOSITES 76
BACKGROUND 76
CHARACTERISTICS 76
BENEFITS 77
MECHANICAL ASPECTS 77
PROCESSES 77
EARLY WORK WITH PLASTICS 78

APPLICATIONS 78
CARBON NANOTUBES 79
NANOCOMPOSITE SUPPLIERS 80
TABLE 17 SELECTED NANOCOMPOSITE SUPPLIERS 80
TABLE 17 (CONTINUED) 81
RECENT NANOCOMPOSITE CONFERENCE 81

CHAPTER FOUR: EMI/RFI: MATERIALS AND TECHNOLOGIES (PLS005J) 82
INTRODUCTION 82
STUDY OBJECTIVES 82
SCOPE AND FORMAT 82
METHODOLOGY 83
CONTRIBUTION OF THE STUDY 83
ANALYST CREDENTIALS 83
RELATED BCC REPORTS 84
SUMMARY 84
TABLE 18 GLOBAL EMI/RFI SHIELDING BY METHOD, THROUGH 2016 ($ MILLIONS) 85
FIGURE 4 GLOBAL EMI/RFI SHIELDING BY METHOD, 2010–2016 ($ MILLIONS) 85
SHIELDING TECHNOLOGIES AND MATERIALS 86
OVERVIEW 86
FARADAY CAGES/SHIELDS 87
COST AND PERFORMANCE CHARACTERISTICS OF THE SHIELDING OPTIONS 87
COST COMPARISONS 88
TABLE 19 TOTAL RAW MATERIAL AND LABOR COSTS ASSOCIATED WITH THE MAJOR SHIELDING OPTIONS 88
TABLE 20 RELATIVE COST STRUCTURE OF VARIOUS SHIELDING OPTIONS ($/LB) 89
PERFORMANCE COMPARISONS 89
TABLE 21 SUMMARY OF STRENGTHS AND WEAKNESSES OF KEY EMI SHIELDING OPTIONS 90
TABLE 22 QUALITATIVE RATINGS OF THE MAJOR SHIELDING OPTIONS 90
TABLE 22 (CONTINUED) 91
EMC SHIELDING NEEDS TO KEEP UP WITH END-USER REQUIREMENTS 91
METALLIZATION PROCESSES 91
BACKGROUND 91
OVERVIEW 92
METALLIZATION MATERIALS 92
TABLE 23 METALLIZATION MATERIALS—FUNCTIONAL COATING 92
SHIELDING EFFECTIVENESS OVERVIEW BY TYPE OF COATING 92

TABLE 24 SHIELDING EFFECTIVENESS OF KEY COATINGS..... 93
CONDUCTIVE PLASTICS..... 93
OVERVIEW..... 93
BACKGROUND..... 93
FORMULATION OPTIONS..... 94
HOW DO CONDUCTIVE PLASTICS WORK?..... 95
DIELECTRIC PROPERTIES OF PLASTICS..... 95
TABLE 25 DIELECTRIC CONSTANTS FOR SELECTED MATERIALS..... 96
TECHNIQUES FOR MAKING PLASTICS CONDUCTIVE..... 97
TABLE 26 HOW TO MAKE PLASTICS CONDUCTIVE..... 97
TYPES OF CONDUCTIVE MATERIALS..... 97
TABLE 27 SURFACE RESISTIVITY FOR ELECTRONIC DEVICE SUBSTRATES..... 97
TABLE 28 RESISTANCE SPECTRUM FOR METHODS OF MAKING PLASTICS CONDUCTIVE..... 98
FUNCTIONS..... 99
CONDUCTIVE ADDITIVE SELECTION..... 99
CONDUCTIVITY TESTS..... 99
REVIEW OF ADVANTAGES AND DISADVANTAGES..... 99
COMPOUNDING CONDUCTIVE PLASTICS..... 100
EXAMPLES OF COMPANIES PRODUCING CONDUCTIVE PLASTICS..... 101
TABLE 29 SELECTED KEY COMPANIES PRODUCING CONDUCTIVE PLASTICS..... 101
CONDUCTIVE PLASTIC ADDITIVES..... 102
Overview..... 102
Background..... 102
Fibers and Powders..... 102
Silver Coatings..... 103
Carbon Fibers and Powders..... 103
Overview..... 103
Carbon Fibers..... 103
Carbon Blacks..... 104
Metal Fibers..... 105
Overview..... 105
Advantages..... 105
Metal Fiber Conductivity..... 106
Metallized Glass Fibers..... 106
Nickel-Coated Graphite Fibers..... 106
Background..... 106
Advantages..... 107
Stainless Steel Fibers..... 108
Overview..... 108
Technology..... 108

Effect on Processing 109
Fiber Forms 109
Advantages and Disadvantages 110
TABLE 30 ADVANTAGES AND DISADVANTAGES OF STAINLESS STEEL FIBERS 111
Copper Fibers 111
Conductive Filler Suppliers 111
TABLE 31 SELECTED MAJOR CONDUCTIVE FILLER SUPPLIERS 111
TABLE 31 (CONTINUED) 112
CARBON NANOTUBES 112
Overview 112
Usage in Producing Electrically Conductive Composites 113
Overview 113
Technical Problems 114
Carbon Nanotube Producers/Suppliers 114
TABLE 32 SELECTED KEY SUPPLIERS OF CARBON NANOTUBES 114
New Developments in Carbon Nanotubes 114
BASF Introduces Conductive Plastics Using Carbon Nanotubes 114
Hyperion New Applications 115
Aerospace Applications 115
Eikos Receives Funds for U.S. Navy Research 115
Nanocomp Technologies Secures Air Force Contract 115
Other Brief Developments Related to Carbon Nanotube-Based Electromagnetic Compliance Include 115
CONDUCTIVE PLASTICS TECHNICAL ISSUES 116
CONDUCTIVE FILMS 117
OVERVIEW 117
EXAMPLES OF COMPANY PRODUCTS 117
Donatech VCF Series 117
Z-Flo Conductive Films 118
INHERENTLY CONDUCTIVE POLYMERS 118
BACKGROUND 118
POTENTIAL APPLICATIONS 118
POLYANILINES 118
OTHER TYPES OF ICPS 119
PRICING 119
PROSPECTS 119
COMPARISON OF CONDUCTIVITIES OF ICPS WITH METALS, SEMICONDUCTORS, AND INSULATORS 120
TABLE 33 CONDUCTIVITIES OF DOPED ICPS COMPARED WITH METAL, SEMICONDUCTORS, AND INSULATORS 120
PROCESSING OPTIONS FOR ICPS 120

TABLE 34 CONDUCTIVITIES OF DOPED ICPS COMPARED WITH METALS, SEMICONDUCTORS AND INSULATORS *120*
TABLE 35 STABILITY AND PROCESSING ATTRIBUTES OF KEY ICPS *121*
RECENT ACTIVITIES AND DEVELOPMENT 121
H.C. Starck Activities 121
Polyanilines for EMI Shielding 121
Other Academic Advances 121
CONDUCTIVE ELASTOMERS 122
OVERVIEW 122
TABLE 36 SHIELDING EFFECTIVENESS OF CONDUCTIVE ELASTOMERS (MEASURED IN DB) *122*
TABLE 37 COMPARATIVE TESTING OF CONDUCTIVE ELASTOMERS FOR GALVANIC CORROSION *123*
TECHNOLOGY AND APPLICATIONS RELATED TO EMI 123
EXAMPLES OF CONDUCTIVE ELASTOMER PRODUCTS 124
Conductive Composites—Midway, UT 124
Laird Technologies—Chesterfield, MO 124
Leader Tech—Tampa, FL 124
CONDUCTIVE COATINGS 124
INTRODUCTION 124
BACKGROUND 124
EMI SHIELDING COMPOUNDS COMPARED WITH CONDUCTIVE COATINGS 125
TABLE 38 COMPARING EMI SHIELDING COMPOUNDS AND CONDUCTIVE COATINGS BY SEVERAL KEY VARIABLES *126*
CONDUCTIVE COATING ISSUES 126
COMPARISON OF CONDUCTIVE COATINGS 127
TABLE 39 COMPARISON OF CONDUCTIVE COATINGS BY CONDUCTIVITY AND SHIELDING EFFECTIVENESS *127*
PERFORMANCE OF ALTERNATE CONDUCTIVE COATINGS 127
ADVANTAGES AND DISADVANTAGES 128
PROS AND CONS OF CONDUCTIVE COATINGS 128
TABLE 40 ADVANTAGES AND DISADVANTAGES OF CONDUCTIVE COATINGS FOR EMI SHIELDING *129*
CONDUCTIVE COATING COST COMPARISONS 129
COATING BINDERS 130
SOLVENT-BASED VERSUS WATERBORNE CONDUCTIVE COATINGS 130
COPPER, NICKEL, AND SILVER USAGE 131
Advantages of Copper versus Nickel 131
Advantages of Nickel versus Copper 131
Silver 132
Summary of Attributes of the Major Metal Combinations Used as Conductive Materials 132

ELECTROPLATED COATINGS 133
ELECTROLESS PLATING 134
BACKGROUND 134
OVERVIEW 134
ATTRIBUTES 135
REVIEW OF TECHNOLOGY DETAILS 135
METALS INVOLVED 135
TABLE 41 ELECTROLESS PLATING PROCESS 136
ADVANTAGES AND DISADVANTAGES 136
TABLE 42 ADVANTAGES AND DISADVANTAGES OF ELECTROLESS PLATING FOR EMI SHIELDING 136
PLASTIC SUBSTRATES 137
APPLICATIONS 137
TABLE 43 SELECTED APPLICATIONS USING ELECTROLESS PLATING FOR EMI SHIELDING 137
MULTILAYERS 137
TABLE 44 SEQUENCE OF STEPS FOR ELECTROLESS PLATING OF PLASTICS 138

CHAPTER FIVE: BIODEGRADABLE POLYMERS (PLS025D) 139
INTRODUCTION 139
STUDY GOALS AND OBJECTIVES 139
REASONS FOR DOING THE STUDY 139
SCOPE OF REPORT 139
SOURCES 140
ANALYST CREDENTIALS 140
RELATED BCC REPORTS 141
SUMMARY 141
TABLE 45 GLOBAL BIODEGRADABLE POLYMER MARKET BY APPLICATION, THROUGH 2016 (MILLION LBS) 141
TABLE 45 (CONTINUED) 142
FIGURE 5 GLOBAL BIODEGRADABLE POLYMER MARKET BY APPLICATION, 2010–2016 (MILLION LBS) 142
SUMMARY (CONTINUED) 143
BACKGROUND/HISTORICAL 144
OVERVIEW 144
THE BIOPOLYMER-SYNTHETIC POLYMER GAP 144
NICHE MARKETS 144
NEW EMPHASIS 145
STILL HAVE ENVIRONMENTAL PROBLEMS 145
INTEGRATION OF BIODEGRADABLE PLASTICS WITH DISPOSAL INFRASTRUCTURE 145
EARLY STARCH-BASED MATERIALS 146
INTRODUCTION OF COMPOSTABLE BAGS 146
EARLY ENTRANTS 147

IMPORTANCE OF LOOSE-FILL 147
OTHER FACTORS 147
BIOPOLYMERS, CONVENTIONAL PLASTICS, AND BIODEGRADABLE PLASTICS 148
NATURAL OR SYNTHETIC 148
THE MOVE TO RENEWABLE SOURCES 149
EXTENDING THE RECYCLING LOOP 149
PROCESSING 150
PROPERTIES 150
DEFINING BIODEGRADABLE POLYMERS 150
PUBLIC ATTITUDES 151
ENVIRONMENTAL ISSUES 152
COMPOSTING 152
MARKET ESTIMATES AND FORECASTS 153
BACKGROUND 153
OVERVIEW 153
TABLE 46 GLOBAL BIODEGRADABLE POLYMER MARKET, THROUGH 2016 (MILLION LBS) 154
FIGURE 6 GLOBAL BIODEGRADABLE POLYMER MARKET, 2010–2016 (MILLION LBS) 154
OVERVIEW (CONTINUED) 155

CHAPTER SIX: PLASTICS IN ELECTRONIC ENCLOSURES: GLOBAL MARKETS (PLS048A) 156
INTRODUCTION 156
STUDY OBJECTIVES 156
REASON FOR DOING STUDY 156
SCOPE AND FORMAT 157
METHODOLOGY 158
ABOUT THE AUTHOR 158
RELATED BCC REPORTS 158
BCC ONLINE SERVICES 158
SUMMARY 159
TABLE 47 GLOBAL MARKET FOR RESINS FOR STATIONARY AND MOBILE ENCLOSURES BY TYPE OF ELECTRONIC ENCLOSURE, THROUGH 2017 (MILLION LBS) 160
FIGURE 7 GLOBAL MARKET FOR RESINS FOR STATIONARY AND MOBILE ENCLOSURES BY TYPE OF ELECTRONIC ENCLOSURE, 2011-2017 (MILLION LBS) 160
OVERVIEW OF ELECTRONIC ENCLOSURES 161
DEFINITIONS 161
PLANNING 162
FUNCTIONS 162
BACKGROUND 162
THE EMI ISSUE 163

HEAT-MANAGEMENT 164
DOWNSIZING 164
STILL A COMPETITIVE SCENARIO 164
EFFECTS ON PERFORMANCE REQUIREMENTS AND DESIGN 165
MATERIAL AND PROCESS SELECTION 166
SIGNIFICANCE OF THIN-WALLING ON RESIN SELECTION 167
ISSUE OF FLAME-RETARDANCY 168
COSTS 168
ORGANIZATIONS PUBLISHING STANDARDS FOR ELECTRONIC ENCLOSURES 169
NEW DEVELOPMENTS 169
Less Plastic and More Metal Enclosures 169
Performance Criteria for Electronic Enclosures 170
Background 170
Comparison of Performance Criteria 170
TABLE 48 COMPARISON OF KEY PERFORMANCE CRITERIA FOR ELECTRONIC ENCLOSURES: METALS VS. PLASTICS 171
PROCESS TECHNOLOGY FOR ELECTRONIC ENCLOSURES 171
BACKGROUND 171
INJECTION-MOLDING 171
STRUCTURAL FOAM MOLDING 172
THERMOFORMING 173
DIFFERENCES IN MOLDING ENCLOSURES FOR MOBILE VS. STATIONARY DEVICES 174
Background 174
Distinctions between Mobile and Stationary Enclosures 174
Other Factors 175
EMI ASPECTS 175
BACKGROUND 175
OVERVIEW OF EMI-SHIELDING 176
MECHANISMS OF SHIELDING 176
ELECTROMAGNETIC CONTROL (EMC) 176
THE IMPORTANCE OF SHIELDING 177
CONTROLLING EMI 177
SHIELDING-EFFECTIVENESS 178
TABLE 49 GENERAL RATINGS OF SHIELDING-EFFECTIVENESS 179
COST AND PERFORMANCE OF SHIELDING OPTIONS 179
USE OF THERMOPLASTICS 179
EMI-SHIELDING COMPOUNDS VERSUS COATINGS 180
ELECTRONIC INDUSTRY/EMI-SHIELDING INTERFACE 180
Background 180
Enclosures 181
Overview 181

Background 181
Aesthetics 182
EMI Leakage 183
Cost Considerations 183
Computers and EMI 184
Cellular Phones 184
Summing Up the Issues of EMI and Shielded Enclosures 185
Suppliers of Shielded Enclosures 185