

CHM040B- Table of Contents

INTRODUCTION	XXV
STUDY GOALS AND OBJECTIVES	XXV
REASONS FOR DOING THE STUDY	XXV
INTENDED AUDIENCE	XXVI
SCOPE OF REPORT	XXVI
INFORMATION SOURCES	XXVII
ANALYST CREDENTIALS	XXVII
RELATED REPORTS	XXVII
BCC ONLINE SERVICES	XXVIII
DISCLAIMER	XXVIII
SUMMARY	XXIX
SUMMARY TABLE TOTAL U.S. PRODUCTION OF END-USE ALTERNATIVE CHEMICAL PRODUCTS, THROUGH 2013 (\$ BILLIONS)	XXX
SUMMARY FIGURE A ALTERNATIVE CHEMICALS COMPARISON AS A PERCENTAGE OF TOTAL CHEMICAL END-USE PRODUCTION, 2008 (%)	XXXI
SUMMARY FIGURE B ALTERNATIVE CHEMICALS COMPARISON AS A PRCENTAGE OF TOTAL CHEMICAL END-USE PRODUCTION, 2013 (%)	XXXII
OVERVIEW	1
HISTORY OF THE CHEMICAL INDUSTRY	1
FROM PLANTS TO FOSSIL FUEL CHEMICALS	1
GREEN CHEMISTRY BEGINNINGS	1
THE CHEMICAL INDUSTRY	2
TABLE 1 REPRESENTATIVE CHEMICAL PRODUCT MARKET BILLIONS)	2 (\$
NEED FOR ALTERNATIVE CHEMICAL PRODUCTS	3
GREEN CHEMISTRY DEFINED	3
Environmentally Benign Chemicals	3
Green Initiatives	4
Twelve Principles of Green Chemistry	4
Twelve Principles ... (Continued)	5
ENVIRONMENTAL IMPACT	6
POLLUTION PREVENTION	6
SUSTAINABILITY ISSUES	6
DEPENDENCE ON FOSSIL FUELS	7
WASTE GENERATION AND BYPRODUCTS	7
EMISSION STANDARDS	8
NON-RENEWABLE RESOURCES	9
OZONE DEPLETING SUBSTANCES	9
MAJOR BIOMASS FEEDSTOCKS	10
MAJOR BIOBASED ALTERNATIVE CHEMICALS	10
MAJOR END PRODUCTS OF ALTERNATIVE CHEMICAL MANUFACTURING	11
MAJOR ALTERNATIVE CHEMICAL PROCESSES	12
MANUFACTURERS	12

SALES OPPORTUNITIES	12
FORECASTING PRODUCT SALES	13
PRODUCTS	14
FEEDSTOCKS	14
DEFINITION OF FEEDSTOCKS USED IN ALTERNATIVE CHEMICAL PRODUCTION	14
FEEDSTOCK CATEGORIES	15
TABLE 2 TOTAL U.S. CROP AND WASTE BASED FEEDSTOCK PRODUCTION FOR CHEMICAL MANUFACTURING, THROUGH 2013 (\$ TONS)	16
TABLE 3 TOTAL U.S. BIOMASS FEEDSTOCK PRODUCTION FOR BIOBASED CHEMICAL MANUFACTURING, THROUGH 2013 (\$ MILLIONS)	17
Crop-Based Feedstocks	18
TABLE 4 TOTAL U.S. CROP-BASED FEEDSTOCK PRODUCTION FOR CHEMICAL MANUFACTURING, THROUGH 2013 (\$ TONS)	19
TABLE 5 TOTAL U.S. CROP-BASED FEEDSTOCK PRODUCTION FOR CHEMICAL MANUFACTURING, THROUGH 2013 (\$ MILLIONS)	20
Corn	21
Soy-Based Feedstocks	22
Perennial Grasses	22
Sugar Crops	23
Sucrose	23
Specialty Sucrose Esters	23
Miscellaneous Plant Crops	24
Miscellaneous Grain Crops	24
Woody Crops	24
Microbial Feedstocks	24
TABLE 6 TOTAL U.S. MICROBIAL BIOMASS FEEDSTOCK PRODUCTION FOR CHEMICAL MANUFACTURING, THROUGH 2013 (\$ MILLIONS)	25
Microorganism Biomass Feedstocks	26
Enzymes	27
Celluloses and Hydrolyses	27
Biotechnology Trends	27
Waste Biomass Feedstocks	28
TABLE 7 TOTAL U.S. WASTE-BASED FEEDSTOCK PRODUCTION FOR CHEMICAL MANUFACTURING, THROUGH 2013 (\$ TONS)	28
TABLE 8 TOTAL U.S. WASTE-BASED FEEDSTOCK PRODUCTION FOR CHEMICAL MANUFACTURING, THROUGH 2013 (\$ MILLIONS)	29
Crop Waste	30
Crop Waste (Continued)	31
Wood Residues	32
Industrial Waste	32
Municipal Solid Waste Residues	32
Biomass Feedstock Negatives	33
Future Feedstock Sales	33
BIOBASED CHEMICAL PRODUCTS	34

TRADITIONAL CHEMICAL PRODUCTS	34
Inorganic Chemical Products	34
Organic Chemical Products	34
Alternative Chemical Products versus Petrochemical Products	35
PETROCHEMICAL INDUSTRY	35
Oil and Gas Prices a Major Factor	35
Cost of Processing Chemicals	36
TABLE 9 COST OF PROCESSING CHEMICALS, PETROCHEMICAL VS. BIOBASED ALTERNATIVE CHEMICALS, 2008 (%)	36
FIGURE 1 COST OF PROCESSING CHEMICALS, PETROCHEMICAL VS. BIOBASED ALTERNATIVE CHEMICALS, 2008 (%)	37
BIOBASED ALTERNATIVE CHEMICAL PRODUCT MARKET	38
Novel Properties	38
TABLE 10 TOTAL U.S. PRODUCTION OF BIOBASED CHEMICALS, THROUGH 2013 (\$ BILLIONS)	38
TABLE 11 U.S. PRODUCTION OF BIOBASED ALTERNATIVE CHEMICALS, COMPARISON BY CATEGORY, 2008 (\$ BILLIONS, %)	39
FIGURE 2 U.S. PRODUCTION OF BIOBASED ALTERNATIVE CHEMICALS, COMPARISON BY CATEGORY, 2008 (%)	40
Alternative Chemical Use of Biomass Feedstocks	40
TABLE 12 TOTAL U.S. PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTLERNATIVE CHEMICALS, THROUGH 2013 (\$ MILLIONS)	41
TABLE 13 TOTAL U.S. PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTERNATIVE CHEMICALS, 2008 (\$ MILLIONS, %)	42
FIGURE 3 TOTAL U.S. PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTLERNATIVE CHEMICALS, 2008 (%)	42
TABLE 14 BIOBASED ALTERNATIVE CHEMICAL USE OF CROP-BASED BIOMASS FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)	43
TABLE 15 BIOBASED ALTERNATIVE CHEMICAL USE OF WASTE-BASED BIOMASS FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)	44
TABLE 16 BIOBASED ALTERNATIVE CHEMICAL USE OF MICROBIAL FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)	45
Biobased Bulk Alternative Chemical Market	46
TABLE 17 TOTAL U.S. PRODUCTION OF BIOBASED BULK CHEMICALS, THROUGH 2013 (\$ BILLIONS)	47
TABLE 18 U.S. PRODUCTION OF BIOBASED ALTERNATIVE BULK CHEMICALS, COMPARISON BY CATEGORY, 2008 (\$ BILLIONS, %)	48
FIGURE 4 U.S. PRODUCTION OF BIOBASED ALTERNATIVE BULK CHEMICALS, COMPARISON BY CATEGORY, 2008 (%)	49
Organic Acids	49
Lactic Acid	50
Glycerol	50
Ethanol	50
Miscellaneous Solvents	51

Miscellaneous Resins	51
Other Bulk Chemicals	51
Feedstocks Used in Alternative Bulk Chemical Production	51
TABLE 19 BIOBASED BULK USE OF BIOMASS FEEDSTOCKS, THROUGH 2-13 (\$ MILLIONS)	52
TABLE 20 COMPARISON OF PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTERNATIVE BULK CHEMICALS AND TOTAL BIOBASED FEEDSTOCK MARKET, 2008 (\$ MILLIONS, %)	53
FIGURE 5 COMPARISON OF PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTERNATIVE BULK CHEMICALS AND TOTAL BIOBASED FEEDSTOCK MARKET, 2008 (\$ MILLIONS)	53
TABLE 21 TOTAL U.S. PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTERNATIVE BULK CHEMICALS, 2008 (\$ MILLIONS, %)	54
FIGURE 6 TOTAL U.S. PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTERNATIVE BULK CHEMICALS, 2008 (%)	54
TABLE 22 BIOBASED BULK USE OF CROP-BASED BIOMASS FEEDSTOCKS, THROUGH 2013 (\$ BILLIONS)	55
TABLE 23 BIOBASED ALTERNATIVE BULK CHEMICAL USE OF WASTE-BASED BIOMASS FEEDSTOCKS, THROUGH 2013 (\$ BILLIONS)	56
TABLE 24 BIOBASED ALTERNATIVE BULK CHEMICAL USE OF MICROBIAL FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)	57
Biobased Specialty and Fine Alternative Chemical Market	58
TABLE 25 TOTAL U.S. PRODUCTION OF BIOBASED SPECIALTY/FINE CHEMICALS, THROUGH 2013 (\$ BILLIONS)	59
TABLE 26 U.S. PRODUCTION OF BIOBASED ALTERNATIVE SPECIALTY/FINE CHEMICALS, COMPARISON BY CATEGORY, 2008 (\$ BILLIONS, %)	60
FIGURE 7 U.S. PRODUCTION OF BIOBASED ALTERNATIVE SPECIALTY/FINE CHEMICALS, COMPARISON BY CATEGORY, 2008 (%)	61
Specialty Fine Chemicals	61
Agrochemicals	62
Enzymes	62
TABLE 27 ALTERNATIVE SPECIALTY/FINE CHEMICAL USE OF BIOMASS FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)	63
TABLE 28 COMPARISON OF PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTERNATIVE SPECIALTY/FINE CHEMICALS AND TOTAL BIOBASED FEEDSTOCK MARKET, 2008 (\$ MILLIONS, %)	64
FIGURE 8 COMPARISON OF PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTERNATIVE SPECIALTY/FINE CHEMICALS AND TOTAL BIOBASED FEEDSTOCK MARKET, 2008 (\$ MILLIONS)	64
TABLE 29 TOTAL U.S. PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTERNATIVE SPECIALTY/FINE CHEMICALS, 2008 (\$ MILLIONS, %)	65

FIGURE 9 TOTAL U.S. PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTERNATIVE SPECIALTY/FINE CHEMICALS, 2008 (%)

65

TABLE 30 BIOBASED ALTERNATIVE SPECIALTY/FINE CHEMICAL USE OF CROP-BASED BIOMASS FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS) 66

TABLE 31 BIOBASED SPECIALTY/FINE ALTERNATIVE CHEMICAL USE OF WASTE-BASED BIOMASS FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS) 67

TABLE 32 BIOBASED ALTERNATIVE SPECIALTY/FINE CHEMICAL USE OF MICROBIAL FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)

68

Biobased Polymer Alternative Chemical Market 69

TABLE 33 TOTAL U.S. PRODUCTION OF BIOBASED POLYMERS, THROUGH 2013 (\$ MILLIONS) 70

TABLE 34 U.S. PRODUCTION OF BIOBASED ALTERNATIVE POLYMERS, COMPARISON BY CATEGORY, 2008 (\$ MILLIONS, %) 71

FIGURE 10 U.S. PRODUCTION OF BIOBASED ALTERNATIVE POLYMERS, COMPARISON BY CATEGORY, 2008 (%) 72

Poly(lactic Acid (PLA) 72

Poly(hydroxyalkanoate (PHA) 73

1,3 Propanediol (PDO) 73

Starch Polymers 73

Cellulose Polymer 74

Other Polymers 74

Microbial Sources and Polymers 74

TABLE 35 BIOBASED POLYMER USE OF BIOMASS FEEDSTOCK, THROUGH 2013 (\$ MILLIONS) 75

TABLE 36 COMPARISON OF PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTERNATIVE POLYMERS AND TOTAL BIOBASED FEEDSTOCK MARKET, 2008 (\$ MILLIONS, %) 76

FIGURE 11 COMPARISON OF PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTERNATIVE POLYMERS AND TOTAL BIOBASED FEEDSTOCK MARKET, 2008 (\$ MILLIONS) 77

TABLE 37 TOTAL U.S. PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTERNATIVE POLYMERS, 2008 (\$ MILLIONS, %) 78

FIGURE 12 TOTAL U.S. PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTERNATIVE POLYMERS CHEMICALS, 2008 (%) 78

TABLE 38 BIOBASED ALTERNATIVE POLYMER CHEMICAL USE OF CROP-BASED BIOMASS FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)

79

TABLE 39 BIOBASED ALTERNATIVE POLYMER CHEMICAL USE OF WASTE-BASED BIOMASS FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)

80

TABLE 40 BIOBASED ALTERNATIVE POLYMER CHEMICAL USE OF MICROBIAL FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS) 81

MARKET BY ALTERNATIVE CHEMICAL END-USE PRODUCTS 82

FORECASTS ON SALES FOR ALTERNATIVE CHEMICAL END-USE PRODUCTS

82

TABLE 41 TOTAL U.S. PRODUCTION OF END-USE ALTERNATIVE CHEMICAL PRODUCTS, THROUGH 2013 (\$ BILLIONS) 83

Forecasts on Sales for (Continued) 84

TABLE 42 ALTERNATIVE CHEMICAL END-USE PRODUCTS COMPARISON AS A PERCENTAGE OF TOTAL CHEMICAL END-USE PRODUCTION, 2008 AND 2013 (\$ BILLIONS, %) 85

FIGURE 13 ALTERNATIVE CHEMICALS END-USE PRODUCT SHARES OF TOTAL ALTERNATIVE END-USE PRODUCTS, 2008 (%) 86

FIGURE 14 ALTERNATIVE CHEMICALS END-USE PRODUCT SHARES OF TOTAL ALTERNATIVE END-USE PRODUCTS, 2013 (%) 87

Forecasts on Sales for (Continued) 88

ALTERNATIVE END-USE PRODUCT CATEGORIES 89

Alternative Plastics 89

Biobased and Biodegradable Plastic Technology 89

Resins, Polyesters, and Plastics 89

Specialty Plastics 90

TABLE 43 ALTERNATIVE PLASTICS USE OF BIOBASED FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS) 90

Alternative Pharmaceutical Products 91

New Drug Therapies 92

TABLE 44 ALTERNATIVE PHARMACEUTICAL USE OF BIOBASED FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS) 92

Alternative Packaging 93

TABLE 45 ALTERNATIVE PACKAGING USE OF BIOBASED FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS) 94

Alternative Cleaning Products 95

Vegetable Cleaners 96

TABLE 46 ALTERNATIVE PACKAGING USE OF BIOBASED FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS) 97

Alternative Personal Care Products 98

TABLE 47 ALTERNATIVE PERSONAL CARE PRODUCTS' USE OF BIOBASED FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS) 98

Alternative Agrochemicals 99

Fertilizers 100

Biodegradable Waste to Compost 100

TABLE 48 ALTERNATIVE AGROCHEMICAL USE OF BIOBASED FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS) 101

Alternative Detergents 102

Alternative Detergent Offerings 102

TABLE 49 ALTERNATIVE DETERGENT USE OF BIOBASED FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS) 103

Alternative Painting and Coatings 104

TABLE 50 ALTERNATIVE PAINT AND COATINGS' USE OF BIOBASED FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS) 105

Alternative Adhesive Products	106
TABLE 51 ALTERNATIVE ADHESIVES' USE OF BIOBASED FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)	106
Alternative Lubricants	107
TABLE 52 ALTERNATIVE LUBRICANTS' USE OF BIOBASED FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)	108
Alternative Pigments and Dyes Products	109
TABLE 53 ALTERNATIVE PIGMENTS' AND DYES' USE OF BIOBASED FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)	109
Alternative Ink Products	110
Soy Based Inks	111
TABLE 54 ALTERNATIVE INKS' USE OF BIOBASED FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)	111
Soy Based Inks (Continued)	112
TECHNOLOGY	113
TABLE 55 TECHNOLOGY DEVELOPMENT AND ITS SIGNIFICANCE TO THE CHEMICAL INDUSTRY	113
POLLUTION PREVENTION AND COST SAVINGS	113
RESEARCH AND DEVELOPMENT	114
MICROBIAL RESEARCH	114
LIFE-CYCLE ASSESSMENT	115
CHEMICAL PROCESSES	115
PROCESS EFFICIENCIES AND PRODUCT STEWARDSHIP	116
NONTRADITIONAL CHEMICAL PROCESSING	116
IMPORTANT RESEARCH AREAS	117
FIGURE 15 DIAGRAM OF A TYPICAL CHEMICAL MANUFACTURING PROCESS	117
Creating Robust Measurement Techniques	118
Chemical Pathways	118
REAGENTS	119
SOLVENTS	120
WATER	121
IONIC LIQUIDS	121
SUPERCRITICAL FLUIDS	122
CATALYSTS	122
FERMENTATION	123
BIOPROCESSING	123
Biorefineries	124
COMPUTATIONAL DESIGN	125
PRODUCT AND PROCESSES RESEARCH AND DEVELOPMENT	125
COMMERCIAL PRODUCT AND PROCESS R&D	125
Cargill and Novozymes	125
Natureworks, LLC	125
Rohm and Haas and Novasep	126
Ashland Inc.	126
Metabolix	126

Ashland Inc. and Cargill	127
The Dow Chemical Company and Crystalsev	127
Vertec BioSolvents, Inc.	127
Meredian, Inc.	127
DuPont	128
ACADEMIC PRODUCT AND PROCESS R & D	128
Rice University	128
University of Oregon	128
Polytechnic University	129
University of California	129
Georgia Institute of Technology	130
Iowa State University	130
National Science Foundation (NSF) Academic R&D	131
Georgia Institute of Technology	131
University of South Florida	131
University of Texas at Arlington	131
Oregon State University	131
Illinois Wesleyan University	132
University of New Mexico	132
GOVERNMENT R & D	133
U.S. Department of Agriculture (USDA)	133
Agriculture Research Service (ARS)	133
ARS: “Valuable Polysaccharide-Based Products from Sugar Beet Pulp and Citrus Peel”	133
ARS: “Industrial Products from New Crops”	133
Department of Energy	134
Office of Energy Efficiency and Renewable Energy - Biomass Program	134
Office of Science—Office of Basic Energy Sciences	134
Pacific Northwest National Laboratory	135
“Value-Added Products from Hemicellulose Utilization in Dry-Mill Ethanol Plants”	135
“Isosorbide Production”	135
Oak Ridge National Laboratory—The Plant Genomics Group	136
PATENTS	136
PATENTS BY COMPANY	137
TABLE 56 PATENTS BY COMPANY	137
Patents by Company (Continued)	138
TABLE 57 PATENTS ISSUED BY TECHNOLOGY AND YEAR, 2005-2007	139
PATENT REVIEW	139
U.S. Patent No. 6,320,077: Lactic Acid Processing; Methods; Arrangements; and Product	139
U.S. Patent No. 5,656,682: Polymer Composition Comprising Esterified Starch and Esterified Cellulose	140
U.S. Patent No. 7,217,545: Method for Production of Lactic Acid	141
U.S. Patent No. 7,294,486: Enzymatic Process for the Synthesis of Organo- fluorine Compounds	141

U.S. Patent No. 7,247,230: Electrochemical Synthesis and Processing of Conducting Polymers in Supercritical Media	142
U.S. Patent No. 7,229,804: Biological Systems for Manufacture of Polyhydroxyalkanoate Polymers Containing 4-hydroxyacids	142
U.S. Patent No. 7,285,523: Enzyme-containing Granule and Detergent Composition	143
U.S. Patent No. 7,309,805: Method and System to Contact an Ionic Liquid Catalyst with Oxygen to Improve a Chemical Reaction	143
U.S. Patent No. 7,275,572: Eco Tire	143
U.S. Patent No. 7,275,572: Eco Tire (Continued)	144
INDUSTRY STRUCTURE AND MARKET COMPETITION	145
MARKET DYNAMICS FOR ALTERNATIVE CHEMICAL PRODUCTS	145
MARKET DRIVERS	145
Alternative Chemical Costs	145
Product Price	145
Regulations	146
Environmental Drivers	147
Research and Development	147
TABLE 58 ALTERNATIVE CHEMICAL R&D EXPENDITURES VERSUS MARKETING EXPENDITURES, 2008 (%)	148
GOVERNMENT FUND OF R&D	149
Capital Investment Essential	149
COMPETITIVE STRATEGIES	149
Branding	150
Environmental Image	150
Chemical Industry Voluntary Programs	150
Responsible Care	151
Economies of Scale	151
Alliances	152
Production Innovation	153
COMPANIES	154
Biotechnology and Life Sciences Industries	154
Agriculture Industry	154
Biomass Feedstock Processors Market Share	155
TABLE 59 BIOMASS FEEDSTOCK PROCESSORS' MARKET SHARE COMPARISON, 2008 (\$ MILLIONS, %)	155
FIGURE 16 BIOMASS FEEDSTOCK PROCESSORS' MARKET SHARE COMPARISON, BY TIER 2008 (%)	156
Alternative Chemical Manufacturer's Market Share	157
TABLE 60 BIOBASED CHEMICAL MANUFACTURERS' MARKET SHARE COMPARISON, 2008 (\$ BILLIONS, %)	157
FIGURE 17 BIOBASED CHEMICAL MANUFACTURES' MARKET SHARE COMPARISON, BY TIER, 2008 (%)	158
COMPANY SIZE	159
SMALL TO MEDIUM COMPANIES	159
LEADERSHIP	160

PRESIDENTIAL GREEN CHEMISTRY CHALLENGE AWARDS	160
TABLE 61 PRESIDENTIAL GREEN CHEMISTRY CHALLENGE AWARD WINNERS, 2005–2007	161
TABLE 61 (CONTINUED)	162
SUPPLY CHAIN MANAGEMENT	162
GLOBAL COMPETITION	163
INTERNATIONAL MARKET	164
INTERNATIONAL MARKET DYNAMICS	164
FOREIGN INVESTMENT	164
CHALLENGED BY DEVELOPING REGIONS	164
GLOBALIZATION	165
SUPPLY AND DEMAND	165
GLOBAL ENVIRONMENTAL AWARENESS	165
A SHIFT TO BIOBASED AND BIOTECHNOLOGIES	166
U.S. EXPORTS	166
TABLE 62 U.S. PRODUCTION OF ALTERNATIVE CHEMICAL END-USE PRODUCTS—EXPORTS/IMPORTS, THROUGH 2013	(\$ BILLIONS) 167
TABLE 63 U.S. PRODUCTION OF ALTERNATIVE PLASTICS—EXPORTS/IMPORTS, THROUGH 2013 (\$ BILLIONS)	168
TABLE 64 U.S. PRODUCTION OF ALTERNATIVE PHARMACEUTICALS—EXPORTS/IMPORTS, THROUGH 2013	(\$ BILLIONS) 169
TABLE 65 U.S. PRODUCTION OF ALTERNATIVE PACKAGING PRODUCTS—EXPORTS/IMPORTS, THROUGH 2013 (\$ BILLIONS)	170
U.S. EXPORTS (CONTINUED)	171
TABLE 66 U.S. PRODUCTION OF ALTERNATIVE CLEANING PRODUCTS—EXPORTS/IMPORTS, THROUGH 2013 (\$ BILLIONS)	172
TABLE 67 U.S. PRODUCTION OF ALTERNATIVE PERSONAL CARE PRODUCTS—EXPORTS/IMPORTS, THROUGH 2013 (\$ BILLIONS)	173
TABLE 68 U.S. PRODUCTION OF ALTERNATIVE AGROCHEMICALS—EXPORTS/IMPORTS, THROUGH 2013	(\$ BILLIONS) 174
TABLE 69 U.S. PRODUCTION OF ALTERNATIVE DETERGENTS—EXPORTS/IMPORTS, THROUGH 2013 (\$ BILLIONS)	175
TABLE 70 U.S. PRODUCTION OF ALTERNATIVE PAINTING & COATINGS—EXPORTS/IMPORTS, THROUGH 2013 (\$ BILLIONS)	176
U.S. EXPORTS (CONTINUED)	177
TABLE 71 U.S. PRODUCTION OF ALTERNATIVE ADHESIVES—EXPORTS/IMPORTS, THROUGH 2013 (\$ BILLIONS)	178
TABLE 72 U.S. PRODUCTION OF ALTERNATIVE LUBRICANTS—EXPORTS/IMPORTS, THROUGH 2013 (\$ BILLIONS)	179
TABLE 73 U.S. PRODUCTION OF ALTERNATIVE PIGMENTS AND DYES—EXPORTS/IMPORTS, THROUGH 2013 (\$ BILLIONS)	180
TABLE 74 U.S. PRODUCTION OF ALTERNATIVE INKS EXPORTS/IMPORTS, THROUGH 2013 (\$ BILLIONS)	181
WORLDWIDE REGIONAL MARKETS	182

TABLE 75 WORLDWIDE REGIONAL PRODUCTION OF ALTERNATIVE CHEMICAL END-USE PRODUCTS, THROUGH 2013 (\$ BILLIONS)	183
TABLE 76 GLOBAL COMPARISON OF PRODUCTION OF ALTERNATIVE CHEMICAL END-USE PRODUCTION, 2008 (\$ BILLIONS, %)	184
FIGURE 18 GLOBAL COMPARISON OF PRODUCTION OF ALTERNATIVE CHEMICAL END-USE PRODUCTION, 2008 (%)	185
TABLE 77 GLOBAL PRODUCTION OF ALTERNATIVE CHEMICAL END-USE PRODUCTS, THROUGH 2013 (\$ BILLIONS)	185
TABLE 77 (CONTINUED)	186
WESTERN EUROPE	187
EASTERN EUROPE	188
CANADA	188
LATIN AMERICA	188
Brazil	189
Mexico	189
ASIA PACIFIC	190
China	190
China's Environmental Regulations	191
Japan	191
INDUSTRIAL VERSUS DEVELOPING REGIONS	192
Industrialized Countries	192
Advanced Technology	193
INTERNATIONAL REGULATION AND AGREEMENTS	193
EUROPEAN UNION REGULATION	194
Registration, Evaluation, Authorization and Restriction of Chemicals (Reach)	194
THE KYOTO PROTOCOL	195
UNITED NATIONAL GLOBAL COMPACT	195
INTERNATIONAL COMPANIES	197
INTERNATIONAL COMMERCIAL DEVELOPMENTS	197
Akzo Nobel and ICI	197
Bayer	197
BASF	198
Braskem	198
Croda	198
Crystalsev	199
DSM	199
Indorama	199
Neochim	199
Novamont	200
Novozymes A/S	200
PHB Industrial S.A.	200
Plantic	201
Purac	201
Rhodia	201
Roquette and DSM	201
Solanic	202

Solvay	202
Tate & Lyle	202
Teijin Group	203
FINANCING AND EXPORT ASSISTANCE	203
EX-IM BANK	203
EXPORT WORKING CAPITAL PROGRAM	204
OVERSEAS PRIVATE INVESTMENT CORPORATION	204
COMMERCIAL BANKS	205
REGULATION	206
HISTORICAL SIGNIFICANCE	206
STATE AND FEDERAL INTERACTIONS	206
EPCRA	207
EPA'S GREEN CHEMISTRY FOCUS	207
THE CLEAN AIR ACT	208
WATER POLLUTION CONTROL ACT	208
CLEAN WATER ACT	208
CLEAN WATER ACT AMENDMENTS	209
RESOURCE CONSERVATION AND RECOVERY ACT	209
"CRADLE-TO-GRAVE" CONTROL OF HAZARDOUS WASTE	210
POLLUTION PREVENTION ACT	211
TOXIC SUBSTANCES CONTROL ACT	211
MICROBIAL PRODUCTS OF BIOTECHNOLOGY; FINAL REGULATIONS UNDER THE TOXIC SUBSTANCE CONTROL ACT	211
TSCA INVENTORY NOMENCLATURE AND REPORTING FOR ENZYMES	212
BIOMASS RESEARCH AND DEVELOPMENT ACT OF 2000	212
BIOMASS RESEARCH AND ... (CONTINUED)	213
THE FOOD, CONSERVATION, AND ENERGY ACT OF 2008	214
NEW DEVELOPMENTS IN REGULATION	214
H.R. 2850 GREEN CHEMISTRY RESEARCH AND DEVELOPMENT ACT OF 2007	214
S.2307 GLOBAL CHANGE RESEARCH IMPROVEMENT ACT OF 2007	215
S.1884 HARVESTING ENERGY ACT OF 2007	216
H.R.3775 INDUSTRIAL ENERGY EFFICIENCY RESEARCH AND DEVELOPMENT ACT OF 2007	217
HR 2752 MARKET INCENTIVES FOR BIOBASED PRODUCTS ACT OF 2007	217
COMPANY PROFILES	218
AG PROCESSING INC.	218
ARCHER DANIELS MIDLAND COMPANY (ADM)	218
ASHLAND INC.	218
CEREPLAST	219
CODEXIS, INC.	220
THE DOW CHEMICAL CO.	220
DUPONT	220
EASTMAN CHEMICAL CO.	221
GENENCOR DIVISION, DANISCO US INC.	221

METABOLIX	222
NATIONAL STARCH AND CHEMICAL COMPANY	222
NATUREWORKS LLC	222
PENFORD CORP.	223
ROHM AND HAAS	223
TATE & LYLE	223
VERENIUM CORPORATION	224
VERTEC BIOSOLVENTS, INC	224
APPENDIX: REFERENCES	225
WORKS CITED	225
WORKS CITED (CONTINUED)	226
WORKS CITED (CONTINUED)	227
WORKS CITED (CONTINUED)	228
WORKS CITED (CONTINUED)	229

SUMMARY TABLE TOTAL U.S. PRODUCTION OF END-USE ALTERNATIVE
CHEMICAL PRODUCTS, THROUGH 2013 (\$ BILLIONS) XXX

TABLE 1 REPRESENTATIVE CHEMICAL PRODUCT MARKET	(\$ BILLIONS)	2
TABLE 2 TOTAL U.S. CROP AND WASTE BASED FEEDSTOCK PRODUCTION FOR CHEMICAL MANUFACTURING, THROUGH 2013 (\$ TONS)		16
TABLE 3 TOTAL U.S. BIOMASS FEEDSTOCK PRODUCTION FOR BIOBASED CHEMICAL MANUFACTURING, THROUGH 2013	(\$ MILLIONS)	17
TABLE 4 TOTAL U.S. CROP-BASED FEEDSTOCK PRODUCTION FOR CHEMICAL MANUFACTURING, THROUGH 2013 (\$ TONS)		19
TABLE 5 TOTAL U.S. CROP-BASED FEEDSTOCK PRODUCTION FOR CHEMICAL MANUFACTURING, THROUGH 2013 (\$ MILLIONS)		20
TABLE 6 TOTAL U.S. MICROBIAL BIOMASS FEEDSTOCK PRODUCTION FOR CHEMICAL MANUFACTURING, THROUGH 2013 (\$ MILLIONS)		25
TABLE 7 TOTAL U.S. WASTE-BASED FEEDSTOCK PRODUCTION FOR CHEMICAL MANUFACTURING, THROUGH 2013 (\$ TONS)		28
TABLE 8 TOTAL U.S. WASTE-BASED FEEDSTOCK PRODUCTION FOR CHEMICAL MANUFACTURING, THROUGH 2013 (\$ MILLIONS)		29
TABLE 9 COST OF PROCESSING CHEMICALS, PETROCHEMICAL VS. BIOBASED ALTERNATIVE CHEMICALS, 2008 (%)		36
TABLE 10 TOTAL U.S. PRODUCTION OF BIOBASED CHEMICALS, THROUGH 2013 (\$ BILLIONS)		38
TABLE 11 U.S. PRODUCTION OF BIOBASED ALTERNATIVE CHEMICALS, COMPARISON BY CATEGORY, 2008 (\$ BILLIONS, %)		39
TABLE 12 TOTAL U.S. PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTLERNATIVE CHEMICALS, THROUGH 2013	(\$ MILLIONS)	41

TABLE 13	TOTAL U.S. PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTERNATIVE CHEMICALS, 2008	(\$ MILLIONS, %)	42
TABLE 14	BIOBASED ALTERNATIVE CHEMICAL USE OF CROP-BASED BIOMASS FEEDSTOCKS, THROUGH 2013	(\$ MILLIONS)	43
TABLE 15	BIOBASED ALTERNATIVE CHEMICAL USE OF WASTE-BASED BIOMASS FEEDSTOCKS, THROUGH 2013	(\$ MILLIONS)	44
TABLE 16	BIOBASED ALTERNATIVE CHEMICAL USE OF MICROBIAL FEEDSTOCKS, THROUGH 2013	(\$ MILLIONS)	45
TABLE 17	TOTAL U.S. PRODUCTION OF BIOBASED BULK CHEMICALS, THROUGH 2013	(\$ BILLIONS)	47
TABLE 18	U.S. PRODUCTION OF BIOBASED ALTERNATIVE BULK CHEMICALS, COMPARISON BY CATEGORY, 2008	(\$ BILLIONS, %)	48
TABLE 19	BIOBASED BULK USE OF BIOMASS FEEDSTOCKS, THROUGH 2-13	(\$ MILLIONS)	52
TABLE 20	COMPARISON OF PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTERNATIVE BULK CHEMICALS AND TOTAL BIOBASED FEEDSTOCK MARKET, 2008	(\$ MILLIONS, %)	53
TABLE 21	TOTAL U.S. PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTERNATIVE BULK CHEMICALS, 2008	(\$ MILLIONS, %)	54
TABLE 22	BIOBASED BULK USE OF CROP-BASED BIOMASS FEEDSTOCKS, THROUGH 2013	(\$ BILLIONS)	55
TABLE 23	BIOBASED ALTERNATIVE BULK CHEMICAL USE OF WASTE-BASED BIOMASS FEEDSTOCKS, THROUGH 2013	(\$ BILLIONS)	56
TABLE 24	BIOBASED ALTERNATIVE BULK CHEMICAL USE OF MICROBIAL FEEDSTOCKS, THROUGH 2013	(\$ MILLIONS)	57
TABLE 25	TOTAL U.S. PRODUCTION OF BIOBASED SPECIALTY/FINE CHEMICALS, THROUGH 2013	(\$ BILLIONS)	59
TABLE 26	U.S. PRODUCTION OF BIOBASED ALTERNATIVE SPECIALTY/FINE CHEMICALS, COMPARISON BY CATEGORY, 2008	(\$ BILLIONS, %)	60
TABLE 27	ALTERNATIVE SPECIALTY/FINE CHEMICAL USE OF BIOMASS FEEDSTOCKS, THROUGH 2013	(\$ MILLIONS)	63
TABLE 28	COMPARISON OF PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTERNATIVE SPECIALTY/FINE CHEMICALS AND TOTAL BIOBASED FEEDSTOCK MARKET, 2008	(\$ MILLIONS, %)	64
TABLE 29	TOTAL U.S. PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTERNATIVE SPECIALTY/FINE CHEMICALS, 2008	(\$ MILLIONS, %)	65
TABLE 30	BIOBASED ALTERNATIVE SPECIALTY/FINE CHEMICAL USE OF CROP-BASED BIOMASS FEEDSTOCKS, THROUGH 2013	(\$ MILLIONS)	66
TABLE 31	BIOBASED SPECIALTY/FINE ALTERNATIVE CHEMICAL USE OF WASTE-BASED BIOMASS FEEDSTOCKS, THROUGH 2013	(\$ MILLIONS)	67

TABLE 32 BIOBASED ALTERNATIVE SPECIALTY/FINE CHEMICAL USE OF MICROBIAL FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)	68
TABLE 33 TOTAL U.S. PRODUCTION OF BIOBASED POLYMERS, THROUGH 2013 (\$ MILLIONS)	70
TABLE 34 U.S. PRODUCTION OF BIOBASED ALTERNATIVE POLYMERS, COMPARISON BY CATEGORY, 2008 (\$ MILLIONS, %)	71
TABLE 35 BIOBASED POLYMER USE OF OF BIOMASS FEEDSTOCK, THROUGH 2013 (\$ MILLIONS)	75
TABLE 36 COMPARISON OF PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTERNATIVE POLYMERS AND TOTAL BIOBASED FEEDSTOCK MARKET, 2008 (\$ MILLIONS, %)	76
TABLE 37 TOTAL U.S. PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTERNATIVE POLYMERS, 2008 (\$ MILLIONS, %)	78
TABLE 38 BIOBASED ALTERNATIVE POLYMER CHEMICAL USE OF CROP-BASED BIOMASS FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)	79
TABLE 39 BIOBASED ALTERNATIVE POLYMER CHEMICAL USE OF WASTE-BASED BIOMASS FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)	80
TABLE 40 BIOBASED ALTERNATIVE POLYMER CHEMICAL USE OF MICROBIAL FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)	81
TABLE 41 TOTAL U.S. PRODUCTION OF END-USE ALTERNATIVE CHEMICAL PRODUCTS, THROUGH 2013 (\$ BILLIONS)	83
TABLE 42 ALTERNATIVE CHEMICAL END-USE PRODUCTS COMPARISON AS A PERCENTAGE OF TOTAL CHEMICAL END-USE PRODUCTION, 2008 AND 2013 (\$ BILLIONS, %)	85
TABLE 43 ALTERNATIVE PLASTICS USE OF BIOBASED FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)	90
TABLE 44 ALTERNATIVE PHARMACEUTICAL USE OF BIOBASED FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)	92
TABLE 45 ALTERNATIVE PACKAGING USE OF BIOBASED FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)	94
TABLE 46 ALTERNATIVE PACKAGING USE OF BIOBASED FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)	97
TABLE 47 ALTERNATIVE PERSONAL CARE PRODUCTS' USE OF BIOBASED FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)	98
TABLE 48 ALTERNATIVE AGROCHEMICAL USE OF BIOBASED FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)	101
TABLE 49 ALTERNATIVE DETERGENT USE OF BIOBASED FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)	103
TABLE 50 ALTERNATIVE PAINT AND COATINGS' USE OF BIOBASED FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)	105
TABLE 51 ALTERNATIVE ADHESIVES' USE OF BIOBASED FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)	106

TABLE 52 ALTERNATIVE LUBRICANTS' USE OF BIOBASED FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)	108
TABLE 53 ALTERNATIVE PIGMENTS' AND DYES' USE OF BIOBASED FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)	109
TABLE 54 ALTERNATIVE INKS' USE OF BIOBASED FEEDSTOCKS, THROUGH 2013 (\$ MILLIONS)	111
TABLE 55 TECHNOLOGY DEVELOPMENT AND ITS SIGNIFICANCE TO THE CHEMICAL INDUSTRY	113
TABLE 56 PATENTS BY COMPANY	137
TABLE 57 PATENTS ISSUED BY TECHNOLOGY AND YEAR, 2005-2007	139
TABLE 58 ALTERNATIVE CHEMICAL R&D EXPENDITURES VERSUS MARKETING EXPENDITURES, 2008 (%)	148
TABLE 59 BIOMASS FEEDSTOCK PROCESSORS' MARKET SHARE COMPARISON, 2008 (\$ MILLIONS, %)	155
TABLE 60 BIOBASED CHEMICAL MANUFACTURERS' MARKET SHARE COMPARISON, 2008 (\$ BILLIONS, %)	157
TABLE 61 PRESIDENTIAL GREEN CHEMISTRY CHALLENGE AWARD WINNERS, 2005-2007	161
TABLE 62 U.S. PRODUCTION OF ALTERNATIVE CHEMICAL END-USE PRODUCTS—EXPORTS/IMPORTS, THROUGH 2013 (\$ BILLIONS)	167
TABLE 63 U.S. PRODUCTION OF ALTERNATIVE PLASTICS—EXPORTS/IMPORTS, THROUGH 2013 (\$ BILLIONS)	168
TABLE 64 U.S. PRODUCTION OF ALTERNATIVE PHARMACEUTICALS—EXPORTS/IMPORTS, THROUGH 2013 (\$ BILLIONS)	169
TABLE 65 U.S. PRODUCTION OF ALTERNATIVE PACKAGING PRODUCTS—EXPORTS/IMPORTS, THROUGH 2013 (\$ BILLIONS)	170
TABLE 66 U.S. PRODUCTION OF ALTERNATIVE CLEANING PRODUCTS—EXPORTS/IMPORTS, THROUGH 2013 (\$ BILLIONS)	172
TABLE 67 U.S. PRODUCTION OF ALTERNATIVE PERSONAL CARE PRODUCTS—EXPORTS/IMPORTS, THROUGH 2013 (\$ BILLIONS)	173
TABLE 68 U.S. PRODUCTION OF ALTERNATIVE AGROCHEMICALS—EXPORTS/IMPORTS, THROUGH 2013 (\$ BILLIONS)	174
TABLE 69 U.S. PRODUCTION OF ALTERNATIVE DETERGENTS—EXPORTS/IMPORTS, THROUGH 2013 (\$ BILLIONS)	175
TABLE 70 U.S. PRODUCTION OF ALTERNATIVE PAINTING & COATINGS—EXPORTS/IMPORTS, THROUGH 2013 (\$ BILLIONS)	176
TABLE 71 U.S. PRODUCTION OF ALTERNATIVE ADHESIVES—EXPORTS/IMPORTS, THROUGH 2013 (\$ BILLIONS)	178
TABLE 72 U.S. PRODUCTION OF ALTERNATIVE LUBRICANTS—EXPORTS/IMPORTS, THROUGH 2013 (\$ BILLIONS)	179
TABLE 73 U.S. PRODUCTION OF ALTERNATIVE PIGMENTS AND DYES—EXPORTS/IMPORTS, THROUGH 2013 (\$ BILLIONS)	180
TABLE 74 U.S. PRODUCTION OF ALTERNATIVE INKS EXPORTS/IMPORTS, THROUGH 2013 (\$ BILLIONS)	181
TABLE 75 WORLDWIDE REGIONAL PRODUCTION OF ALTERNATIVE CHEMICAL END-USE PRODUCTS, THROUGH 2013 (\$ BILLIONS)	183

TABLE 76 GLOBAL COMPARISON OF PRODUCTION OF ALTERNATIVE CHEMICAL END-USE PRODUCTION, 2008 (\$ BILLIONS, %) 184
TABLE 77 GLOBAL PRODUCTION OF ALTERNATIVE CHEMICAL END-USE PRODUCTS, THROUGH 2013 (\$ BILLIONS) 185

SUMMARY FIGURE A ALTERNATIVE CHEMICALS COMPARISON AS A PERCENTAGE OF TOTAL CHEMICAL END-USE PRODUCTION, 2008 (%) XXXI
SUMMARY FIGURE B ALTERNATIVE CHEMICALS COMPARISON AS A PERCENTAGE OF TOTAL CHEMICAL END-USE PRODUCTION, 2013 (%) XXXII

FIGURE 1 COST OF PROCESSING CHEMICALS, PETROCHEMICAL VS. BIOBASED ALTERNATIVE CHEMICALS, 2008 (%) 37
FIGURE 2 U.S. PRODUCTION OF BIOBASED ALTERNATIVE CHEMICALS, COMPARISON BY CATEGORY, 2008 (%) 40
FIGURE 3 TOTAL U.S. PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTERNATIVE CHEMICALS, 2008 (%) 42
FIGURE 4 U.S. PRODUCTION OF BIOBASED ALTERNATIVE BULK CHEMICALS, COMPARISON BY CATEGORY, 2008 (%) 49
FIGURE 5 COMPARISON OF PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTERNATIVE BULK CHEMICALS AND TOTAL BIOBASED FEEDSTOCK MARKET, 2008 (\$ MILLIONS) 53
FIGURE 6 TOTAL U.S. PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTERNATIVE BULK CHEMICALS, 2008 (%) 54
FIGURE 7 U.S. PRODUCTION OF BIOBASED ALTERNATIVE SPECIALTY/FINE CHEMICALS, COMPARISON BY CATEGORY, 2008 (%) 61
FIGURE 8 COMPARISON OF PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTERNATIVE SPECIALTY/FINE CHEMICALS AND TOTAL BIOBASED FEEDSTOCK MARKET, 2008 (\$ MILLIONS) 64
FIGURE 9 TOTAL U.S. PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTERNATIVE SPECIALTY/FINE CHEMICALS, 2008 (%) 65
FIGURE 10 U.S. PRODUCTION OF BIOBASED ALTERNATIVE POLYMERS, COMPARISON BY CATEGORY, 2008 (%) 72
FIGURE 11 COMPARISON OF PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTERNATIVE POLYMERS AND TOTAL BIOBASED FEEDSTOCK MARKET, 2008 (\$ MILLIONS) 77
FIGURE 12 TOTAL U.S. PRODUCTION OF BIOBASED FEEDSTOCKS FOR PRODUCTION OF ALTERNATIVE POLYMERS CHEMICALS, 2008 (%) 78
FIGURE 13 ALTERNATIVE CHEMICALS END-USE PRODUCT SHARES OF TOTAL ALTERNATIVE END-USE PRODUCTS, 2008 (%) 86
FIGURE 14 ALTERNATIVE CHEMICALS END-USE PRODUCT SHARES OF TOTAL ALTERNATIVE END-USE PRODUCTS, 2013 (%) 87
FIGURE 15 DIAGRAM OF A TYPICAL CHEMICAL MANUFACTURING PROCESS 117

FIGURE 16 BIOMASS FEEDSTOCK PROCESSORS' MARKET SHARE
COMPARISON, BY TIER 2008 (%) 156

FIGURE 17 BIOBASED CHEMICAL MANUFACTURES' MARKET SHARE
COMPARISON, BY TIER, 2008 (%) 158

FIGURE 18 GLOBAL COMPARISON OF PRODUCTION OF ALTERNATIVE
CHEMICAL END-USE PRODUCTION, 2008 (%) 185