Plastics and Polymer Composites in Light Vehicles

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Executive Summary

The $353 billion North American light vehicle industry represents an important sector of economy of both the United States and Canada and is a large end-use customer market for chemistry. In 2016, the 14.65 million light vehicles assembled in the United States and Canada required some 4.9 billion pounds of plastics and polymer composites valued at $5.7 billion, or $390 in every vehicle.

The latest data indicate that the average weight of US/Canadian light vehicles rose. In 2016, the use of plastics in light vehicles increased by about 75 million pounds. At an average of 332 pounds of plastic and composite per vehicle were used in 2016. Polypropylene, however, is also used in thermoplastics polyolefin elastomers (TPO) and its use in that area is reported separately under rubber. In addition, carbon fiber is utilized to manufacture carbon fiber reinforced plastics (CFRP) for automotive applications. Average TPO and carbon fiber use is about 35 pounds per vehicle and if they were included in plastics and polymer composites the total would be equivalent to about 367 pounds per vehicle. A change in consumer preferences for larger trucks and SUVs played a role. But because of low gas prices and the increased weight of the average vehicle, the percentage of total vehicle weight slipped slightly (at 8.3%) in 2016. Plastics and polymer composites are still essential to a wide range of safety and performance breakthroughs in today's cars, minivans, pickups and SUVs. In fact, the use of plastic and polymer composites in light vehicles has increased from less than 20 pounds per vehicle in 1960 to 332 pounds per car in 2016.

The role of plastics is actually much larger as these materials are compounded with colorant and other additives that impart functionality and other positive attributes. The value of these additives and compounding services along with value-added among producers of plastic automotive parts and components bring the market for finished automotive plastics and polymer composite products up to $20.8 billion in the United States. These automotive plastic products are produced at 1,618 plants located in 45 states. These plants directly employ about 61,836 people and feature a payroll of $3.1 billion.

Michigan is the leading state in terms of direct employment (over 15,125) and is followed by Ohio (over 8,758), Indiana (about 8,175), Tennessee (over 4,150), Minnesota (nearly 3,025), Pennsylvania (nearly 2,750), Wisconsin (over 2,275), Illinois (over 2,100), North Carolina (nearly 1,700), and New York (over 1,500).

Producers of automotive plastics and polymer composites purchase plastic resins, additives, other materials, components and services. As a result, the contributions of plastics and polymer composites go well beyond its direct economic footprint. The automotive plastics and polymer composites industry fosters economic activity indirectly through supply-chain purchases and through the payrolls paid both by the industry itself and its suppliers. This, in turn, leads to induced economic output as well. As a result, every job in the automotive plastics and polymer composites industry generates an additional job elsewhere in the US economy, for a total of nearly 117,000 jobs.

This year's edition includes initial estimates of plastics and polymer composite consumption in light vehicles for Mexico. The data are presented in appendix tables 1 and 2. Mexican light vehicle production totaled 3.47 million units in 2016. This is up from 1.98 million units in 2006. Vehicles assembled in Mexico tend to be smaller in size. In 2016, the Mexican market for plastics and polymer composites in OEM light vehicles totaled 880 million pounds.

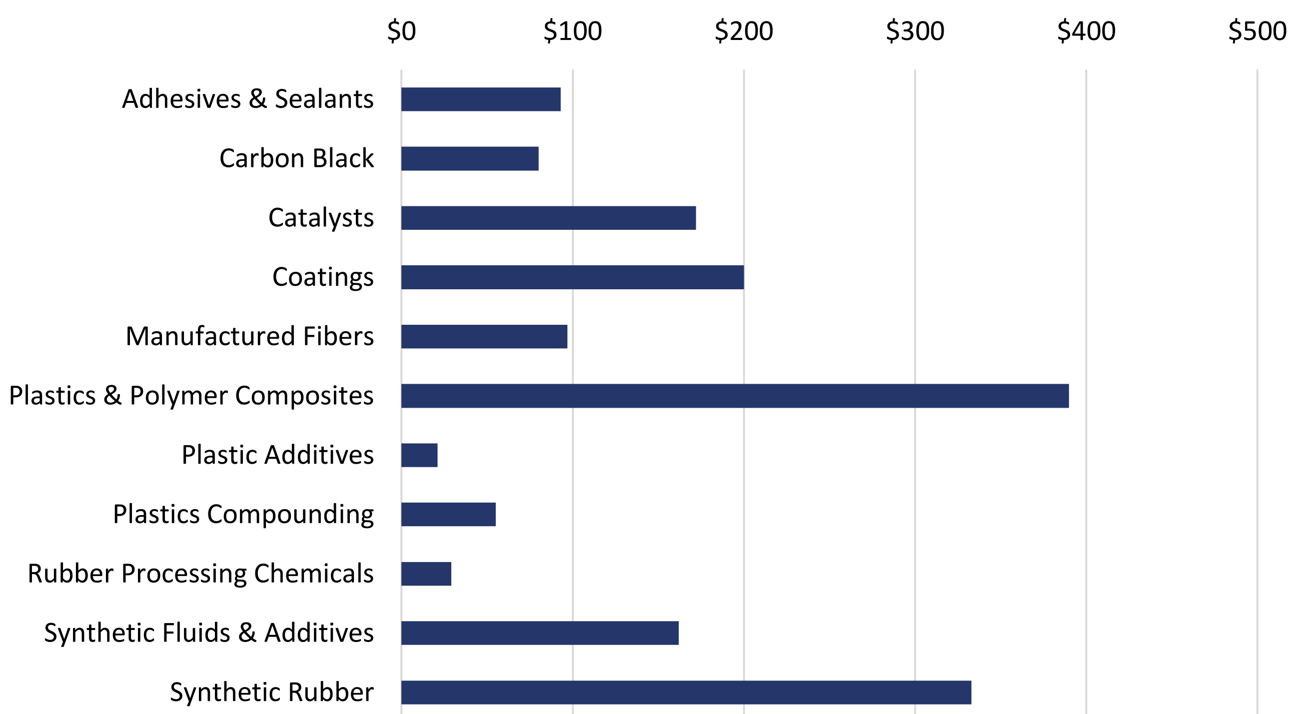
Introduction

This report presents the latest results of an assessment of the chemistry and other materials make-up of light vehicles, a major end-use customer for chemistry. With 14.65 million light vehicles assembled in the United States and Canada during 2016 this important market represents the equivalent of some $44.1 billion in chemistry. This chemistry value is up from $43.9 billion in 2015 when 14.38 million units were assembled. This 2016 value has increased significantly from the depths of the recession in 2009, when 6.94 million units were assembled and the associated chemistry value was $20.7 billion.

Chemistry and Light Vehicles

The light vehicle industry represents a large share of the economies of the United States and Canada, totaling more than $353 billion in shipments (at the manufacturer's level) in 2016 and employing 945,000 workers. The light vehicle industry continues to be an important customer for most manufacturing industries, including the chemical industry. This relationship is particularly strong in basic and specialty chemicals because every light vehicle produced in the United States and Canada contains $3,013 of chemistry (chemical products and chemical processing). The chemistry value per vehicle has grown considerably over the past 10 years, having grown 23% since 2006 when it was $2,444 per vehicle. With the weakness in oil prices and prices for most chemistry, average chemistry value fell 1.3% from 2015. Included in the chemistry value, for example, are antifreeze and other fluids, catalysts, plastic instrument panels and other components, rubber tires and hoses, upholstery fibers, coatings and adhesives. Virtually every component of a light vehicle, from the front bumper to the rear tail-lights features some chemistry.

Figure 1
Average Value of Direct Chemistry Content of US/Canada Light Vehicles in 2016 ($/vehicle)



Note: Data are for the US and Canada only. Mexico is excluded.

The average values of direct chemistry content in US/Canadian light vehicles in 2016 for a variety of segments of the business of chemistry are presented in Figure 1 (measured in dollars per vehicle). Only details on the direct chemistry value of materials are presented (the chemistry value from processing and other indirect chemistry is not displayed).

Table 1
Average Value of Chemistry Content of US/Canada Light Vehicles ($/vehicle)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Adhesives & Sealants	$71	$74	$78	$82	$84	$90	$92	$93	$94	$94	$93
Carbon Black	55	53	74	96	102	108	109	106	104	85	80
Catalysts	128	132	138	140	148	165	163	169	177	175	172
Coatings	131	140	143	163	168	177	175	179	198	200	200
Manufactured Fibers	108	103	108	131	118	116	109	111	110	101	97
Plastics/Polymer Composites	337	356	396	392	409	457	430	428	431	409	390
Plastic Additives	19	20	22	22	22	25	24	24	24	22	21
Plastics Compounding	43	48	53	53	54	62	58	59	60	57	55
Rubber Processing Chemicals	22	22	28	28	32	43	33	30	28	27	29
Synthetic Fluids & Additives	99	108	136	135	139	167	173	169	170	165	162
Synthetic Rubber	269	277	355	355	406	536	416	357	334	307	333
Materials	**$1,282**	**$1,334**	**$1,532**	**$1,596**	**$1,682**	**$1,946**	**$1,781**	**$1,725**	**$1,731**	**$1,641**	**$1,632**
Processing/Other Chemistry	1,162	1,084	1,441	1,388	1,492	1,690	1,757	1,756	1,760	1,412	1,381
Total Chemistry Content	**$2,444**	**$2,418**	**$2,973**	**$2,984**	**$3,174**	**$3,636**	**$3,538**	**$3,481**	**$3,491**	**$3,053**	**$3,013**

Note: Data are for the US and Canada only. Mexico is excluded.

The direct chemistry value during 2016 averaged $1,632 per vehicle, 54% of the total chemistry value. Details on chemistry used are presented in Table 1. The remaining 46% (or $1,381 per vehicle) was from processing and other indirect chemistry (for example, glass manufacture uses soda ash and other processing chemicals).

Materials and Light Vehicles

The light vehicle industry is an important customer for a number of metal and other materials manufacturing industries. For plastics and polymer composites in particular there is significant competition with other materials, especially aluminum and steel.

In 2016, average vehicle weight (of US/Canadian vehicles) increased by 0.9% (35 pounds) to 4,026 pounds. In 1990, average vehicle weight was 3,426 pounds. In 2000, the average vehicle weight was 3,922 pounds. The rising popularity of SUVs was a contributing factor in rising vehicle weight during the 1990s and for most of the last decade. Higher gasoline prices in 2008, however, prompted a reversal of this trend and a shift to smaller, more fuel-efficient vehicles. As a result, average vehicle weight slipped. An economic recovery and renewed popularity of larger vehicles in combination with lower gasoline prices then fostered increases in weight. Offsetting this is further penetration by plastics and composites and other lightweight materials which reduces average vehicle weight.

Table 2

Average Materials Content of US/Canada Light Vehicles (pound/vehicle)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Average Weight	**4,081**	**4,103**	**4,046**	**3,953**	**3,960**	**4,007**	**3,896**	**3,900**	**3,928**	**3,991**	**4,026**
Regular Steel	1,622	1,644	1,627	1,501	1,458	1,439	1,368	1,354	1,342	1,330	1,335
High- & Medium-Strength	502	518	523	524	555	608	619	627	649	701	742
Stainless Steel	73	75	75	69	72	73	68	74	73	75	74
Other Steels	34	34	33	31	32	32	30	32	32	32	32
Iron Castings	331	322	253	206	242	261	270	271	278	268	249
Aluminum	323	319	316	324	338	344	349	355	368	395	410
Magnesium	10	10	11	11	11	12	10	10	10	10	11
Copper and Brass	67	66	71	71	74	73	71	70	68	67	66
Lead	39	41	44	42	41	39	35	35	36	35	35
Zinc Castings	10	9	9	9	9	9	8	8	8	8	8
Powder Metal	42	43	43	41	41	42	44	45	46	45	44
Other Metals	5	5	5	5	5	5	5	5	4	5	5
Plastics/Polymer Composites	342	339	348	384	359	353	332	328	329	334	332
Rubber	198	192	204	245	228	223	205	198	196	198	199
Coatings	30	30	31	36	36	33	28	28	28	28	28
Textiles	47	46	48	58	56	50	49	50	49	45	44
Fluids and Lubricants	211	215	214	217	219	221	219	222	224	225	226
Glass	105	103	99	88	92	98	95	96	96	95	93
Other	89	92	91	90	92	93	91	92	93	95	92
As a Percent of Total Weight	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Regular Steel	39.7%	40.1%	40.2%	38.0%	36.8%	35.9%	35.1%	34.7%	34.2%	33.3%	33.2%
High- & Medium-Strength	12.3%	12.6%	12.9%	13.3%	14.0%	15.2%	15.9%	16.1%	16.5%	17.6%	18.4%
Stainless Steel	1.8%	1.8%	1.9%	1.7%	1.8%	1.8%	1.7%	1.9%	1.9%	1.9%	1.8%
Other Steels	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%
Iron Castings	8.1%	7.8%	6.3%	5.2%	6.1%	6.5%	6.9%	6.9%	7.1%	6.7%	6.2%
Aluminum	7.9%	7.8%	7.8%	8.2%	8.5%	8.6%	9.0%	9.1%	9.4%	9.9%	10.2%
Magnesium	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.2%	0.2%	0.3%
Copper and Brass	1.6%	1.6%	1.7%	1.8%	1.9%	1.8%	1.8%	1.8%	1.7%	1.7%	1.6%
Lead	1.0%	1.0%	1.1%	1.1%	1.0%	1.0%	0.9%	0.9%	0.9%	0.9%	0.9%
Zinc Castings	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Powder Metal	1.0%	1.0%	1.1%	1.0%	1.0%	1.0%	1.1%	1.2%	1.2%	1.1%	1.1%
Other Metals	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Plastics/Polymer Composites	8.4%	8.3%	8.6%	9.7%	9.1%	8.8%	8.5%	8.4%	8.4%	8.4%	8.3%
Rubber	4.8%	4.7%	5.1%	6.2%	5.8%	5.6%	5.3%	5.1%	5.0%	5.0%	4.9%
Coatings	0.7%	0.7%	0.8%	0.9%	0.9%	0.8%	0.7%	0.7%	0.7%	0.7%	0.7%
Textiles	1.2%	1.1%	1.2%	1.5%	1.4%	1.3%	1.3%	1.3%	1.2%	1.1%	1.1%
Fluids and Lubricants	5.2%	5.2%	5.3%	5.5%	5.5%	5.5%	5.6%	5.7%	5.7%	5.6%	5.6%
Glass	2.6%	2.5%	2.4%	2.2%	2.3%	2.4%	2.4%	2.5%	2.4%	2.4%	2.3%
Other	2.2%	2.2%	2.2%	2.3%	2.3%	2.3%	2.3%	2.4%	2.4%	2.4%	2.3%

Note: Polypropylene is also used in thermoplastics polyolefin elastomers (TPO) as well and its use in that area is reported separately under rubber. Average TPO use is about 35 pounds per vehicle. Data are for the US and Canada only. Mexico is excluded.

The performance of vehicles has improved significantly over the years. According to EPA data, for example, the average horsepower (HP) of model 2016 vehicles in the United States was 229 HP, compared to 214 HP In 2010, 181 HP in 2000 and 135 HP in 1990. Average fuel efficiency now averages 25.6 miles per gallon (MPG) compared to 22.6 MPG in 2010, 19.8 MPG in 2000 and 21.2 MPG in 1990. Although vastly improved engine technologies have played a role, so have chemistry and lightweight materials.

Regular steel and high- and medium-strength steel are the dominant materials in light vehicles. Combined, this steel accounts for 52% of vehicle weight. High- and medium-strength steel have been gaining share away from regular steel. In addition, hot-stamping offers many advantages and has supported steel use. Other steel and iron castings have generally lost share. Combined, all iron and steel (including castings) accounted for slightly over 60% of average vehicle weight, up from less than 60% in 2010, but down from 65% in 2000 and 70% in 1990.

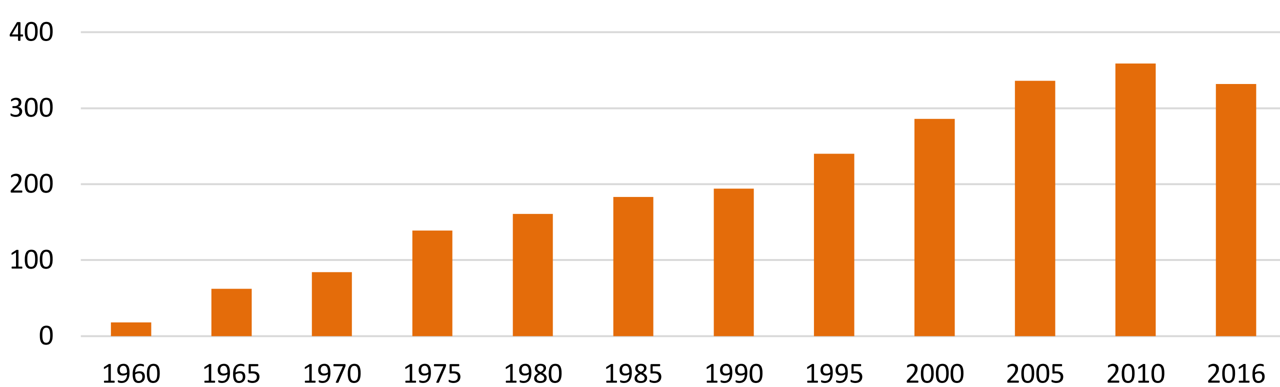
Over the last several decades, lightweight materials have gained share away from iron and steel. For example, aluminum gained share in 2016, rising 3.8% (or 15 pounds) to an average of 410 pounds per vehicle. This is largely the result of the newly redesigned F-150 truck. Aluminum use represented 10.2% of average vehicle weight, up from 8.5% in 2010, 6.9% in 2000 and 4.7% in 1990. During this period, other lightweight materials such as magnesium and plastics and composites have also gained market share away from iron castings, steel, lead, and other heavier materials. Details on materials used are presented in Table 2. Additional metals include copper and brass, lead, and zinc, and others in both powder and solid form. Glass, rubber, coatings, textiles, fluids and lubricants, and other materials round out the composition of a typical light vehicle.

Plastics and Polymer Composites in Light Vehicles

Light vehicles represent an important market for plastics and polymer composites, one that has grown significantly during the last five decades. The average US/Canadian light vehicle now contains 332 pounds of plastics and polymer composites, 8.3% of the total weight. This is down from 359 pounds in 2010, but up from 286 pounds in 2000 and 194 pounds in 1990. In 1960, less than 20 pounds were used. The typical light vehicle may contain over than 1,000 plastic parts.

Figure 2

Long-Term Trends in US/Canada Light Vehicle Plastics & Polymer Composites Use (pounds/vehicle)



Note: Data are for the US and Canada only. Mexico is excluded.

Composites are any combination of polymer matrix and fibrous reinforcement. Glass, carbon, aramid, and other fibers provide strength and stiffness while the polymer matrix (or resin) of polyester, polyurethane, epoxy, polypropylene, nylon, or other resin protects and transfers loads between fibers. This creates a material with attributes superior to polymer or fiber alone. In recent years, carbon fiber-reinforced composites have made inroads into light vehicle applications.

Plastics and polymer composites have been essential to a wide range of safety and performance breakthroughs in today's cars, minivans, pickups and SUVs. Today's plastics typically make up 50% of the volume of a new light vehicle but less than 10% of its weight, which helps make cars lighter and more fuel efficient, resulting in lower greenhouse gas emissions. Tough, modern plastics and polymer composites also help improve passenger safety and automotive designers rely on the versatility of plastics and polymer composites and the aesthetic possibilities when designing today's vehicles. In addition, many plastic resins are recyclable.

- **Automotive Body Exterior -** Plastics and polymer composites have revolutionized the design of body exteriors. From bumpers to door panels, light weight plastic provides vehicles with better gas mileage and allows designers and engineers the freedom to create innovative concepts that otherwise would be impossible. In the past, metals were synonymous with auto body exterior design and manufacturing. However, they are susceptible to dents, dings, stone chips and corrosion. They are also heavier and more expensive than plastics. Specifying plastics and composites for automotive body exterior panels and parts allows manufacturers to adopt modular assembly practices, lower production costs, improve energy management, achieve better dent resistance, and use advanced styling techniques for sleeker, more aerodynamic exteriors.

- **Automotive Interior -** The elements of automotive interior design -- comfort, noise level, aesthetic appeal, ergonomic layout, and durability -- have a great effect on a consumer's purchasing decision. Plastic automotive interior parts address all of these aspects, and more, in a remarkably effective and efficient manner.

- **Automotive Safety -** The versatility of plastics allows design options that reduce vehicle weight while producing safer vehicles. Included are plastic composite structures in the front end of a vehicle that reduce vehicle weight without compromising safety and plastic components in crumple zones that help absorb energy while lowering vehicle weight. Plastics are also used in door modules to maintain or improve side impact safety, plastic layers in automotive safety glass prevent passenger injuries, and plastic foams can add strength to automotive body cavities and increase occupant safety in vehicles.

- **Automotive Electrical Systems –** Over the last 20 years, the electrical systems of light vehicles have undergone a major revolution. Automotive electrical and electronic system components are now more numerous and important with computer chips regulating and monitoring ABS brakes, fuel injection, and oxygen sensors, GPS navigation equipment, obstacle sensors, state-of-the-art audio systems, and other systems. Plastics make possible the inclusion, operation, interconnection and housing of sockets, switches, connectors, circuit boards, wiring and cable, and other electrical and electronic devices.

- **Automotive Chassis -** A chassis is the supporting frame of a light vehicle. It gives the vehicle strength and rigidity, and helps increase crash-resistance through energy absorption. The chassis is especially important in ensuring low levels of noise, vibration and harshness (NVH) throughout the vehicle. Not only does a reduction in NVH allow for a more pleasant driving experience, but by putting less stress on connecting components it can help increase the life span of these components. The key determinant permitting reduced levels of NVH is energy absorption. As a result, passenger protection can be enhanced in the event of a collision. Plastics are making inroads into the chassis market. Innovations in plastic technology have brought about the development of successful chassis applications and structure, support and suspension performance.

- **Automotive Powertrains -** The powertrain is one of a light vehicle's most complicated parts. The term "powertrain" refers to the system of bearings, shafts, and gears that transmit the engine's power to the axle. Included are composite drive shafts that increase torque. Plastics help reduce the number of parts needed to assemble these complex components. Plastics also help reduce vehicle weight, which helps lower assembly costs while increasing fuel efficiency. For example, the utilization of lightweight plastics in a vehicle can allow manufacturers to utilize smaller, lighter weight engines.

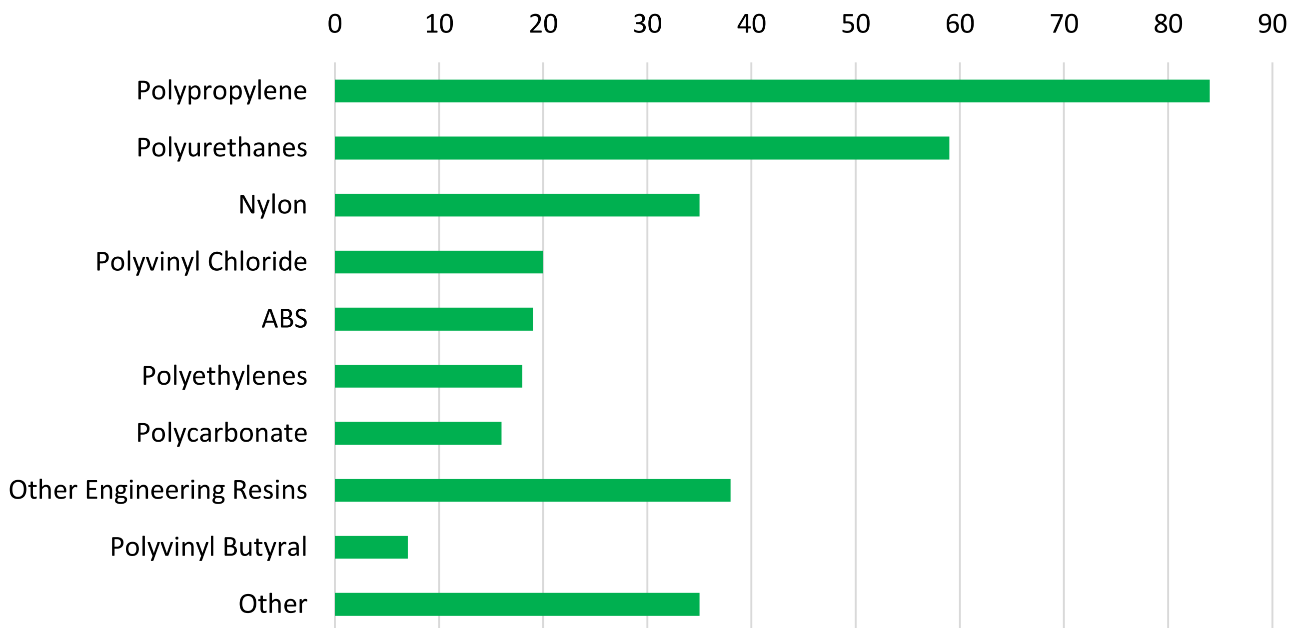
- **Automotive Fuel Systems -** For automotive fuel system components, plastics have several advantages that enable it to outperform metals. Plastic frees engineers from the design constraints that metal imposes. Plastic's light weight makes vehicles more fuel-efficient and from a safety standpoint, rupture-resistant plastics with high impact strength are helping keep automotive fuel tanks and related delivery systems leak-proof, corrosion-resistant, and reliable.

- **Automotive Engine Components -** Many of today's automotive engine components are plastic. From air-intake manifolds and systems to cooling systems to valve covers and other engine parts, plastic helps make engine systems easier to design, easier to assemble, and lighter in weight. Plastics' versatility has revolutionized automotive engine component design.

The automotive market is an important market for plastic resins such as polypropylene, polyurethane, nylon (polyamides), other engineering polymers, and thermoplastic polyesters. Light vehicle applications account for over 30% of the demand for each resin. Other resins include ABS and polyvinyl butyral. For the latter resin which is used in safety glass, the automotive market accounts for over 85% of total demand. Engineering polymers such as nylon, polycarbonate (and polycarbonate blends) and others are supplanting metals in many applications. Typical plastics and composite applications include exterior panels, trim, and bumper fascia, as well as interior trim panels, window encapsulation, headlamp housings, manifolds and valve covers, electronic/electric parts and components, wiring harnesses, steering wheels, insulation, dampening and deadeners, upholstery, mechanical parts and components, safety glass, and myriad other uses.

Average plastics and composites per vehicle use (in US/Canadian vehicles assemblies) slipped two pounds (0.6%) to 332 pounds in 2016, and plastics and composites lost some share of the overall weight of a typical vehicle. Over 15 major resins find significant use in light vehicles. Details on resin use are presented in Tables 3 and 4. Major polymers used in light vehicles include on average 84 pounds of polypropylene (PP), 59 pounds of polyurethanes, 35 pounds of nylon, 20 pounds of polyvinyl chloride (PVC), 19 pounds of acrylonitrile-butadiene-styrene (ABS), 18 pounds of polyethylene resins, and 16 pounds of polycarbonate resins.

Figure 3
Average Plastics & Polymer Composites Use in US/Canadian Light Vehicles in 2016 (pounds/vehicle)



Note: Data are for the US and Canada only. Mexico is excluded.

Polypropylene is also used in thermoplastics polyolefin elastomers (TPO) as well and its use in that area is reported separately under rubber. Average TPO use (in US/Canadian light vehicle assemblies) is about 35 pounds per vehicle and if it were included in plastics and polymer composites the total would be the equivalent of nearly 370 pounds per vehicle.

Table 3
Average Large Volume Plastics Content of US/Canadian Light Vehicles (pounds per vehicle)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Total Plastic/Composites	**342**	**339**	**348**	**384**	**359**	**353**	**332**	**328**	**329**	**334**	**332**
Polypropylene	81	80	79	83	88	88	86	84	85	85	84
Polyurethanes	59	56	57	59	58	59	56	55	59	60	59
Nylon	41	42	42	44	39	39	37	36	36	36	35
Polyvinyl Chloride	27	28	29	40	31	26	23	22	21	20	20
ABS	23	22	24	28	24	22	19	18	17	18	19
Polyethylenes	14	15	17	19	18	18	18	17	17	18	18
Polycarbonate	15	15	18	22	19	18	17	16	16	16	16
Other Engineering Resins	42	42	42	47	40	39	36	37	37	38	38
Polyvinyl Butyral	7	7	7	7	7	7	7	7	7	7	7
Other	33	32	34	36	35	36	35	35	34	35	35
Total Plastic/Composites	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Polypropylene	23.8%	23.6%	22.7%	21.5%	24.6%	25.1%	25.9%	25.8%	25.8%	25.5%	25.4%
Polyurethanes	17.2%	16.6%	16.3%	15.4%	16.3%	16.6%	16.8%	16.9%	18.0%	18.1%	17.9%
Nylon	12.0%	12.4%	12.1%	11.4%	10.8%	11.2%	11.2%	11.0%	11.0%	10.9%	10.7%
Polyvinyl Chloride	8.0%	8.1%	8.3%	10.3%	8.6%	7.5%	6.9%	6.7%	6.3%	6.0%	6.2%
ABS	6.8%	6.5%	6.8%	7.3%	6.6%	6.2%	5.6%	5.5%	5.3%	5.4%	5.8%
Polyethylenes	4.0%	4.4%	4.8%	4.8%	4.9%	5.0%	5.3%	5.3%	5.1%	5.3%	5.4%
Polycarbonate	4.2%	4.5%	5.1%	5.7%	5.2%	5.1%	5.1%	5.0%	4.8%	4.8%	4.8%
Other Engineering Resins	12.2%	12.3%	11.9%	12.3%	11.1%	11.1%	10.8%	11.2%	11.3%	11.4%	11.4%
Polyvinyl Butyral	2.1%	2.2%	2.2%	1.9%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Other	9.6%	9.3%	9.8%	9.4%	9.8%	10.2%	10.4%	10.6%	10.3%	10.5%	10.6%

Note: Polypropylene is also used in thermoplastics polyolefin elastomers (TPO) as well but its use in that area is reported separately under rubber in Table 2. TPO use averages about 35 pounds per vehicle. Polypropylene resin applications include Interior trim, under-the-hood components, HVAC components, battery cases, and other OEM uses. Data are for the US and Canada only. Mexico is excluded.

Over the last two decades, other engineering resins such as polyacetal, polyphenylene ether (PPE), and thermoplastic polyester engineering resins have supplanted metals in a number of applications. Average use of these resins was 38 pounds (in US/Canadian light vehicle assemblies) in 2016, off from 40 pounds in 2010, but up from 31 pounds in 2000 and 19 pounds in 1990. Polycarbonate and nylon are also classified as engineering resins (as are some ABS grades) and if polycarbonate and nylon resins were included, total engineering resin consumption would be 89 pounds. An average of seven pounds are polyvinyl butyral are used. Additional resins such as acrylics, phenolics, unsaturated polyester, and others account for the remaining 35 pounds.

Table 4
Average Engineering & Other Plastics Content of US/Canadian Light Vehicles (pounds per vehicle)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Other Engineering Resins	**42**	**42**	**42**	**47**	**40**	**39**	**36**	**37**	**37**	**38**	**38**
Polyacetal	6	6	6	8	6	5	4	5	5	5	4
Polyphenylene Ether (PPE)	13	13	14	12	13	13	13	13	14	14	14
Thermoplastic Polyester Engineering Resins	20	20	19	24	18	17	16	16	16	17	17
All Other Engineering Resins	2	2	3	3	3	3	3	3	3	3	3
Other Plastic/Composites	**33**	**32**	**34**	**36**	**35**	**36**	**35**	**35**	**34**	**35**	**35**
Acrylics	5	5	5	5	4	4	4	5	5	5	5
Phenolics	10	10	11	11	13	13	12	12	12	12	12
Unsaturated Polyester	14	13	13	15	13	13	13	13	12	13	13
All Other Resins	4	4	5	6	6	6	5	5	5	6	6

Note: Data are for the US and Canada only. Mexico is excluded.

Additional opportunities to reduce weight with plastics and polymer composites are possible. These include: 1) reducing the weight of existing plastic and composite parts with the use of low density additives, nanoparticles, and alternate fibers; and 2) converting more metal parts to plastics and composites. Furthermore, industry mega trends for future mobility, including self-driving vehicles and ride-sharing platforms will create numerous unique opportunities for plastics and composites due to increased safety requirements and new vehicle architectures. As a result, the light vehicle market presents significant opportunities for further diffusion of plastics and composites in the future.

Other Chemical Products and Light Vehicles

A variety of other products of chemistry are used in the manufacture of light vehicles. Most chemistry is used in processing and other indirect chemistry (e.g., soda ash in glass manufacture) but also over 270 pounds of rubber, textiles and coatings are used (in US/Canadian light vehicle assemblies) as well.

The typical US/Canadian light vehicle utilizes, on average, 199 pounds of rubber, mainly in tires but also in non-tire applications such as belts and hoses, and other components. Natural rubber is used but by far the most widely used rubber is styrene-butadiene rubber (SBR) which is used in tire and a variety of non-tire applications. Common uses include radiator and heater hoses, various body and chassis parts, bumpers, weather-stripping, door and window seals, mats, grommets, tubes, fan belts and various molded and extruded goods. Thermoplastic polyolefin elastomers (TPO) are another widely used elastomer. Applications include a wide variety of exterior, interior and under-the-hood and chassis applications. Combined, natural rubber, SBR and TPO elastomers account for three-fourths of overall rubber consumption. Other elastomers include butyl rubber, chlorinated polyethylene, chlorosulfonated polyethylene, copolyester-ether, ethylene-propylene, nitrile, polybutadiene, polychloroprene (neoprene), polyisoprene, polyurethane, silicone, styrenic thermoplastics and other elastomers. Changes in tire design since the 1970s have resulted in less vehicle weight devoted to tires, resulting in some fuel savings since then. In recent years, longer-lasting, low- rolling-resistance tires and new materials have been developed and as these products penetrate markets, fuel performance should be enhanced.

The typical US/Canadian light vehicle utilizes 44 pounds of manufactured fibers, primarily synthetic fibers. Very few natural fibers are used and rayon and melamine fiber use has largely disappeared. Most notable synthetic fibers are traditional woven fibers of nylon and polyester but also non-woven fabrics of polypropylene and polyester used in various facings, backings, liners, acoustic panels, reinforcements and panels, and automotive filters. These fibers are derived from hydrocarbons. In recent years, traditional textiles are being supplanted by polyurethanes. Carbon fiber is typically blended with plastics to create carbon fiber reinforced plastics (CFRP) for automotive applications. Carbon fiber's high-strength but very low weight properties can play a major role in automakers' efforts to reduce vehicle weight. This is becoming increasingly important as manufacturers strive to meet fuel economy targets of 54.5 mpg by 2025.

The typical US/Canadian light vehicle also featured 28 pounds of coatings (dry weight) in 2016. In automotive applications, coatings enhance value by making the vehicle attractive and protecting it. Without coatings, vehicles would quickly rust, be dull in appearance, and have a very short service life. Light vehicle applications include topcoats, primers and coatings for underbody components and include solvent-borne, water-borne and powder coatings. Powder coatings are based mainly on epoxy and polyester resins, which upon heating react with curing agents to form very durable coatings that emit virtually zero VOCs (volatile organic compounds). These have gained in use relative to traditional solvent-borne coatings in recent decades. Coatings use has declined in recent years because of reduced waste generation during application, thinner coatings, and the switch to higher solids coatings as well as greater plastics and polymer composite use.

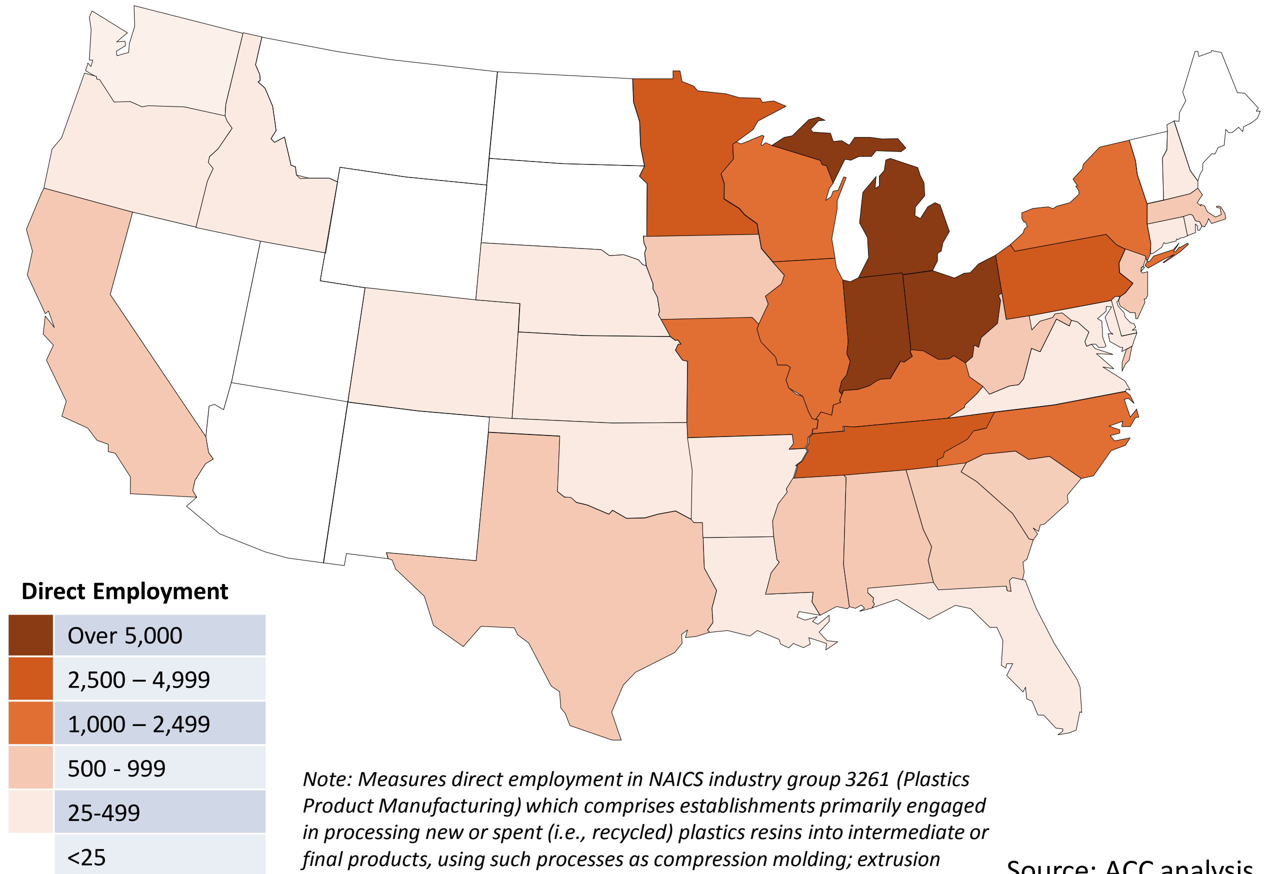
In addition to these materials, chemistry also plays a role in the 226 pounds of fluids and lubricants that a typical light vehicle contains. These include engine oil lubricants, transmissions fluids, windshield wiper fluids, refrigerants for air conditioners, and other products. All of these contain chemical additives to enhance performance while others such as fluorocarbon refrigerants are products of chemistry. In engine oil lubricants, synthetic lubricants are gaining market share away from traditional petroleum products.

Economic Footprint of Automotive Plastics and Polymer Composites in the USA

Light vehicles represent an important market for plastics and polymer composites, one that has grown significantly during the last five decades. The following analysis assesses the jobs (by state) associated with plastic products used in automotive applications in the United States. It measures jobs (and shipment value and the value of wages and salaries) by state at the level of plastic product manufacturing. That is, at the level of North American Industry Classification System (NAICS) industry group 3261 (Plastics Product Manufacturing) which comprises establishments primarily engaged in processing new or spent (i.e., recycled) plastics resins into intermediate or final products, using such processes as compression molding; extrusion molding; injection molding; blow molding; and casting.

Table 5 contains data on 2016 jobs by state as well as shipment and wages and salaries values for automotive plastic products. Shipments measure the value of these finished or fabricated products used in these automotive applications by establishments in NAICS industry group 3261 and produced within that state. In addition to direct employment, the analysis also measures indirect employment supported by the automotive plastic products sector via purchases from its supply chain and induced employment from the spending of those employed directly or indirectly by the automotive plastic products sector.

Figure 4
Automotive Plastics & Polymer Composites Direct Employment by State (2016)



Note: Measures direct employment in NAICS industry group 3261 (Plastics Product Manufacturing) which comprises establishments primarily engaged in processing new or spent (i.e., recycled) plastics resins into intermediate or final products, using such processes as compression molding; extrusion molding; injection molding; blow molding; and casting.

Source: ACC analysis

The analysis is based on plastic processing volume data compiled by Townsend Solutions and data from the Bureau of Labor Statistics and the Census Bureau. The state data are for 2016:

- The value of automotive plastic products produced in the United States was $20.8 billion.
- These automotive plastic products are produced at 1,618 plants located in 45 states.
- These plants directly employ over 61,836 people and feature a payroll of $3.1 billion.
- Michigan is the leading state in terms of direct employment (over 15,125) and is followed by Ohio (over 8,758), Indiana (about 8,175), Tennessee (over 4,150), Minnesota (nearly 3,025), Pennsylvania (nearly 2,750), Wisconsin (over 2,275), Illinois (over 2,100), North Carolina (nearly 1,700), and New York (over 1,500).

The economic contributions of the US automotive plastics industry are numerous, though often overlooked in traditional analyses that consider only the direct jobs and output of the industry. Not only are jobs created directly by the industry, additional jobs are supported by the US automotive plastics industry and by subsequent expenditure-induced activity. The US automotive plastics industry pays its employees' wages and salaries and purchased supplies and services (including transportation, contract workers, warehousing, maintenance, accounting, etc.). These supplier businesses, in turn, made purchases and paid their employees, thus the US automotive plastics industry generates several rounds of economic spending and re-spending.

In addition to the direct effects of the US automotive plastics industry, the indirect and induced effects on other sectors of the economy can also be quantified. The economic impact of an industry is generally manifested through four channels:

- Direct impacts - Such as the employment, output and fiscal contributions generated by the sector itself
- Indirect impacts - Employment and output supported by the sector via purchases from its supply chain
- Induced impacts - Employment and output supported by the spending of those employed directly or indirectly by the sector
- Spillover (or catalytic) impacts - The extent to which the activities of the relevant sector contribute to improved productivity and performance in other sectors of the economy

This report presents the jobs created that are related to the first three channels. Spillover (or catalytic) effects do occur from, but these positive externalities are difficult to accurately quantify and were not examined in the analysis.

To estimate the economic impacts from the US automotive plastics industry, the IMPLAN model was used. The IMPLAN model is an input-output model based on a social accounting matrix that incorporates all flows within an economy. The IMPLAN model includes detailed flow information for 440 industries. As a result, it is possible to estimate the economic impact of a change in final demand for an industry at a relatively fine level of granularity. For a single change in final demand (i.e., change in industry spending), IMPLAN can generate estimates of the direct, indirect and induced economic impacts. Direct impacts refer to the response of the economy to the change in the final demand of a given industry to those directly involved in the activity. Indirect impacts (or supplier impacts) refer to the response of the economy to the change in the final demand of the industries that are dependent on the direct spending industries for their input. Induced impacts refer to the response of the economy to changes in household expenditure as a result of labor income generated by the direct and indirect effects.

An input-output model such as IMPLAN is a quantitative economic technique that quantifies the interdependencies between different industries (or sectors) of a national economy. Although complex, the input-output model is fundamentally linear in nature and as a result, facilitates rapid computation as well as flexibility in computing the effects of changes in demand. In addition to studying the structure of national economies, input-output analysis has been used to study regional economies within a nation, and as a tool for national and regional economic planning. A primary use of input-output analysis is for measuring the economic impacts of events, public investments or programs such as base closures, infrastructure development, or the economic footprint of a university or government program. The IMPLAN model is used by the Army Corp of Engineers, Department of Defense, Environmental Protection Agency, and over 20 other agencies, numerous government agencies in over 40 states, over 250 colleges and universities, local government, non-profits, consulting companies, and other private sector companies.

As shown in Table 5, the direct output and employment generated by the US automotive plastics industry is significant. The $20.8 billion industry directly generated over 61,836 jobs and $3.1 billion in payroll. But the full economic impact of the industry goes well beyond the direct jobs and output. Businesses in the automotive plastics and polymer composites industry purchase plastic resins, plastic additives, other raw materials, compounding and other services, and other products throughout the supply chain. Thus, nearly 20,775 indirect jobs are supported by US automotive plastics and polymer composites operations. Finally, the wages earned by workers in the automotive plastics and polymer composites industry and throughout the supply chain are spent on household purchases and taxes generating nearly 34,175 payroll-induced jobs. All told, the $20.8 billion in automotive plastics output generates a total of nearly 117,000 jobs. As a result, each job in the automotive plastics industry generates an additional job elsewhere in the US economy. These data are shown in Table 6.

Table 5
US Automotive Plastics & Polymer Composites Direct Jobs, Output and Wages & Salaries by State (2016)

State	Shipments ($ million)	Shipments/ Person	Payroll ($ million)	Wages/ Person	Direct Employment
AL	$343	$373,316	$40	$43,350	918
AR	$48	$318,329	$7	$44,278	151
CA	$293	$367,837	$41	$51,499	796
CO	$20	$246,632	$5	$56,062	83
CT	$51	$295,105	$10	$59,141	174
FL	$48	$315,154	$7	$47,218	152
GA	$235	$427,049	$28	$50,895	551
IL	$738	$350,227	$125	$59,165	2,107
IN	$2,239	$273,846	$385	$47,058	8,175
IA	$233	$295,865	$38	$47,859	787
KS	$91	$352,941	$11	$44,081	258
KY	$567	$415,403	$66	$48,135	1,364
MD	$29	$315,846	$6	$67,224	92
MA	$286	$376,476	$49	$64,149	760
MI	$5,290	$349,538	$793	$52,425	15,135
MN	$800	$265,443	$160	$53,176	3,012
MS	$295	$334,052	$36	$40,948	883
MO	$268	$231,701	$55	$47,521	1,158
NE	$15	$297,274	$2	$43,213	50
NH	$51	$183,179	$15	$55,595	278
NJ	$163	$289,667	$32	$56,907	563
NY	$547	$363,714	$78	$51,815	1,505
NC	$515	$303,402	$81	$47,995	1,697
OH	$3,222	$367,897	$408	$46,562	8,758
OK	$15	$407,237	$2	$47,270	38
OR	$18	$279,020	$3	$49,201	65
PA	$850	$309,455	$138	$50,385	2,746
SC	$468	$492,893	$53	$55,760	949
TN	$1,528	$367,689	$195	$46,816	4,155
TX	$401	$444,996	$46	$51,275	902
VA	$108	$404,529	$15	$56,155	267
WA	$21	$294,097	$4	$49,851	72
WV	$147	$241,077	$25	$41,207	608
WI	$628	$275,673	$111	$48,674	2,278
Other	$218	$625,855	$16	$46,297	349
Total	**$20,790**	**$336,205**	**$3,086**	**$49,907**	**61,836**

Sources: ACC analysis based on data from the Bureau of Labor Statistics, the Census Bureau, and Townsend Solutions.

Table 6
US Automotive Plastics & Polymer Composites Direct, Indirect and Induced Jobs by State (2016)

State	Direct Employment	Indirect Employment	Induced Employment	Total Employment	Jobs Multiplier
AL	918	281	406	1,605	1.7
AR	151	39	50	241	1.6
CA	796	332	446	1,574	2.0
CO	83	22	36	141	1.7
CT	174	50	73	297	1.7
FL	152	60	87	300	2.0
GA	551	179	298	1,028	1.9
IL	2,107	744	1,426	4,278	2.0
IN	8,175	2,248	4,155	14,578	1.8
IA	787	198	312	1,297	1.6
KS	258	65	105	428	1.7
KY	1,364	415	577	2,357	1.7
MD	92	26	54	173	1.9
MA	760	245	420	1,425	1.9
MI	15,135	5,866	10,154	31,155	2.1
MN	3,012	1,069	1,813	5,893	2.0
MS	883	206	316	1,405	1.6
MO	1,158	376	584	2,118	1.8
NE	50	14	20	84	1.7
NH	278	83	181	542	2.0
NJ	563	202	271	1,036	1.8
NY	1,505	346	382	2,232	1.5
NC	1,697	531	861	3,089	1.8
OH	8,758	3,054	4,700	16,511	1.9
OK	38	10	15	63	1.7
OR	65	25	36	126	1.9
PA	2,746	913	1,546	5,205	1.9
SC	949	287	480	1,716	1.8
TN	4,155	1,302	1,991	7,449	1.8
TX	902	440	572	1,914	2.1
VA	267	77	121	465	1.7
WA	72	27	35	134	1.9
WV	608	151	191	949	1.6
WI	2,278	774	1,301	4,353	1.9
Other	349	114	156	620	1.8
Total	**61,836**	20,774	34,172	116,782	1.9

Sources: ACC analysis based on data from the Bureau of Labor Statistics, the Census Bureau, and Townsend Solutions.

Appendix: Data on Mexico Plastics & Polymer Composites Consumption

This year's edition includes initial estimates of plastics and polymer composite consumption in light vehicles for Mexico. The data are presented in appendix tables 1 and 2. Mexican light vehicle production totaled 3.47 million units in 2016. This is up from 1.98 million units in 2006. Vehicles assembled in Mexico tend to be smaller in size. In 2016, the Mexican market for plastics and polymer composites in OEM light vehicles totaled 880 million pounds.

Appendix Table 1
Average Large Volume Plastics Content of Mexican Light Vehicles (pounds per vehicle)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Total Plastic/Composites	**262**	**259**	**265**	**293**	**274**	**269**	**253**	**250**	**251**	**254**	**253**
Polypropylene	62	61	60	63	67	67	65	64	65	65	64
Polyurethanes	45	43	43	45	45	45	43	43	45	46	45
Nylon	32	32	32	34	30	30	28	28	28	28	27
Polyvinyl Chloride	21	21	22	30	24	20	18	17	16	16	16
ABS	18	17	18	21	18	17	14	13	13	14	14
Polyethylenes	11	12	13	14	14	14	14	13	13	14	14
Polycarbonate	11	12	13	16	14	14	13	12	12	12	12
Other Engineering Resins	32	32	31	36	30	29	27	27	28	28	28
Polyvinyl Butyral	5	6	6	6	5	5	5	5	5	6	6
Other	25	24	26	27	27	28	27	27	26	27	27
Total Plastic/Composites	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Polypropylene	23.8%	23.6%	22.7%	21.5%	24.6%	25.0%	25.8%	25.7%	25.8%	25.5%	25.3%
Polyurethanes	17.3%	16.7%	16.3%	15.4%	16.3%	16.7%	16.9%	17.1%	18.1%	18.2%	17.9%
Nylon	12.1%	12.4%	12.2%	11.5%	10.9%	11.2%	11.2%	11.1%	11.0%	10.9%	10.7%
Polyvinyl Chloride	8.1%	8.2%	8.4%	10.4%	8.7%	7.6%	7.0%	6.8%	6.4%	6.1%	6.2%
ABS	6.8%	6.4%	6.7%	7.2%	6.5%	6.2%	5.5%	5.4%	5.2%	5.3%	5.7%
Polyethylenes	4.0%	4.4%	4.9%	4.9%	5.0%	5.0%	5.4%	5.4%	5.2%	5.3%	5.5%
Polycarbonate	4.2%	4.5%	5.0%	5.6%	5.2%	5.1%	5.0%	4.9%	4.7%	4.7%	4.6%
Other Engineering Resins	12.1%	12.2%	11.8%	12.1%	11.0%	10.9%	10.6%	11.0%	11.1%	11.1%	11.1%
Polyvinyl Butyral	2.1%	2.2%	2.2%	2.0%	2.0%	2.0%	2.1%	2.1%	2.2%	2.2%	2.2%
Other	9.6%	9.3%	9.9%	9.4%	9.9%	10.2%	10.5%	10.6%	10.4%	10.6%	10.7%

Note: Polypropylene is also used in thermoplastics polyolefin elastomers (TPO) as well but its use in that area is reported separately under rubber. Polypropylene resin applications include Interior trim, under-the-hood components, HVAC components, battery cases, and other OEM uses.

Appendix Table 2
Average Engineering & Other Plastics Content of Mexican Light Vehicles (pounds per vehicle)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Other Engineering Resins	**32**	**32**	**31**	**36**	**30**	**29**	**27**	**27**	**28**	**28**	**28**
Polyacetal	5	5	5	6	4	4	3	4	3	3	3
Polyphenylene Ether (PPE)	10	10	10	9	10	10	10	10	10	10	10
Thermoplastic Polyester Engineering Resins	16	15	14	18	14	13	12	12	12	12	13
All Other Engineering Resins	2	2	2	2	2	2	2	2	2	2	2
Other Plastic/Composites	**25**	**24**	**26**	**27**	**27**	**28**	**27**	**27**	**26**	**27**	**27**
Acrylics	4	4	4	4	3	3	3	4	4	4	4
Phenolics	7	7	9	8	10	10	9	9	9	9	9
Unsaturated Polyester	11	10	10	11	10	10	10	10	9	10	10
All Other Resins	3	3	4	5	4	4	4	4	4	4	4

With initial estimates of plastics and polymer composite consumption in light vehicles for Mexico it is possible to fold the data into the previously reported US/Canadian data to present an estimate of NAFTA. In 2016, the NAFTA market for plastics and polymer composites in OEM light vehicles totaled 5.76 billion pounds.

NAFTA (US, Canada and Mexico) light vehicle production totaled 18.12 million units in 2016. This is up from 15.34 million units in 2006**.** The data are presented in appendix tables 3 and 4.

The Mexico/NAFTA data are not additive but based on consumption divided by assemblies. The figures in the tables are based on average volumes per vehicle. Vehicles assembled in Canada and the US tend to be heavier due to higher volumes of trucks and SUVs and so plastics use per vehicle is higher. Vehicles assembled in Mexico tend to be smaller and so plastics use per vehicle is lower. The NAFTA figures represent an average of all vehicles assembled in the three nations, both the heavier figures and lighter figures, with the average for overall NAFTA being somewhere between the averages for US, Canada and Mexico.

Appendix Table 3
Average Large Volume Plastics Content of NAFTA Light Vehicles (pounds per vehicle)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Total Plastic/Composites	**332**	**328**	**334**	**368**	**343**	**336**	**317**	**314**	**315**	**319**	**318**
Polypropylene	79	78	76	79	84	84	82	81	81	81	80
Polyurethanes	57	55	54	57	56	56	53	53	57	58	57
Nylon	40	41	41	42	37	38	35	35	35	35	34
Polyvinyl Chloride	27	27	28	38	30	25	22	21	20	19	20
ABS	23	21	23	27	23	21	18	17	17	17	18
Polyethylenes	13	15	16	18	17	17	17	17	16	17	17
Polycarbonate	14	15	17	21	18	17	16	16	15	15	15
Other Engineering Resins	40	40	40	45	38	37	34	35	36	36	36
Polyvinyl Butyral	7	7	7	7	7	7	7	7	7	7	7
Other	32	31	33	34	34	34	33	33	33	34	34
Total Plastic/Composites	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Polypropylene	23.8%	23.6%	22.7%	21.5%	24.6%	25.0%	25.8%	25.7%	25.8%	25.5%	25.3%
Polyurethanes	17.2%	16.6%	16.3%	15.4%	16.3%	16.6%	16.8%	16.9%	18.0%	18.0%	17.8%
Nylon	12.0%	12.4%	12.1%	11.4%	10.8%	11.2%	11.2%	11.0%	11.0%	10.9%	10.6%
Polyvinyl Chloride	8.0%	8.1%	8.3%	10.3%	8.6%	7.5%	6.9%	6.7%	6.3%	6.0%	6.2%
ABS	6.8%	6.5%	6.8%	7.3%	6.6%	6.2%	5.6%	5.5%	5.3%	5.4%	5.8%
Polyethylenes	4.0%	4.4%	4.8%	4.8%	4.9%	5.0%	5.3%	5.3%	5.1%	5.3%	5.4%
Polycarbonate	4.2%	4.5%	5.1%	5.7%	5.2%	5.1%	5.1%	5.0%	4.8%	4.8%	4.7%
Other Engineering Resins	12.2%	12.3%	11.9%	12.2%	11.1%	11.0%	10.8%	11.2%	11.3%	11.4%	11.3%
Polyvinyl Butyral	2.1%	2.2%	2.2%	2.0%	2.0%	2.0%	2.1%	2.1%	2.1%	2.1%	2.2%
Other	9.6%	9.3%	9.8%	9.4%	9.8%	10.2%	10.4%	10.6%	10.3%	10.5%	10.6%

Note: Polypropylene is also used in thermoplastics polyolefin elastomers (TPO) as well but its use in that area is reported separately under rubber. Polypropylene resin applications include Interior trim, under-the-hood components, HVAC components, battery cases, and other OEM uses.

Appendix Table 4
Average Engineering & Other Plastics Content of NAFTA Light Vehicles (pounds per vehicle)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Other Engineering Resins	**40**	**40**	**40**	**45**	**38**	**37**	**34**	**35**	**36**	**36**	**36**
Polyacetal	6	6	6	8	6	5	4	5	4	4	4
Polyphenylene Ether (PPE)	12	13	13	12	13	13	13	12	13	13	13
Thermoplastic Polyester Engineering Resins	20	20	18	23	17	16	15	15	15	16	16
All Other Engineering Resins	2	2	2	3	2	3	3	3	3	3	3
Other Plastic/Composites	**32**	**31**	**33**	**34**	**34**	**34**	**33**	**33**	**33**	**34**	**34**
Acrylics	5	5	5	5	4	4	4	4	4	5	5
Phenolics	9	9	11	10	12	12	12	12	12	12	12
Unsaturated Polyester	14	12	12	14	12	12	12	12	11	12	12
All Other Resins	4	4	5	6	5	6	5	5	5	5	5

ACC Plastics Division

ACC's Plastics Division advocates unlimited opportunities for plastics and promotes their economic, environmental and societal benefits. Representing resin producers and distributors, the Plastics Division creates value for its members by promoting a positive issues climate and advantaging plastics in strategic markets. ACC's Plastics Division applies a three-pronged approach to strategic plastics issues management: (1) aggressive advocacy and grassroots action; (2) pre-emptive and targeted communications; and (3) highly focused technical and scientific programs. These integrated efforts enable the Plastics Division to effectively manage emerging and high-profile issues in the environmental and health arenas. Examples include product sustainability, recycling, and other end-of-life issues as well as chemical migration concerns specific to plastic products. In addition, the Plastics Division's four Market Issues Teams – Automotive, Building and Construction, Electrical and Electronics, and Packaging and Consumer Products – work with key customers and the plastics value chain to advantage plastics in strategic markets. Their activities include pre-competitive marketing, leveraging federal research dollars, advocating code and policy changes, and resolving potential obstacles to growth.

The Automotive Market/Issue Team (AMIT) operates in a political and technical environment managing key issues affecting the automotive plastics market such as energy policy, climate change, emissions control, substance disclosure, recycling, environmental sustainability, competitive material challenges, and specific Federal/State technology development programs. The AMIT is a proactive group dedicated to expanding the automotive market for plastics, and the team is focused on those pre-competitive initiatives that will help overcome key barriers and identifying and creating new opportunities to achieving a vision of "unlimited opportunities for plastics." The foundation of the automotive strategy is the implementation of the 2014 Plastics and Polymer Composites Technology Roadmap for Automotive Markets. The Roadmap is designed to maximize the value of polymers throughout the supply chain, provide a strategic technology agenda for plastics, align automotive and plastics industry needs, and engage science, technology, business, academic, and government leaders in support of the Roadmap's New Vision that "By 2030, the automotive industry and society will recognize plastics and polymer composites as preferred material solutions that meet, and in many cases set, automotive performance and sustainability requirements."

The Automotive Center in Troy, Michigan provides a forum to showcase the best in today's automotive plastics applications, encourages innovative thinking, and promotes broader applications for plastics in the industry.

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Economics and Statistics Department

The Economics & Statistics Department provides a full range of statistical and economic advice and services for ACC and its members and other partners. The group works to improve overall ACC advocacy impact by providing statistics on American Chemistry as well as preparing information about the economic value and contributions of American Chemistry to our economy and society. They function as an in-house consultant, providing survey, economic analysis and other statistical expertise, as well as monitoring business conditions and changing industry dynamics. The group also offers extensive industry knowledge, a network of leading academic organizations and think tanks, and a dedication to making analysis relevant and comprehensible to a wide audience.

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Appendix: Data Sources and Methodology

The information presented in this report is an update building on ACC's earlier assessments of materials use per vehicle. Those previous assessments depended upon the materials use per vehicle data supplied by American Metal Market with some adjustments for non-automobile light vehicles (SUVs, light-duty trucks, mini-vans, etc.) The reporter who tabulated this data, however, retired and the data are no longer available. The assessment presented here reflects an attempt to resurrect and re-estimate the data for materials use per vehicle. While the original data reflected typical domestic automobile use of materials, the present assessment reflects the average for all light vehicles on an OEM (original equipment manufacturer) basis. The analysis also builds upon research on automotive high-tech materials initiated during the 1980s (and since maintained) by Dr. TK Swift.

A "bottoms-up" approach was taken by examining light vehicle use by type of material. We examined over 70 distinct materials. The data for the materials use were provided by trade associations and government statistical agencies. Data sources include The Aluminum Association, American Composite Manufacturers Association, American Fiber Manufacturers Association, American Iron & Steel Institute, Copper Development Association, International Magnesium Association, and the Rubber Manufacturers Association. The provision of data and advice from these associations are gratefully acknowledged. Data from the Bureau of the Census and the US Geological Survey were also used.

The plastics and composite data are derived from the American Chemistry Council's Plastics Industry Producers' Statistics (PIPS) service, which provides relevant, timely, comprehensive and accurate business statistics on the plastic resins industry. This was supplemented by an exhaustive search of the trade literature. The averages are calculated using an assessment of the material consumed with adjustments made to take into account replacement demand. The sum of the individual materials data are close to the comparable average vehicle data provided by the Environmental Protection Agency (EPA) and the Office of Energy Efficiency and Renewable Energy (EERE) of the US Department of Energy (DOE).

The data represent the average use of materials for light vehicles assembled in the United States, Canada and Mexico.