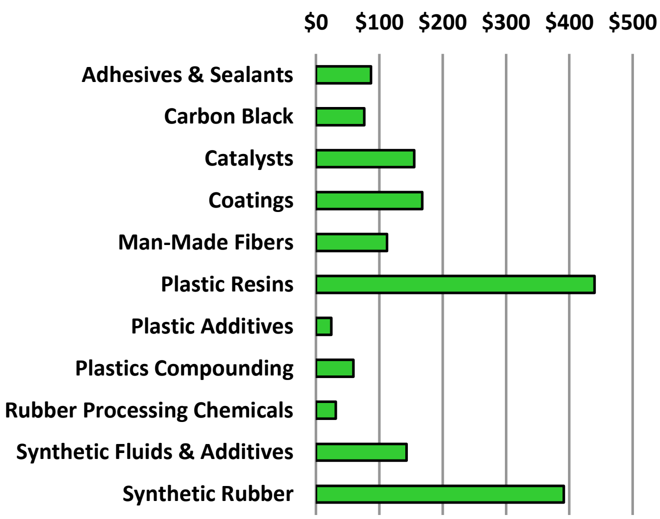
Chemistry & Light Vehicles

American Chemistry Council
December 2011

Introduction

This report presents the annual results of an assessment of the chemistry and other materials component of light vehicles, a major end-use customer for American chemistry. With 9.66 million light vehicles assembled in the United States and Canada during 2010, this important market represents the equivalent of some $31.8 billion in chemistry. This chemistry value is up from $21.0 billion the year before when 7.02 million units were assembled. The chemistry value peaked at $34.8 billion in 2007 (when 13.08 million units were assembled).

FIGURE 1
AVERAGE DIRECT LIGHT VEHICLE CHEMISTRY CONTENT IN 2010
($/vehicle)



Chemistry and Light Vehicles

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 contains $3,297 of chemistry (chemical products and chemical processing). This figure is up 10.5% from $2,984 per vehicle the year before. Indeed, the chemistry value per vehicle has grown considerably. It's up 92.0% since 2000 when it was $1,717 per vehicle. Included, for example, are antifreeze and other fluids, catalysts, plastic dashboards 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 taillights features some chemistry.

Chemistry values are shown in Figure 1 where the chemistry content (measured in dollars per vehicle) for a variety of segments of the business of chemistry is displayed. Figure 1 presents the direct chemistry value of materials only. It excludes the chemistry value from processing and other indirect chemistry.

The direct chemistry value during 2010 averaged $1,688 per vehicle, 51% of the total chemistry. Details on chemistry used are presented in Table 1. The remaining 49% (or $1,609 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 composites in particular there is significant competition with other materials, especially aluminum and steel.

In 2010, average vehicle weight increased by 3.8% (147 pounds) to 4,039 pounds. This followed two consecutive declines. The rising popularity of SUVs was a contributing factor in rising vehicle weight during the 1990s and for most of last decade. Higher gasoline prices in 2008, however, clearly induced a reversal of this trend, and 2009 average weight was at its lowest level since 1999. An economic recovery and renewed popularity of larger vehicles fostered the 2010 increase in weight. In 2000, the average vehicle weight was 3,919 pounds. In 1990, average vehicle weight was 3,425 pounds.

The performance of vehicles has improved significantly over the years. According to EPA data, for example, the average horsepower (HP) of vehicles is 220 HP, compared to 181 HP in 2000 and 135 HP in 1990. Top speed now averages 139 miles per hour (MPH) compared to 129 MPH in 2000 and only 117 MPH in 1990.

Regular steel and high- and medium-strength steel represent the dominant materials in light vehicles. Combined, both account for nearly 52% of vehicle weight. High- and medium-strength steel have been gaining share away from regular steel. Other steel and iron castings have generally lost share. Combined, all iron and steel accounted for nearly 61% of average vehicle weight, down from 65% in 2000 and 70% in 1990.

During the last several decades, lightweight materials have gained share away from iron and steel. For example, aluminum gained share in 2010, rising 6.2% (or 20 pounds) to 344 pounds per vehicle. Aluminum use represented 8.5% of average vehicle weight, up from 6.9% in 2000 and 4.7% in 1990. 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 and Table 3. 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 Light Vehicles

Light vehicles represent an important market for plastic resins and composites, one that has grown significantly during the last five decades. The average light vehicle now contains 378 pounds of plastics and composites, 9.4% by weight. This is up from 286 pounds in 2000 and 194 pounds in 1990. In 1960, less than 20 pounds were used.

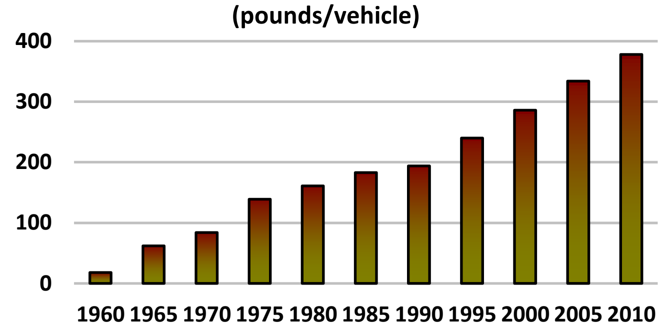
Composites are any combination of polymer matrix and fibrous reinforcement. Glass, carbon, aramid, and other fibers provide strength and stiffness while the polymer matrix (or resin) of polyester, polyurethane, epoxy, polypropylene, nylon, or another resin protects and transfers loads between fibers. This creates a material with attributes superior to either component alone.

The favorable performance properties of plastics and composites are manifold, but weight-savings is primary among these. Each pound of plastics and composites, for example, supplants 2-3 pounds of other, heavier materials. As a result, polymers help to reduce vehicle weight, thus improving fuel efficiency and reducing greenhouse gas (GHG) emissions. In addition, ACC econometric analysis indicates that for each 10 pound increase in plastics substitution for other materials, a vehicle's fuel efficiency improves by 0.11% to 0.14%. A study by McKinsey and Company found that the use of plastics and composites for automotive weight reduction enable a savings of three units of GHG emissions for every unit emitted during production.

Substantial weight reduction is possible as composites are typically up to 40% lighter than steel parts of equal strength. In addition to light-weighting to improve fuel efficiency and reduce emissions, plastics and composites also enhance design flexibility, allow exceptional aerodynamic modeling, enhance safety, provide unparalleled corrosion and damage (dent and ding) resistance, better internal damping (reduced noise, vibration and harshness), and consolidate parts and assembly time. In addition, tooling for composites parts can be as much as 80% lower than comparable steel parts.

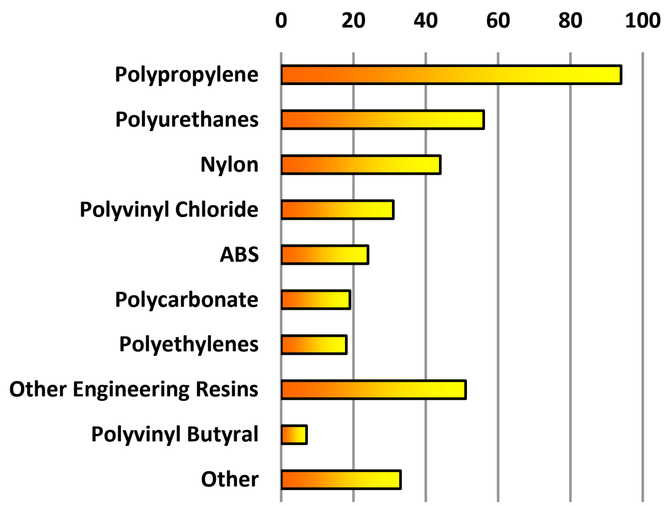
The automotive market is an important market for plastic resins such as polypropylene, polyurethane, nylon, other engineering polymers, and thermoplastic polyesters. Light vehicle applications account for over 30% of the demand for each resin. Other resins include ABS and polyvinyl butyral. For the latter resin which is used in safety glass, the automotive market accounts for over 85% of total demand. Engineering polymers such as nylon, polycarbonate and 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.

FIGURE 2
LONG-TERM TREND IN LIGHT VEHICLE PLASTICS/COMPOSITES USE
(pounds/vehicle)



Although average plastics and composites per vehicle use rose two pounds (0.5%) to 378 pounds in 2010, plastics and composites lost some share of the total vehicle weight. Over 15 major resins find significant use in light vehicles. Details on resin use are presented in Tables 4 and 5. Major polymers used in light vehicles include 94 pounds of polypropylene (PP), 56 pounds of polyurethanes, 44 pounds of nylon, 31 pounds of polyvinyl chloride (PVC), 24 pounds of acrylonitrile-butadiene-styrene (ABS), 19 pounds of polycarbonate resins and 18 pounds of polyethylene resins. Among resins gaining share during 2010 were polypropylene, nylon, and polycarbonate resins.

FIGURE 3
AVERAGE PLASTICS/COMPOSITES IN LIGHT VEHICLE BY RESIN IN 2010
(pounds/vehicle)



During the last two decades, other engineering resins such as polyacetal, polyphenylene ether (PPE), thermoplastic polyester engineering resins, and others have supplanted metals in a number of applications. Average use of these resins reached 51 pounds in 2010, 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 114 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 33 pounds.

Additional opportunities to reduce weight with plastics and 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. 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

In addition to polymers and composites, the typical light vehicle also utilizes 200 pounds of rubber and 54 pounds of man-made fibers. The latter are primarily synthetic fibers. The typical North American light vehicle also featured 34 pounds of coatings (dry weight) in 2010.

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, min-vans, etc.) The reporter who tabulated this data, however, has 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.

A "bottoms-up" approach was taken by examining light vehicle use by type of material. 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). Tables 1-5 present the results of the analysis for 2000-2010. The data related to this analysis are available (contact ACC) in spreadsheet form back to 1987. In subsequent annual updates it is anticipated that more historical details will be presented.

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Economics & Statistics
American Chemistry Council

TABLE 1
AVERAGE CHEMISTRY VALUE OF NORTH AMERICAN LIGHT VEHICLES ($/VEHICLE)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Adhesives & Sealants	$50	$53	$55	$58	$62	$65	$71	$74	$78	$82	$87
Carbon Black	24	24	26	27	34	44	58	57	70	68	76
Catalysts	98	103	104	108	111	100	128	132	138	140	155
Coatings	113	117	110	104	123	130	131	140	143	163	168
Man-Made Fibers	74	73	75	78	92	95	98	95	101	105	112
Plastic Resins	224	226	232	248	287	311	332	358	404	390	440
Plastic Additives	15	17	17	17	18	17	18	20	22	21	24
Plastic Compounding	35	36	37	39	40	39	43	48	55	53	59
Rubber Processing Chemicals	15	14	15	15	16	18	22	23	28	26	31
Synthetic Fluids & Additives	52	56	62	67	69	79	99	108	136	135	143
Synthetic Rubber	169	176	169	185	204	236	272	289	354	319	391
Materials	**$867**	**$896**	**$901**	**$946**	**$1,057**	**$1,134**	**$1,272**	**$1,345**	**$1,530**	**$1,502**	**$1,688**
Processing/Other Chemistry	850	844	813	887	945	1,085	1,172	1,308	1,443	1,482	1,609
Total Chemistry Content	**$1,717**	**$1,740**	**$1,714**	**$1,833**	**$2,002**	**$2,219**	**$2,444**	**$2,653**	**$2,973**	**$2,984**	**$3,297**

TABLE 2
AVERAGE MATERIALS CONTENT OF NORTH AMERICAN LIGHT VEHICLES (POUNDS/VEHICLE)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total Vehicle Weight (pounds)	**3,919**	**3,914**	**3,934**	**3,965**	**4,041**	**4,040**	**4,065**	**4,097**	**4,077**	**3,892**	**4,039**
Regular Steel	1,655	1,652	1,649	1,646	1,650	1,634	1,622	1,644	1,627	1,501	1,542
High- & Medium Strength Steel	408	424	443	460	479	491	502	518	523	524	559
Stainless Steel	62	63	64	65	70	71	73	75	75	72	73
Other Steels	26	28	30	32	34	35	34	34	33	31	33
Iron Castings	432	384	355	336	331	328	331	322	299	206	237
Aluminum	269	279	289	299	311	316	323	319	316	324	344
Magnesium	8	10	9	10	10	10	10	10	11	12	13
Copper and Brass	68	66	69	70	71	71	67	66	65	63	65
Lead	36	37	35	35	37	38	39	41	44	42	40
Zinc	13	11	10	10	10	10	10	9	9	9	9
Metal Powder	36	38	39	41	43	42	42	43	43	41	41
Other Metals	4	4	4	4	5	4	5	5	5	5	6
Plastics/Composites	286	298	307	319	338	334	338	338	353	376	378
Rubber	166	163	167	169	172	179	187	188	193	198	200
Coatings	25	26	26	25	28	27	29	29	30	34	34
Textiles	44	45	45	46	51	49	47	46	48	52	54
Fluids and Lubricants	207	208	209	210	210	210	211	215	214	219	226
Glass	103	104	104	105	105	104	105	103	99	93	94
Other	71	75	79	83	86	87	89	92	91	90	92

TABLE 3
AVERAGE MATERIALS CONTENT OF NORTH AMERICAN LIGHT VEHICLES (% OF TOTAL VEHICLE WEIGHT)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Percent of Total Vehicle 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	42.2%	42.2%	41.9%	41.5%	40.8%	40.4%	39.9%	40.1%	39.9%	38.6%	38.2%
High- & Medium Strength Steel	10.4%	10.8%	11.3%	11.6%	11.9%	12.2%	12.3%	12.6%	12.8%	13.5%	13.8%
Stainless Steel	1.6%	1.6%	1.6%	1.6%	1.7%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%
Other Steels	0.7%	0.7%	0.8%	0.8%	0.8%	0.9%	0.8%	0.8%	0.8%	0.8%	0.8%
Iron Castings	11.0%	9.8%	9.0%	8.5%	8.2%	8.1%	8.1%	7.9%	7.3%	5.3%	5.9%
Aluminum	6.9%	7.1%	7.3%	7.5%	7.7%	7.8%	7.9%	7.8%	7.8%	8.3%	8.5%
Magnesium	0.2%	0.2%	0.2%	0.2%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
Copper and Brass	1.7%	1.7%	1.7%	1.8%	1.8%	1.8%	1.6%	1.6%	1.6%	1.6%	1.6%
Lead	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	1.0%	1.0%	1.1%	1.1%	1.0%
Zinc	0.3%	0.3%	0.3%	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Metal Powder	0.9%	1.0%	1.0%	1.0%	1.1%	1.0%	1.0%	1.0%	1.1%	1.1%	1.0%
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/Composites	7.3%	7.6%	7.8%	8.0%	8.4%	8.3%	8.3%	8.2%	8.7%	9.7%	9.4%
Rubber	4.2%	4.2%	4.3%	4.3%	4.3%	4.4%	4.6%	4.6%	4.7%	5.1%	4.9%
Coatings	0.6%	0.7%	0.7%	0.6%	0.7%	0.7%	0.7%	0.7%	0.7%	0.9%	0.9%
Textiles	1.1%	1.1%	1.2%	1.2%	1.3%	1.2%	1.2%	1.1%	1.2%	1.3%	1.3%
Fluids and Lubricants	5.3%	5.3%	5.3%	5.3%	5.2%	5.2%	5.2%	5.2%	5.2%	5.6%	5.6%
Glass	2.6%	2.7%	2.6%	2.6%	2.6%	2.6%	2.6%	2.5%	2.4%	2.4%	2.3%
Other	1.8%	1.9%	2.0%	2.1%	2.1%	2.2%	2.2%	2.2%	2.2%	2.3%	2.3%

TABLE 4
AVERAGE LARGE VOLUME PLASTIC RESINS/COMPOSITES IN NORTH AMERICAN LIGHT VEHICLES (POUNDS/VEHICLE)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Average Plastics/Composites Weight	**286**	**298**	**307**	**319**	**338**	**334**	**338**	**338**	**353**	**376**	**378**
Polypropylene	62	66	72	78	79	77	81	80	83	89	94
Polyurethanes	54	58	57	60	64	64	59	56	57	57	56
Nylon	38	37	38	39	43	42	41	42	41	42	44
Polyvinyl Chloride	22	23	23	23	25	23	27	28	29	31	31
ABS	20	22	26	25	26	25	21	22	24	28	24
Polycarbonate	12	12	11	12	14	14	15	15	18	18	19
Polyethylenes	11	13	12	12	14	13	14	15	17	21	18
Other Engineering Resins	31	33	33	36	38	38	42	42	43	49	51
Polyvinyl Butyral	6	6	6	6	7	7	7	7	8	7	7
Other	30	29	27	28	30	30	31	30	33	34	33
% of Total Plastics/Composites Weight	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Polypropylene	21.8%	22.1%	23.6%	24.4%	23.3%	23.1%	24.1%	23.7%	23.5%	23.7%	25.0%
Polyurethanes	18.9%	19.3%	18.6%	18.7%	18.9%	19.1%	17.4%	16.7%	16.1%	15.0%	14.9%
Nylon	13.3%	12.4%	12.5%	12.3%	12.7%	12.7%	12.2%	12.4%	11.6%	11.2%	11.8%
Polyvinyl Chloride	7.6%	7.9%	7.6%	7.2%	7.3%	7.0%	8.1%	8.2%	8.2%	8.3%	8.1%
ABS	7.0%	7.4%	8.6%	7.9%	7.8%	7.6%	6.1%	6.5%	6.8%	7.4%	6.2%
Polyethylenes	4.3%	3.9%	3.7%	3.9%	4.1%	4.3%	4.3%	4.5%	5.1%	4.7%	5.1%
Polycarbonate	3.9%	4.4%	4.0%	3.7%	4.0%	3.8%	4.1%	4.4%	4.8%	5.5%	4.7%
Other Engineering Resins	10.8%	10.9%	10.7%	11.2%	11.2%	11.3%	12.3%	12.3%	12.3%	13.1%	13.4%
Polyvinyl Butyral	2.0%	2.1%	1.9%	1.9%	1.9%	2.0%	2.1%	2.2%	2.1%	2.0%	2.0%
Other	10.4%	9.8%	8.9%	8.7%	8.8%	9.1%	9.3%	9.0%	9.4%	9.2%	8.8%

Note: Polypropylene is also used in thermoplastic polyolefin elastomers (TPO) as well but its use in that area is reported separately under rubber.

TABLE 5
AVERAGE OF OTHER PLASTIC RESINS/COMPOSITES IN NORTH AMERICAN LIGHT VEHICLES (POUNDS/VEHICLE)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Other Engineering Resins Weight	**31**	**33**	**33**	**36**	**38**	**38**	**42**	**42**	**43**	**49**	**51**
Polyacetal	6	6	6	5	6	6	6	6	7	8	8
Polyphenylene Ether (PPE)	10	10	10	10	10	11	13	13	15	15	16
Thermoplastic Polyester Engineering Resins	14	15	16	19	20	19	20	20	19	24	24
All Other Engineering Resins	1	1	1	2	2	2	2	2	3	3	3
Other Plastic Resins Weight	**30**	**29**	**27**	**28**	**30**	**30**	**31**	**30**	**33**	**34**	**33**
Acrylics	4	4	4	5	5	5	5	5	5	5	4
Phenolics	9	10	9	9	9	9	10	10	12	13	12
Unsaturated Polyester	14	13	12	11	13	14	14	13	13	12	12
All Other Resins	2	2	2	2	3	3	3	3	4	4	4