

SPECIAL REPORTS

Plastics in the Automotive Industry: Which Materials Will Be the Winners and Losers

December 2018

Priyanka Khemka



This Report was prepared by Nexant, Inc. ("Nexant"). Except where specifically stated otherwise in this Report, the information contained herein is prepared on the basis of information that is publicly available, and contains no confidential third party technical information to the best knowledge of Nexant. Aforesaid information has not been independently verified or otherwise examined to determine its accuracy, completeness or financial feasibility. Neither Nexant, Subscriber nor any person acting on behalf of either assumes any liabilities with respect to the United States of or for damages resulting from the United States of any information contained in this Report. Nexant does not represent or warrant that any assumed conditions will come to pass.

The Report is submitted on the understanding that the Subscriber will maintain the contents confidential except for the Subscriber's internal United States. The Report should not be reproduced, distributed or United States without first obtaining prior written consent by Nexant. Each Subscriber agrees to United States reasonable effort to protect the confidential nature of the Report.

Copyright © by Nexant Inc. 2019. All rights reserved.



Contents

1	Executive Summary	1
1.1	Global Vehicle Park	1
1.2	Vehicle Weight and Use of Plastics	2
1.2	Trends Impacting Plastics Consumption in Vehicles	4
1.2.1	Fuel Economy Standards	4
1.2.2	Lightweighting Trends	5
1.2.3	Lower Cost of Manufacturing Parts	5
1.2.4	Innovation and Design Freedom	6
1.2.5	Noise Vibration Harshness (NVH) Reduction	6
1.3	Polymers Used in Vehicles	6
1.3.1	Regional Plastics Consumption	7
1.4	Trends Impacting Plastics Consumption in Vehicles	9
1.4.1	Exterior	9
1.4.2	Electrical Systems	10
1.4.3	Power Train/Engine	10
1.4.4	Fuel System	11
1.4.5	Automotive Interior	11
1.5	Emerging Trends for Plastics in the Automotive Sector	11
1.5.1	Background on Polymer Composites	11
1.5.2	Trends with Fillers	12
1.5.3	Trends with Fibers	12
1.5.4	Advances in Fabrication Equipment	13
1.5.5	New Polymer Compounds	14
1.5.6	Bio-based Plastics	15
1.6	Forecasts and Scenarios	16
1.6.1	United States	16
1.6.2	Western Europe	17
1.6.3	China	18
1.7	EV Rapid Growth Scenario	19
2	Global Automotive Industry	21
2.1	Global Vehicle Park	21
2.2	Global Vehicle Production	24
2.3	Electric Vehicle Park	27
2.3.1	Electric Vehicle Types	27
2.3.2	Electric Vehicle Park Historical Development	28
2.3.3	Electric Vehicle Market Drivers	29
2.4	Motor Vehicle Manufacturers	30
2.4.1	United States	30
2.4.2	Western Europe	31
2.4.3	China	33



2.4.4	Top Global Motor Vehicle Manufacturers (excluding Chinese Companies)	34
2.4.5	Top Chinese Motor Vehicle Manufacturers	39
2.4.6	Top Manufacturers of Electrified Vehicles	43
3	Developments in the Auto Industry	45
3.1	Fuel Economy Standards	45
3.2	Lightweighting Trends	47
3.3	Safety	51
3.4	Lower Cost of Manufacturing Parts	53
3.5	Innovation and Design Freedom	53
3.6	Noise Vibration Harshness (NVH) Reduction	54
3.7	Use of Plastics in Car Parts	55
3.7.1	Exterior Components	55
3.7.2	Interior Components	58
3.7.3	Under the Hood Components	60
3.8	Material Composition of Traditional Car, 2018	61
4	Plastics Consumption in Traditional Vehicle Production	64
4.1	Polypropylene	67
4.1.1	Plastic Overview	68
4.2	Polyurethane	78
4.2.1	Plastic Overview	78
4.2.2	Automotive Applications	81
4.2.3	Demand in the Automotive Sector	83
4.3	Polyamide	87
4.3.1	Plastic Overview	87
4.3.2	Automotive Applications	88
4.4	Polyethylene	96
4.4.1	Plastic Overview	97
4.5	Acrylonitrile Butadiene Styrene (ABS)	103
4.5.1	Plastic Overview	103
4.5.2	Automotive Applications	105
4.6	Polycarbonate (PC)	113
4.6.1	Plastic Overview	113
4.6.2	Automotive Applications	115
4.6.3	Demand in the Automotive Sector	115
4.7	PVC	120
4.7.1	Plastic Overview	120
4.7.2	Automotive Applications	121
4.7.3	Demand in the Automotive Sector	122
4.8	Other Plastics	126
4.8.1	Polyvinyl Butyral (PVB)	126
4.8.2	Polymethyl Methacrylate (PMMA)	127
4.8.3	Other Engineering Plastics	130



5	Developing Plastics Requirements in Alternative Power Train Vehicles	134
5.1	Introduction.....	134
5.2	Exterior.....	134
5.2.1	Body Exterior	134
5.3	Interior.....	136
5.3.1	Electrical Systems.....	136
5.3.2	Power Train/Engine.....	137
5.3.3	Fuel System.....	138
5.3.4	Automotive Interior	138
6	Emerging Trends for Plastics in the Automotive Sector.....	139
6.1	High Performance Plastics Composites.....	139
6.1.1	Trends with Fillers	139
6.1.2	Trends with Fibers.....	141
6.1.3	Advances in Fabrication Equipment.....	144
6.2	New Plastics Compounds	148
6.3	Bio based Plastics	149
6.4	Recycling of Plastics in the Automotive Sectors	153
7	Forecast Scenarios for Plastics Consumption in the Automotive Sector	159
7.1	Business as Usual	159
7.1.1	Electric Vehicle Park Outlook	159
7.1.2	United States	162
7.1.3	Western Europe	164
7.1.4	China	165
7.2	EV Rapid Growth Scenario	167
7.2.1	United States	169
7.2.2	Western Europe	170
7.2.3	China	170
8	Glossary.....	172
 Appendices		
A	References	173



Figures

Figure 1	Global Motor Vehicle Population, 2005-2017	1
Figure 2	Average Light Vehicle Weight, 2012-2017	3
Figure 3	Plastics Consumption per Vehicle	4
Figure 4	Fuel Economy and Greenhouse Emission Standards Global	5
Figure 5	Plastics Applications in Automotive Parts	7
Figure 6	China Plastics Consumption Automotive Sector, 2012-2017.....	7
Figure 7	North America Plastics Consumption Automotive Sector, 2012-2017.....	8
Figure 8	Western Europe Plastics Consumption Automotive Sector, 2012-2017.....	8
Figure 9	Auto Part Production from “Organosheet”.....	14
Figure 10	North America Plastics Consumption in Automotive Sector, 2012-2025.....	17
Figure 11	Western Europe Plastics Consumption in Automotive Sector, 2012-2025.....	18
Figure 12	China Plastics Consumption in Automotive Sector, 2012-2025.....	19
Figure 13	Total Plastics Consumption Comparison, 2025	20
Figure 14	Global Motor Vehicle Population, 2005-2017	21
Figure 15	Global Motor Vehicle Distribution, 2017.....	22
Figure 16	Global Motor Vehicle Population Growth by Number of Vehicles, 2006-2017.....	23
Figure 17	Motor Vehicle Ownership, 2017	24
Figure 18	Global Motor Vehicle Production, 2000-2017.....	24
Figure 19	Global Motor Vehicle Production by Region, 2017.....	26
Figure 20	Global Motor Vehicle Production Growth	26
Figure 21	Light Vehicle Production in China, North America, and Western Europe.....	27
Figure 22	Electric Vehicles by Type	28
Figure 23	Electric Vehicles by Region.....	29
Figure 24	Motor Vehicle Manufacturing Centers.....	30
Figure 25	Vehicle Manufacturing Centers in the United States	30
Figure 26	Vehicle Manufacturing Centers in Western Europe.....	32
Figure 27	Vehicle Manufacturing Centers in China.....	33
Figure 28	Production of Top Motor Vehicle Manufacturers, 2017	34
Figure 29	Production of Top Chinese Vehicle Manufacturers, 2017.....	40
Figure 30	Fuel Economy & Greenhouse Emission Standards Global	46
Figure 31	Dupont Survey Results for North America	47
Figure 32	Vehicle Mass versus CO ₂ Emissions EU	48
Figure 33	Vehicle Mass and Greenhouse Gas Emissions	48
Figure 34	Auto Lightweighting Agenda of Major Global OEMs.....	49
Figure 35	Average Weight Light Vehicles, 2012-2017	50
Figure 36	Plastics Consumption per Light Vehicle.....	51
Figure 37	General Crumple Zones in Car.....	51
Figure 38	Vehicle Lightweighting and Safety Results - U.S.	52
Figure 39	Volvo 40 External Airbag.....	53
Figure 40	Plastics Automotive Components.....	55
Figure 41	Headlight Housing.....	57
Figure 42	Body in White	58
Figure 43	A and B Pillar Covers.....	59
Figure 44	Intake Manifold	60
Figure 45	Leaf Spring in Passenger Car	61



Figure 46	North America Materials used in Light Vehicle Manufacture, 2007 and 2017	63
Figure 47	Typical Plastics Applications in Automotive Parts	64
Figure 48	China Plastics Consumption in Automotive Sector, 2017	65
Figure 49	China Plastics Consumption in Automotive Sector, 2012-2017	65
Figure 50	North America Plastics Consumption in Automotive Sector, 2017	66
Figure 51	North America Plastics Consumption in Automotive Sector, 2012-2017	66
Figure 52	Western Europe Plastics Consumption in Automotive Sector, 2017	67
Figure 53	Western Europe Plastics Consumption in Automotive Sector, 2012-2017	67
Figure 54	Polypropylene Applications in Automotive Parts	69
Figure 55	Polypropylene Properties Range	69
Figure 56	TPO Applications in Interior and Exterior	71
Figure 57	Polypropylene Adhesion Potential to Metals	72
Figure 58	EPP Applications in Automotive Parts	73
Figure 59	Polypropylene Consumption in the Automotive Sector, 2012-2017	74
Figure 60	Polypropylene Consumption per Vehicle, 2012-2017	75
Figure 61	China Polypropylene Automotive Demand, 2012-2017	76
Figure 62	North America Polypropylene Automotive Demand, 2012-2017	77
Figure 63	Western Europe Polypropylene Automotive Demand, 2012-2017	78
Figure 64	Applications of Polyurethane in a Car	82
Figure 65	Polyurethane Consumption in the Automotive Sector, 2012-2017	83
Figure 66	Polyurethane Consumption per Vehicle, 2012-2017	84
Figure 67	China Polyurethane Automotive Demand, 2012-2017	85
Figure 68	North America Polyurethane Automotive Demand, 2012-2017	86
Figure 69	Western Europe Polyurethane Automotive Demand, 2012-2017	87
Figure 70	Polyamide Demand in the Automotive Sector, 2012-2017	91
Figure 71	Polyamide Consumption per Vehicle, 2012-2017	91
Figure 72	China Polyamide Automotive Demand, 2012-2017	93
Figure 73	North America Polyamide Automotive Demand, 2012-2017	95
Figure 74	Western Europe Polyamide Automotive Demand, 2012-2017	96
Figure 75	Tank Structure	98
Figure 76	E10 Barrier Comparison of Plastics	98
Figure 77	Polyethylene Demand in the Automotive Sector, 2012-2017	99
Figure 78	Polyethylene Consumption per Vehicle, 2012-2017	100
Figure 79	China Polyethylene Automotive Demand, 2012-2017	101
Figure 80	North America Polyethylene Automotive Demand, 2012-2017	102
Figure 81	Western Europe Polyethylene Automotive Demand, 2012-2017	103
Figure 82	Olli	107
Figure 83	Strati	107
Figure 84	ABS Consumption in Automotive Sector, 2012-2017	108
Figure 85	ABS Consumption per Vehicle, 2012-2017	109
Figure 86	China ABS Automotive Demand, 2012-2017	110
Figure 87	North America ABS Automotive Demand, 2012-2017	111
Figure 88	Western Europe ABS Automotive Demand, 2012-2017	113
Figure 89	Polycarbonate Demand in the Automotive Sector, 2012-2017	116
Figure 90	Polycarbonate Consumption per Vehicle, 2012-2017	116
Figure 91	China Polycarbonate Automotive Demand, 2012-2017	117



Figure 92	North America Polycarbonate Automotive Demand, 2012-2017.....	118
Figure 93	Western Europe Polycarbonate Automotive Demand, 2012-2017.....	119
Figure 94	PVC Demand in the Automotive Sector, 2012-2017	122
Figure 95	PVC Demand Per Vehicle, 2012-2017	123
Figure 96	China PVC Automotive Demand, 2012-2017.....	124
Figure 97	North America PVC Automotive Demand, 2012-2017.....	125
Figure 98	Western Europe PVC Automotive Demand, 2012-2017.....	126
Figure 99	PVB Consumption in Automotive Sector, 2012-2017.....	127
Figure 100	PVB Consumption per Vehicle, 2012-2017.....	127
Figure 101	PMMA Applications in Car.....	128
Figure 102	PMMA Consumption Automotive Sector, 2012-2017	129
Figure 103	PMMA Consumption per Vehicle, 2012-2017	129
Figure 104	Other Engineering Plastics Consumption Automotive Sector, 2012-2017	133
Figure 105	Other Engineering Plastics Consumption per Vehicle, 2012-2017	133
Figure 106	Structural Frame Parts of a Car.....	136
Figure 107	Battery Cell, Modules and Packs.....	137
Figure 108	Corvette 2016.....	140
Figure 109	Celstran PP Composite.....	141
Figure 110	GMC Sierra 2019.....	142
Figure 111	Corvette Stingray 2014	142
Figure 112	Henry Ford.....	143
Figure 113	Extruder/ Screw for Glass Fiber Addition	145
Figure 114	Auto Part Production from “Organosheet”.....	146
Figure 115	Renolit Composites.....	146
Figure 116	Injection Molded Auto Part	147
Figure 117	LED Light Components.....	149
Figure 118	World’s First Bio Based Car	152
Figure 119	Bio-composite Car	152
Figure 120	Automotive Recycling Process Flow.....	153
Figure 121	Typical Parts Recycled in Cars.....	155
Figure 122	Typical Recovery Option for Selected Polyurethane Automotive Applications	155
Figure 123	Recycled Plastics Used in Cars.....	157
Figure 124	Electric Vehicles Growth Projection, North America.....	160
Figure 125	Electric Vehicles Growth Projection, Western Europe.....	161
Figure 126	Electric Vehicles Growth Projection, China	162
Figure 127	Electric Vehicle Growth Projection, North America	168
Figure 128	Electric Vehicle Growth Projection, Western Europe.....	168
Figure 129	Electric Vehicle Growth Projection, China.....	169



Tables

Table 1	Typical Input Requirements for Selected Polyurethanes	80
Table 2	ABS Uses in Automotive/Transportation Sector.....	106
Table 3	Natural Fiber Composite Applications in Vehicles.....	144
Table 4	Vehicle Production Growth, 2012-2025	159
Table 5	Plastics Consumption in Automotive Sector, 2012-2025.....	163
Table 6	Plastics Consumption in Automotive Sector, 2012-2025.....	164
Table 7	Plastics Consumption in Automotive Sector, Western Europe	165
Table 8	Plastics Consumption in Automotive Sector, Western Europe	165
Table 9	Plastics Consumption in Automotive Sector, China	166
Table 10	Plastics Consumption in Automotive Sector, China	167
Table 11	North America Polymers Consumption, 2012-2025	169
Table 12	Western Europe Polymers Consumption, 2012-2025	170
Table 13	China Polymers Consumption, 2012-2025	171