# Chemistry and Automobiles
*Driving the Future*

May 2024

American Chemistry Council

# Executive Summary

Automobiles that are lighter weight, more fuel efficient and safer for occupants are made possible by plastics and other products of chemistry.

The North American automobile manufacturing industry represents a significant end-use market for the chemical industry. In 2023, an estimated 15.8 million passenger automobiles and light-duty trucks were produced in the United States, Canada, and Mexico and, on average, each vehicle contains nearly $4,400 in chemistry.

Compared to a decade ago, the average chemistry value per vehicle has grown by more than $1,000 (or 31%). This includes $695 in plastics and polymer composites, $679 in synthetic rubber and elastomers, $567 in semiconductors and other electronic chemicals, $329 in textiles, and $291 in fluids and lubricants, along with hundreds of dollars' worth of other products of chemistry.

The average weight of an automobile in 2023 was 4,439 pounds, up 136 pounds (3%) compared to 2022. Plastics and polymer composites account for nearly 10% (426 pounds) of the average weight, up 19% compared to a decade ago. Plastics are used in a variety of innovative ways to help make cars safer and more fuel efficient. Plastics can make vehicles more lightweight, help increase fuel efficiency and reduce carbon emissions, and help provide safety benefits like seatbelts and airbags. In addition to plastics and polymer composites, the typical vehicle includes 231 pounds of synthetic rubber, 204 pounds of fluids and lubricants, 105 pounds of textiles, and 44 pounds of coatings – all products of chemistry.

In electric vehicles (EVs), the weight of the chemistry and plastics content is significantly higher than their internal combustion engine (ICE) counterparts: a mid-size EV is likely to contain 45% more plastics and polymer composites and 52% more synthetic rubber and elastomers than a similarly sized ICE vehicle. And, with a significant increase in use of higher-value materials like carbon fiber and semiconductors, the total value of chemistry in an EV could be 85% higher than an ICE vehicle.

Innovation in the automotive industry is driven by a combination of factors including technological advancements and changing consumer preferences. The landscape of the automotive industry is changing as EVs and hybrids become a larger share of the market, and as automobiles become increasingly focused on technology. Many of the innovations in how vehicles are designed, manufactured, and used—both the vehicles of today and those of the future—are made possible by products of chemistry.

# Introduction

Plastics and other products of chemistry are critical to today's automobile which, for purposes of this report, includes both passenger automobiles and light-duty trucks (pick-up trucks, minivans, and sport utility vehicles). This report presents an analysis of the volume and value of chemistry components in an average automobile produced in North America (United States, Canada, and Mexico).

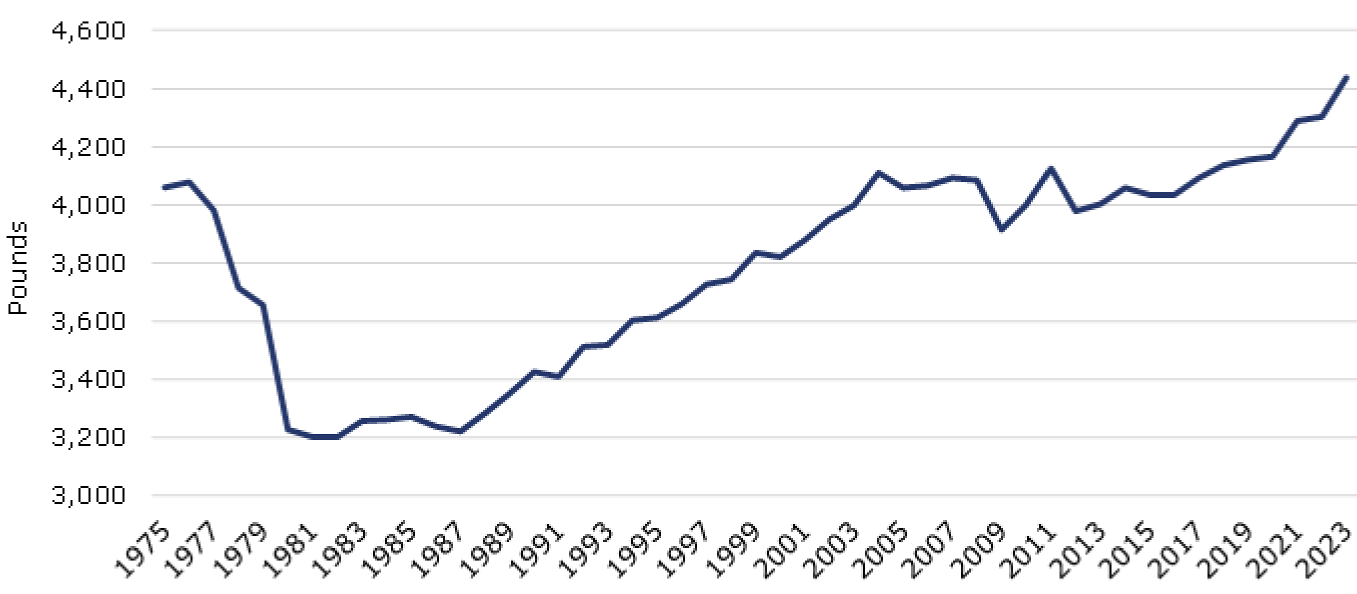
An estimated 15.8 million automobiles were produced in North America in 2023. These vehicles were manufactured by more than twenty companies and include hundreds of models. While this report attempts to quantify the chemistry content in an average automobile, it should be noted that the components of individual vehicles can vary widely.

*Note: for the purposes of this report, the term "automobile" is used to refer to a class of vehicles including passenger cars (e.g., sedans, wagons, small sport utility vehicles) and light trucks (e.g., pickups, minivans, larger sport utility vehicles). The term "vehicle" is used interchangeably with "automobile" except when otherwise delineated.*

## *Trends in Automobiles*

In 2023, the average weight of a North American-manufactured automobile rose by 136 pounds (or 3.1%) to 4,439 pounds – the highest since 1975. In 1976, the average vehicle weighed 4,079 pounds, but by 1980 that figure had dropped by 20% driven by higher gas prices and the introduction of fuel economy efficiency and emissions standards. Vehicle weight averaged around 3,250 pounds through the 1980s and slowly started to increase, with an average weight

*Figure 1.* Average Vehicle Weight

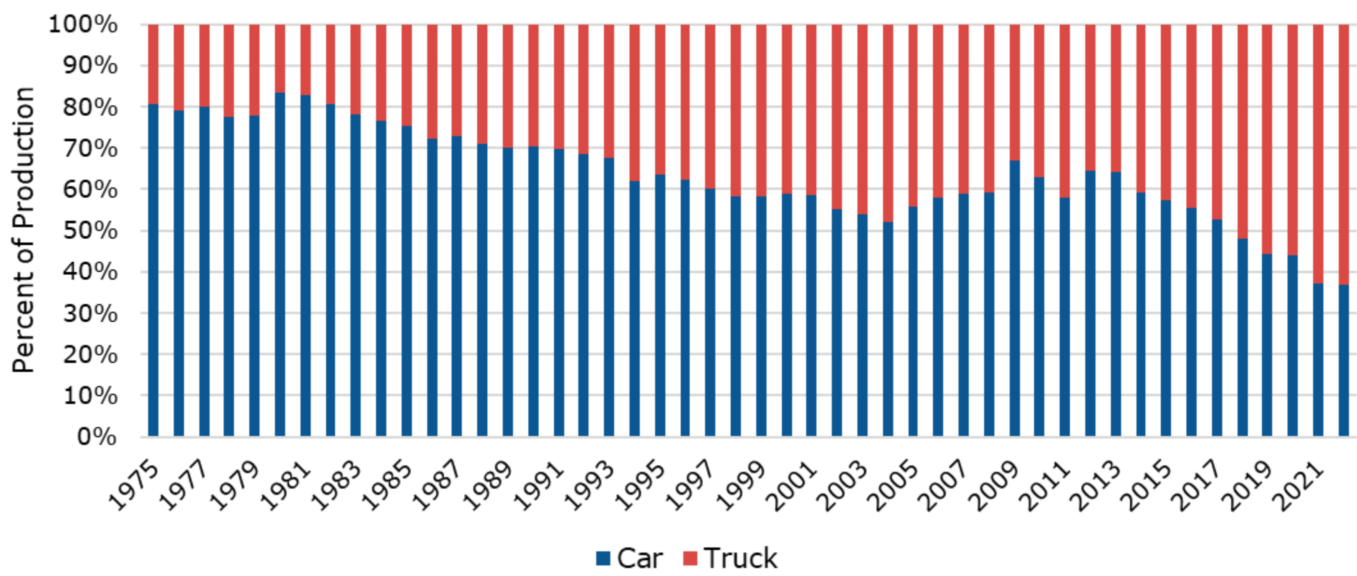



*Source: EPA*

of 3,600 pounds in the 1990s. Weight continued to inch up in the 2000s and, in 2004, the average vehicle weight surpassed 4,000 pounds for the first time since 1976. The average weight hovered around 4,000 pounds through the 2010s but has increased every year since 2017.

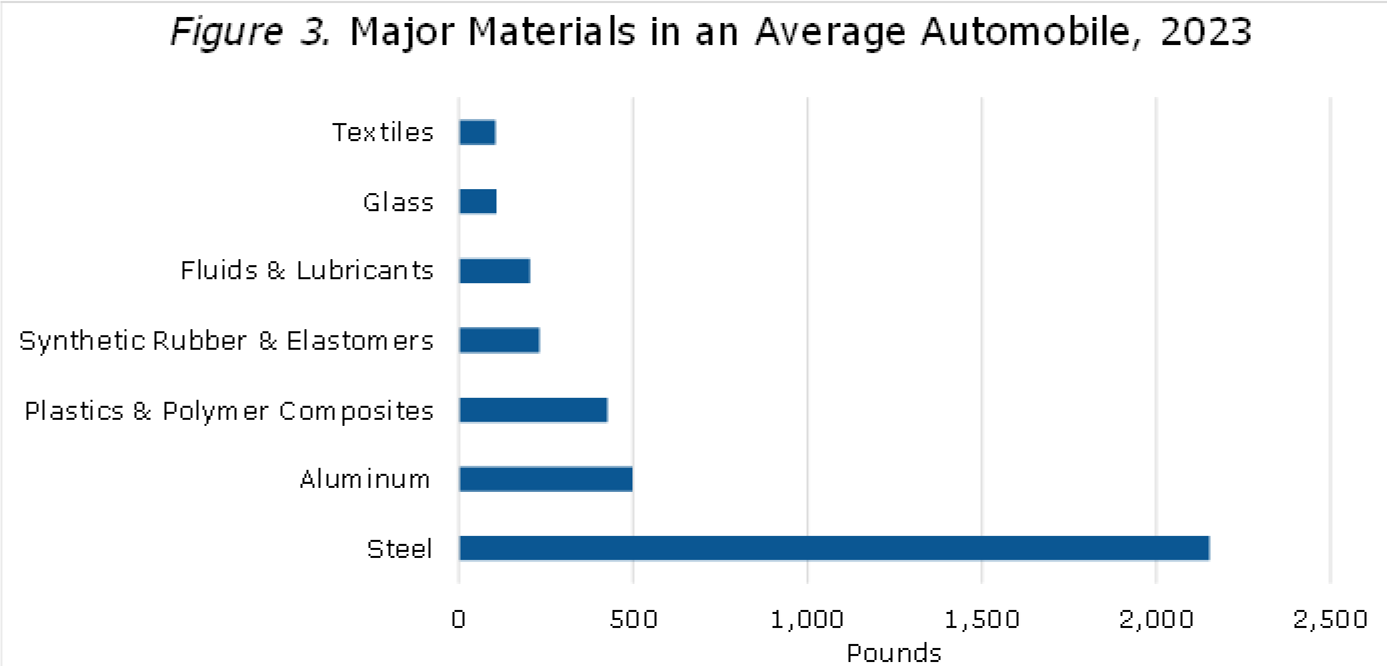
The rise and fall of average vehicle weights over time can be attributed to several factors, including consumer preferences, gasoline prices, material composition, and types of vehicles. For example, the average automobile weight began to increase in the 1990s as light-duty trucks and SUVs became a larger share of the automotive market. In fact, trucks (including larger SUVs and minivans) have continued to increase market share over the past several decades and have held more than 50% of the market since 2018. In 2022, trucks accounted for nearly two-thirds (63%) of vehicles produced in the U.S.

*Figure 2.* Production of Cars vs. Trucks




*Source: EPA, ACC analysis*

The material composition also plays a key role in the overall weight of the vehicle. Over the years, plastics and polymer composites and other lightweight materials have replaced heavier materials, such as steel and other metals, reducing the vehicle weight. All told, the fluctuations in average vehicle weight cannot be attributed to a single factor, but rather a multitude of elements reflecting the ever-changing dynamics in the automotive industry.




## Automotive Chemistry

The automobile manufacturing industry represents a large share of the North American economy, totaling $367 billion in manufacturers' shipments in 2021. Motor vehicle manufacturing is also an important end-use market for the chemical industry; nearly every component of an automobile contains, or has been touched by, chemistry. In 2023, on average, every automobile manufactured for sale in North America contained $4,371 in chemistry (chemical products and processing chemicals).

Over the past decade, the average chemistry value per vehicle has grown by 31% (or $1,047). Chemistry is used in automobiles from the front bumper, which uses plastics such as polyethylene and/or polypropylene, to the taillight housing, which can made with polycarbonate, acrylonitrile butadiene styrene (ABS), and/or polybutylene terephthalate (PBT). Chemistry is a key component of automotive exteriors, such as paints and coatings, windows and windshields, and door handles. Automotive interiors such as airbags and seatbelts, seating, and dashboards are also products of chemistry.

In addition to the increased weight of chemistry in the average vehicle, the increase in the value of chemistry can also be attributed to the increased use of specialty chemistries and plastics. As vehicles become more sophisticated, and consumers look for more features, vehicle manufacturers have increasingly turned to chemistry to meet these needs.

## *Plastics and Polymer Composites*

### Automotive Applications

Lightweight plastics and polymer composites play a critical role in today's automobiles, as well as in the transition to next-generation vehicles, as they enable vehicle weight reduction that helps automakers meet increasingly stringent fuel economy standards, while enhancing safety for drivers, passengers, and pedestrians.

Today's plastics make up 50% or more of the volume of an average vehicle but less than 10% of its weight, according to ACC calculations. Weight reduction in automotive design is a key driver in boosting fuel efficiency, reducing emissions, and lowering operating costs for motorists. The performance of vehicles has improved significantly over the years: according to EPA data the average horsepower (HP) of model 2023 vehicles reached a high of 272, compared to 230 just ten years ago and 210 HP two decades ago. Average fuel efficiency (real-world miles per gallon) reached 26.9 MPG in 2023, more than double the 1975 average. Although improved engine technologies and drive trains have played a role, so have chemistry and lightweight materials.

The following are just a few examples of how plastics and polymer composites contribute to the safety, performance, and aesthetics of today's vehicles. For more detailed information on the uses and benefits of plastics and polymer composites in automobiles, visit http://www.plasticmakers.org/autos

*Exterior* - From bumper to bumper, plastics help keep the vehicle—and the passengers inside—safe. Bumpers made of materials such as thermoplastic olefins (TPOs), polycarbonates, polyesters, polypropylene, and polyurethanes provide impact resistance as well as design flexibility. Plastic bumpers typically contain reinforcements that allow them to be as impact resistant as possible. Plastic composites in automobile hoods can improve a vehicle's aerodynamics, while also contributing to the overall design aesthetic. Plastics also resist dents, dings, and corrosion, making them especially desirable for door panels and hoods. Additionally, plastics used in exterior components can be formulated with UV resistance and engineered to perform in extreme temperatures.

*Interior* - Many modern car interior parts are made with polymers, including lightweight seats, instrument panels, durable upholstery, sound control fabrics, the headliner, dash, and door panels. Instrument panels made from resins such as ABS, polycarbonates, and polypropylene allow for complex designs in items such as airbag housings, center stacks for instrument panels, and large, integrated instrument panel pieces. Consoles (e.g., armrests, cup holders, and storage spaces) would be difficult to reproduce as efficiently and with the same performance results using any family of materials other than plastics.

Design flexibility, corrosion resistance, and favorable mechanical properties make polymer composites a logical choice for upholstery and interior surfaces. Plastic car interior parts can provide similar aesthetics to natural materials with excellent scratch resistance for interior seats and surfaces. For example, many manufacturers are using artificial leather in automobiles owing to cost efficiency, aesthetic appeal, and other benefits. Automotive textiles can also utilize recycled materials, such as post-industrial fiber and post-consumer water bottles.

*Safety* - Many of the essential safety features in vehicles are made possible by chemistry and plastics. According to the National Highway Traffic Safety Administration (NHTSA), seat belts—which are typically made from polyester—saved nearly 15,000 lives in 2017. Air bags, which are commonly made from high-strength nylon fabric, are credited with saving 50,457 lives in the period from 1987 to 2017.

Fiber-reinforced polymer composites can absorb four times the crush energy of steel while polypropylene and polyurethane foams and other polymer composites provide additional impact protection. Advanced Driver Assistance Systems (ADAS) rely on plastic for the multitude of cameras and sensors that enable automated safety innovations, including back-up cameras and automated emergency braking systems.

*Windshields, Windows & Sunroofs* - North American windshields come as a multi-layer unit; the combination can be thinner, lighter, and stronger than tempered glass alone. The tear-resistant plastic layer helps both prevent occupant ejection while also preventing glass from shattering—and injuring passengers—during a crash. Plastics can provide glare prevention and UV protection, as well as sealing solutions for sunroofs and windows.

*Lighting* - Plastics can operate at high temperatures, making them desirable materials for headlights, fog lights and taillights. Plastic LEDs and acrylic fiber optic light tubes help make controls and instrument panels more readable. Plastics' use in safety door lighting helps alert oncoming cars of stopped roadside vehicles. Exterior lighting helps the driver see other vehicles and pedestrians, while also making the vehicle more visible to other vehicles.

*Chassis* - The chassis is the primary framework of an automobile, forming a base for the entire vehicle. The chassis supports the other parts of a vehicle, as well as the passengers. Plastics play a critical role in today's car chassis design, typically providing lighter weight, higher stiffness, and lower cost than traditional materials such as steel. Advanced plastics, polymer composites, and carbon fiber-reinforced plastics enable remarkable improvements in car frames. New material formulas and technology are making vehicles lighter and increasing fuel efficiency. Increased battery range and more flexible, aesthetically pleasing design are additional benefits.

*Electrical* - A car's electrical system used to be limited to a few components, but today's vehicles rely on electrical components for myriad functions. Plastic components are strong, light, and can withstand high temperatures and resist corrosion. Less than two decades ago, dashboards were crammed with heavy copper wiring but advances in acrylic fiber optic cables have eliminated the need for copper. This means enhanced illumination of the interior, more accurate GPS data, and highly responsive ABS sensors. Acrylic fiber-optic is used for wiring, single light sources, or light boxes; Polybutylene terephthalate (PBT) is a highly valued connector for fuel injectors.

*Under the Hood* - As under-the-hood conditions become more challenging, automakers and their suppliers increasingly rely on plastic car parts to help reduce weight and cost, increase parts integration, and provide for longer service life. The powertrain, a system of bearings, shafts, and gears, is one of a car's most complicated parts and plastics can help reduce the number of parts needed per component.  Automakers rely on plastic's high strength-to-weight ratio combined with its anti-corrosive properties for electric vehicles and hybrid electric vehicles. Temperature resistant and thermally conductive plastics are used in heat sensitive applications, including electric vehicle battery parts and enclosures. Replacing metal components with plastics in EVs aids in weight reduction, reduces corrosion, provides design flexibility, and helps help keep batteries safe during collisions -- and on average weigh 35% less than metal enclosures.

Compared with metal assemblies, large-format all-plastic housings enable cycle time reductions and contribute to lighter vehicle weight, thus extending the range of electric vehicles.

**Table 1. Plastics & Polymer Composites in an Average Automobile (lbs./vehicle)**

| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|
| Polypropylene | 84 | 84 | 85 | 88 | 91 | 93 | 93 | 97 | 97 | 100 |
| Polyurethane Foam | 74 | 76 | 76 | 76 | 78 | 80 | 81 | 82 | 84 | 85 |
| Nylon | 38 | 38 | 38 | 39 | 39 | 39 | 36 | 40 | 42 | 45 |
| High-Density Polyethylene (HDPE) | 27 | 27 | 28 | 29 | 31 | 31 | 32 | 33 | 33 | 33 |
| Polyvinyl Chloride (PVC) | 27 | 27 | 27 | 28 | 29 | 30 | 30 | 31 | 31 | 32 |
| Acrylonitrile Butadiene Styrene (ABS) | 22 | 22 | 22 | 24 | 22 | 21 | 21 | 21 | 21 | 24 |
| Polycarbonate | 18 | 17 | 17 | 18 | 18 | 18 | 19 | 19 | 20 | 22 |
| Phenolic Resins | 11 | 11 | 11 | 12 | 12 | 13 | 13 | 15 | 15 | 17 |
| Polyvinyl Butyral | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 |
| Polybutylene Terephthalate (PBT) | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 6 | 5 |
| Polymethyl Methacrylate (PMMA) | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Polyacetal Resins | 8 | 8 | 8 | 9 | 9 | 9 | 9 | 10 | 9 | 8 |
| Other Plastics* | 36 | 36 | 36 | 36 | 37 | 38 | 38 | 40 | 40 | 43 |
| **Plastics & Polymer Composites Total** | **360** | **361** | **363** | **375** | **382** | **388** | **388** | **406** | **410** | **426** |

*Other Plastics includes liquid crystal polymers, high-performance polyamides, polyphenylene ether, unsaturated polyester, and polyphenylene sulfide resins, among other small-volume plastics.
Note. See *Data and Methodology* for data sources.

### Weight of Plastics & Polymer Composites in Automobiles

The average automobile contained 426 pounds of plastics and polymer composites in 2023 (9.6% of a vehicle's total weight). This is up 18% compared to a decade ago. Over a dozen major resins find significant use in automobiles, including on average 100 pounds of polypropylene (PP), 85 pounds of polyurethane foam, 45 pounds of nylon, 33 pounds of high-density polyethylene (HDPE), and 32 pounds of polyvinyl chloride (PVC).

## *Synthetic Rubber and Elastomers in Automobiles*

The average automobile contained 231 pounds of synthetic rubber and elastomers, with an additional 75 pounds of natural rubber, in 2023. Olefinic thermoplastic elastomers, such as thermoplastic polyolefins, accounted for 55 pounds of total vehicle weight, followed by styrene-butadiene rubber (SBR) at 49 pounds. Polybutadiene use averaged 27 pounds per vehicle and polyurethane elastomers accounted for 26 pounds. While tires account for most rubber use in vehicles, synthetic rubber and elastomers are used in a wide range of applications, including seals and gaskets, weatherstripping, mats and flooring, and hoses, among others.

The use of most synthetic rubber and elastomers has grown over the past decade, up 20%, while the weight of natural rubber in an average automobile has dropped by 11%. In general, synthetic rubber offers superior qualities compared to natural rubber, particularly in its temperature and abrasion resistance. Additionally, property-enhancing chemical additives can further improve the performance of synthetic rubber and elastomers. Tire manufacturers are also increasing their use of recycled rubber chemicals and synthetic rubber in new tire manufacturing.

**Table 2. Synthetic Rubber/Elastomers in an Average Automobile (lbs./vehicle)**

| | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** |
|---|---|---|---|---|---|---|---|---|---|---|
| Olefinic Thermoplastic Elastomers | 49 | 49 | 50 | 50 | 51 | 52 | 52 | 53 | 52 | 55 |
| Styrene Butadiene Rubber | 41 | 40 | 40 | 41 | 43 | 43 | 43 | 46 | 46 | 49 |
| Polyurethane Elastomers | 23 | 23 | 22 | 22 | 23 | 24 | 24 | 25 | 25 | 26 |
| Polybutadiene | 21 | 21 | 21 | 22 | 23 | 23 | 24 | 25 | 25 | 27 |
| Ethylene-Propylene Elastomers | 19 | 20 | 19 | 20 | 21 | 21 | 21 | 22 | 22 | 23 |
| Butyl Rubber | 12 | 12 | 12 | 13 | 13 | 14 | 15 | 16 | 16 | 17 |
| Nitrile Elastomers | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 |
| Polyurethane Elastomers | 22 | 21 | 21 | 22 | 23 | 23 | 24 | 25 | 25 | 27 |
| **Synthetic Rubber/ Elastomers Total** | **193** | **192** | **191** | **196** | **203** | **206** | **209** | **219** | **218** | **231** |

Note. See *Data and Methodology* for data sources.

### *Other Chemical Products*

Numerous other products of chemistry are used in automobiles, both in the composition of the vehicle itself and in the manufacturing processes.

The average vehicle contains 204 pounds of fluids such as lubricants, engine oil, transmission fluid, antifreeze, gear oil, and windshield wiper fluids. These types of fluids contain chemistry, such as methanol in windshield wiper fluid, ethylene glycol in antifreeze, propylene glycol in engine coolants, and polyalphaolefins in synthetic lubricants. Automotive fluids often contain performance-enhancing chemical additives as well.

On average, today's automobiles contain 108 pounds of glass, an increase of 21% over the past decade. The most common type of glass—in automotive and myriad other applications—is soda-lime glass, which is primarily comprised of three chemical compounds: silica, sodium carbonate (soda ash), and calcium carbonate. Various other polymers and chemistries are used as layers and laminates to impart additional functionality to automotive glass, such as shatter-resistance, improved clarity, and UV-resistance.[i] Today's vehicles contain more glass than ever before: not only do larger vehicles require larger windshields, side windows, and sunroofs, but the surface area of windshields continues to grow as drivers desire increased visibility. Additionally, glass can be used in dashboards and consoles, which increasingly include chemistry-enabled functionality such as touch screens.

The use of textiles (e.g., synthetic fibers, nonwovens, composites) in the average automobile was 105 pounds in 2023, an increase of 27 pounds (35%) compared to 2014. The increase is partly attributable to shifting consumer preferences for luxury-like interiors. Textiles are used throughout automobiles; in addition to the visible uses such as upholstery, flooring, and seatbelts, textiles are used in door panels and as reinforcement for tires and belts, among other applications.

The typical North American vehicle also uses an average of 45 pounds of coatings. In addition to the paint that provides color to the vehicle, coatings include primers, topcoats, and protective coatings for underbody components. A wide range of types of chemistries are used in automotive coating applications, including acrylic, melamine, polyurethanes, and thermosetting resins. As a percentage of total weight, coatings have declined slightly as coatings become thinner and application processes improve, thus reducing waste.

**Table 3. Other Chemical Products in an Average Automobile (lbs./vehicle)**

| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|
| Textiles | 78 | 81 | 81 | 86 | 89 | 91 | 94 | 99 | 102 | 105 |
| Coatings | 45 | 44 | 44 | 45 | 41 | 42 | 42 | 45 | 43 | 44 |
| Glass | 89 | 91 | 93 | 94 | 99 | 100 | 101 | 106 | 105 | 108 |
| Fluids & Lubricants | 199 | 198 | 194 | 188 | 190 | 183 | 187 | 195 | 198 | 204 |
| Carbon Fiber | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 |

Note. See *Data and Methodology* for data sources.
Data include revisions.

### *Other Automotive Materials*

Since the start of the automotive industry, steel and steel alloys have comprised a large share of an automobile's weight. For much of the twentieth century, steel was the primary material used in automobile chassis and bodies. While steel can provide the strength needed in automobiles, it is also extremely dense. As such, when lightweighting of vehicles became a focus in the late 1970s to improve fuel efficiency, some steel parts were replaced by lighter metals such as aluminum which can be as much as three times lighter than steel. Other lightweight materials such as magnesium and plastics and polymer composites have also gained market share away from steel and other heavier materials such as iron and lead.

While steel still accounts for a significant portion of an automobile's weight, mild (low-carbon) steel has increasingly been replaced by lighter grades, such as high-strength steel and advanced high-strength steel (AHSS). In 2010, more than half of the steel in an automobile was mild steel, while high-strength steel and AHSS (combined) represented 39% of total steel. In 2023, an estimated 70% of an automobile's steel content was high-strength or AHSS, while mild steel accounted for less than one-third.

In addition to 2,153 pounds of steel, the average automobile contains 498 pounds of aluminum and 272 pounds of iron, as well as other metals such as zinc, copper and copper alloys, and magnesium.

**Table 4. Metals Content in an Average Automobile (lbs./vehicle)**

| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|
| Mild Steel | 912 | 828 | 774 | 737 | 709 | 665 | 633 | 631 | 590 | 553 |
| High-Strength Steel | 578 | 603 | 611 | 655 | 632 | 685 | 712 | 694 | 696 | 680 |
| AHSS | 499 | 509 | 530 | 532 | 585 | 564 | 554 | 694 | 759 | 834 |
| Other Steels & Steel Alloys | 102 | 118 | 122 | 123 | 101 | 101 | 79 | 84 | 63 | 86 |
| Steel (Total) | 2,091 | 2,058 | 2,038 | 2,047 | 2,027 | 2,015 | 1,979 | 2,102 | 2,108 | 2,153 |
| Aluminum | 366 | 381 | 399 | 413 | 420 | 422 | 459 | 480 | 485 | 498 |
| Iron | 322 | 314 | 312 | 315 | 313 | 313 | 307 | 268 | 270 | 272 |
| Magnesium | 12 | 14 | 20 | 27 | 31 | 31 | 33 | 36 | 37 | 42 |
| Copper and Copper Alloys | 37 | 37 | 37 | 38 | 38 | 39 | 41 | 44 | 50 | 54 |
| Zinc | 48 | 48 | 50 | 51 | 53 | 54 | 55 | 57 | 52 | 53 |
| Lead | 34 | 33 | 33 | 31 | 31 | 30 | 29 | 28 | 26 | 25 |
| Platinum group metals | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 |
| Other metals/alloys | 67 | 68 | 60 | 62 | 65 | 66 | 68 | 74 | 63 | 67 |
| **Metals/Alloys (Total)** | **2,977** | **2,953** | **2,949** | **2,984** | **2,978** | **2,970** | **2,971** | **3,089** | **3,091** | **3,164** |

Note. See *Data and Methodology* for data sources.
Data include revisions.

**Table 5. Materials Content as a Percent of Total Vehicle Weight**

| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|
| Steel | 51.5% | 51.0% | 50.5% | 50.0% | 49.0% | 48.5% | 47.5% | 49.0% | 49.6% | 49.4% |
| Aluminum | 9.0% | 9.4% | 9.9% | 10.1% | 10.2% | 10.2% | 11.0% | 11.2% | 11.4% | 11.4% |
| Plastics & Polymer Composites | 8.9% | 8.9% | 9.0% | 9.2% | 9.2% | 9.3% | 9.3% | 9.5% | 9.5% | 9.6% |
| Iron | 7.9% | 7.8% | 7.7% | 7.7% | 7.6% | 7.5% | 7.4% | 6.2% | 6.4% | 6.2% |
| Other Metals/Alloys | 4.9% | 5.0% | 5.0% | 5.1% | 5.3% | 5.3% | 5.4% | 5.6% | 5.4% | 5.5% |
| Synthetic Rubber/Elastomers | 4.8% | 4.8% | 4.7% | 4.8% | 4.9% | 5.0% | 5.0% | 5.1% | 5.1% | 5.3% |
| Fluids & Lubricants | 4.9% | 4.9% | 4.8% | 4.6% | 4.6% | 4.4% | 4.5% | 4.5% | 4.7% | 4.7% |
| Glass | 2.2% | 2.3% | 2.3% | 2.3% | 2.4% | 2.4% | 2.4% | 2.5% | 2.5% | 2.5% |
| Textiles | 1.9% | 2.0% | 2.0% | 2.1% | 2.2% | 2.2% | 2.3% | 2.3% | 2.4% | 2.4% |
| Natural rubber | 2.1% | 2.0% | 2.0% | 2.0% | 2.0% | 2.0% | 1.9% | 1.8% | 1.8% | 1.7% |
| Coatings | 1.1% | 1.1% | 1.1% | 1.1% | 1.0% | 1.0% | 1.0% | 1.0% | 1.0% | 1.0% |

Note. Due to rounding, figures may not add to 100%.
See *Data and Methodology* for data sources.
Data include revisions.

## The Value of Chemistry in Automobiles

The value of the chemistry content in an average automobile was $4,371 in 2023, up 31% (or $1,047) compared to a decade ago. The chemistry content includes $695 in plastics and polymer composites, $679 in synthetic rubber and elastomers, $567 in semiconductors and other electronic chemicals, $291 in fluids and lubricants, and $329 in textiles, along with hundreds of dollars' worth of other products of chemistry.

*Figure 4.* Value of Select Chemistries in an Automobile

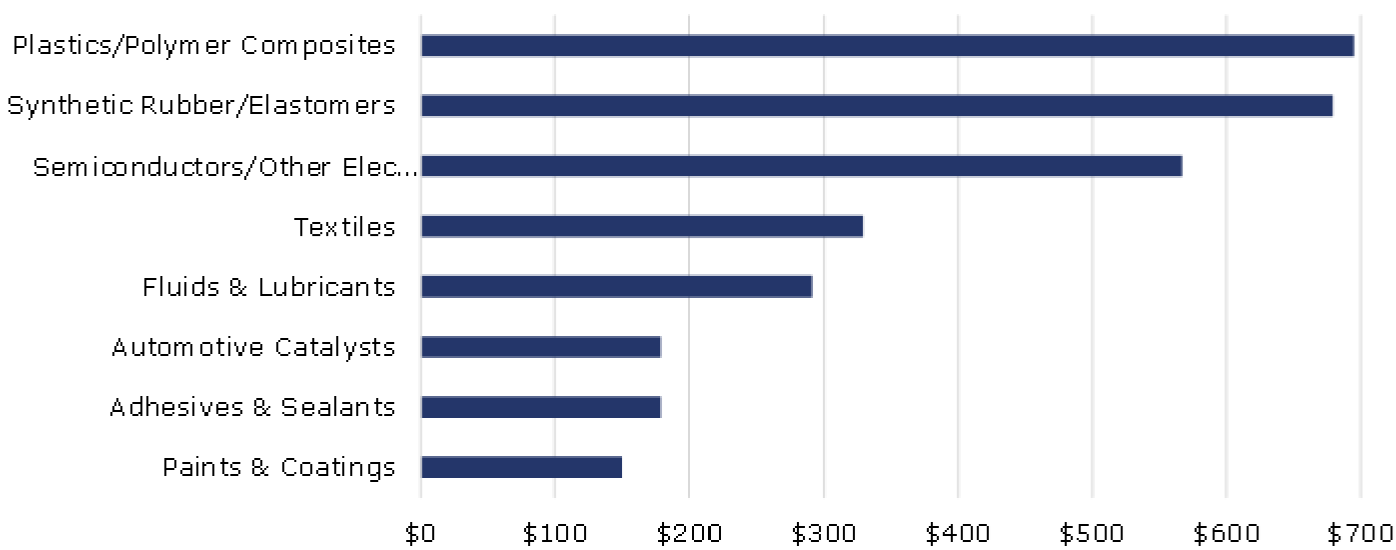


**Table 6. Value of Chemistry in an Average Automobile ($/vehicle)**

| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|
| Plastics & Polymer Composites | 589 | 553 | 540 | 571 | 581 | 583 | 577 | 710 | 773 | 695 |
| Synthetic Rubber/Elastomers | 595 | 551 | 522 | 554 | 570 | 549 | 537 | 650 | 681 | 679 |
| Semiconductors & Electronic Chemicals | 422 | 413 | 433 | 396 | 450 | 480 | 504 | 540 | 540 | 567 |
| Textiles | 226 | 219 | 214 | 221 | 235 | 237 | 229 | 275 | 311 | 329 |
| Fluids & Lubricants | 210 | 209 | 221 | 240 | 246 | 267 | 320 | 314 | 301 | 291 |
| Automotive Catalysts | 164 | 167 | 168 | 170 | 171 | 173 | 175 | 180 | 182 | 179 |
| Adhesives & Sealants | 102 | 102 | 103 | 108 | 111 | 114 | 115 | 136 | 155 | 179 |
| Paints & Coatings | 114 | 112 | 111 | 115 | 104 | 112 | 112 | 129 | 148 | 150 |
| Carbon Black | 73 | 67 | 63 | 74 | 79 | 82 | 77 | 95 | 140 | 134 |
| Plastics Compounding | 70 | 71 | 75 | 83 | 85 | 103 | 108 | 110 | 130 | 128 |
| Plastics Additives | 85 | 74 | 69 | 73 | 83 | 79 | 73 | 98 | 106 | 96 |
| Rubber Processing Chemicals | 66 | 66 | 67 | 64 | 64 | 62 | 60 | 59 | 77 | 69 |
| Other Chemistry* | 608 | 588 | 630 | 664 | 701 | 747 | 783 | 847 | 841 | 875 |
| **Total Chemistry Value ($)** | **$3,324** | **$3,192** | **$3,216** | **$3,333** | **$3,480** | **$3,588** | **$3,670** | **$4,143** | **$4,385** | **$4,371** |

*Includes processing chemicals.
Note. See *Data and Methodology* for data sources.
Data include revisions.

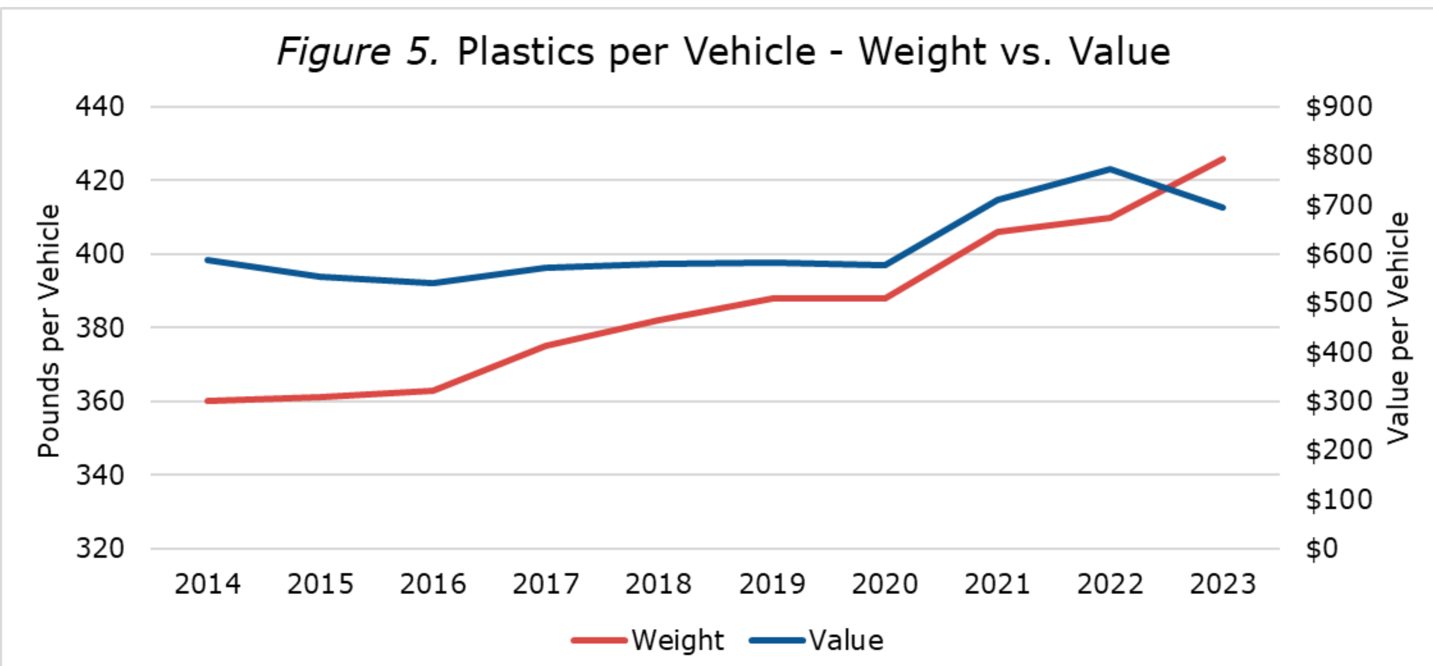
## *Value of Plastics & Polymer Composites*

The value of plastics and polymer composites in an average automobile was $695 per vehicle in 2023, an increase of 17% compared to a decade ago, although it is slightly lower than the past two years due to higher pricing in 2021 and 2022 for many products. This includes $92 of nylon, $74 of polyurethane foam, and $58 of polypropylene. Although the value of plastics and polymer composites generally increase as the cumulative weight of the products used in a vehicle increase, the pricing of plastics and polymer composites vary year to year and are based on various factors, including feedstock availability and cost, energy costs, labor rates, and currency exchange rates, among others. As such, the trends in value of plastics and polymer composites do not always correlate with the trends in materials use.

**Table 7. Average Value of Plastics & Polymer Composites ($/vehicle)**

| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|
| Nylon | 60 | 52 | 48 | 54 | 65 | 68 | 58 | 62 | 80 | 92 |
| Polyurethane Foam | 57 | 60 | 58 | 59 | 67 | 68 | 63 | 67 | 80 | 74 |
| Polypropylene | 74 | 60 | 49 | 52 | 61 | 50 | 46 | 94 | 79 | 58 |
| Polycarbonate | 35 | 30 | 30 | 25 | 28 | 27 | 29 | 32 | 38 | 36 |
| ABS Resins | 19 | 14 | 14 | 20 | 19 | 14 | 15 | 13 | 26 | 24 |
| PVC | 19 | 18 | 19 | 18 | 20 | 21 | 21 | 40 | 35 | 23 |
| HDPE | 28 | 18 | 19 | 22 | 26 | 25 | 17 | 27 | 27 | 21 |
| All Other Plastics/Polymers | 298 | 301 | 305 | 320 | 296 | 311 | 328 | 375 | 408 | 367 |
| **Total Plastics & Polymer Composites** | **$589** | **$553** | **$540** | **$571** | **$581** | **$583** | **$577** | **$710** | **$773** | **$695** |

Note. See *Data and Methodology* for data sources.
Data include revisions.



## *Value of Synthetic Rubber and Elastomers*

The value of synthetic rubber and elastomers in an average automobile was $679 in 2023, including $133 of olefinic elastomers and $83 of polyurethane elastomers. As with other products, the value of synthetic rubber and elastomers in an average automobile is a function of volume as well as pricing for raw materials.

**Table 8. Average Value of Synthetic Rubber/Elastomers ($/vehicle)**

| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|
| Olefinic Thermoplastic Elastomers | 98 | 98 | 100 | 108 | 107 | 104 | 120 | 127 | 122 | 133 |
| Polyurethane Elastomers | 69 | 69 | 69 | 66 | 67 | 68 | 72 | 75 | 78 | 83 |
| Styrene Butadiene Rubber | 47 | 30 | 27 | 38 | 40 | 33 | 26 | 35 | 39 | 37 |
| Ethylene-Propylene Elastomers (EPDM) | 29 | 29 | 24 | 24 | 26 | 25 | 24 | 26 | 28 | 26 |
| Polybutadiene | 25 | 17 | 18 | 23 | 24 | 19 | 17 | 24 | 27 | 21 |
| Butyl Rubber | 19 | 13 | 11 | 17 | 17 | 15 | 13 | 17 | 19 | 18 |
| Other Synthetic Rubber | 308 | 295 | 273 | 278 | 289 | 285 | 265 | 347 | 368 | 360 |
| **Total Synthetic Rubber/Elastomers** | **$595** | **$551** | **$522** | **$554** | **$570** | **$549** | **$537** | **$650** | **$681** | **$679** |

Note. See *Data and Methodology* for data sources.
Data include revisions.

## *Other Products of Chemistry*

The automotive industry is one of the largest end users of semiconductors and other electronic chemicals, which enable a wide range of safety and performance functions in automobiles. Features which were recently limited to luxury vehicles, such as advanced driver assistance systems (ADAS), navigation systems, adaptive cruise control, in-vehicle infotainment (IVI) systems, and keyless entry, are made possible by semiconductors and electronic chemicals. An average vehicle contained $567 in semiconductors and other electronic chemicals in 2023, up 35% compared to just ten years ago.

Adhesives and sealants play a large role in the manufacturing of automobiles, from bonding body panels to attaching trim to sealing windows and doors. Chemistries used in adhesives and sealants include polyurethanes, epoxies, and acrylics, among others. Carbon black is a major component of tires, but it is also used in other elastomers such as hoses, belts, and cables, as well as in paints and coatings.

## *Processing Chemicals*

Chemistry is a critical component to the processing of many of the materials that go into automobiles. While these products are often not present in the finished vehicle, they are integral to the production process. In addition to $69 in rubber processing chemicals, other processing chemicals contribute $669 to the value of chemistry in an average automobile. This includes industrial gases, which are used in applications such as welding, cutting, and testing vehicle components; metalworking fluids; water treatment chemicals; and textile chemicals, among others.

## Chemistry and Future of Automobiles

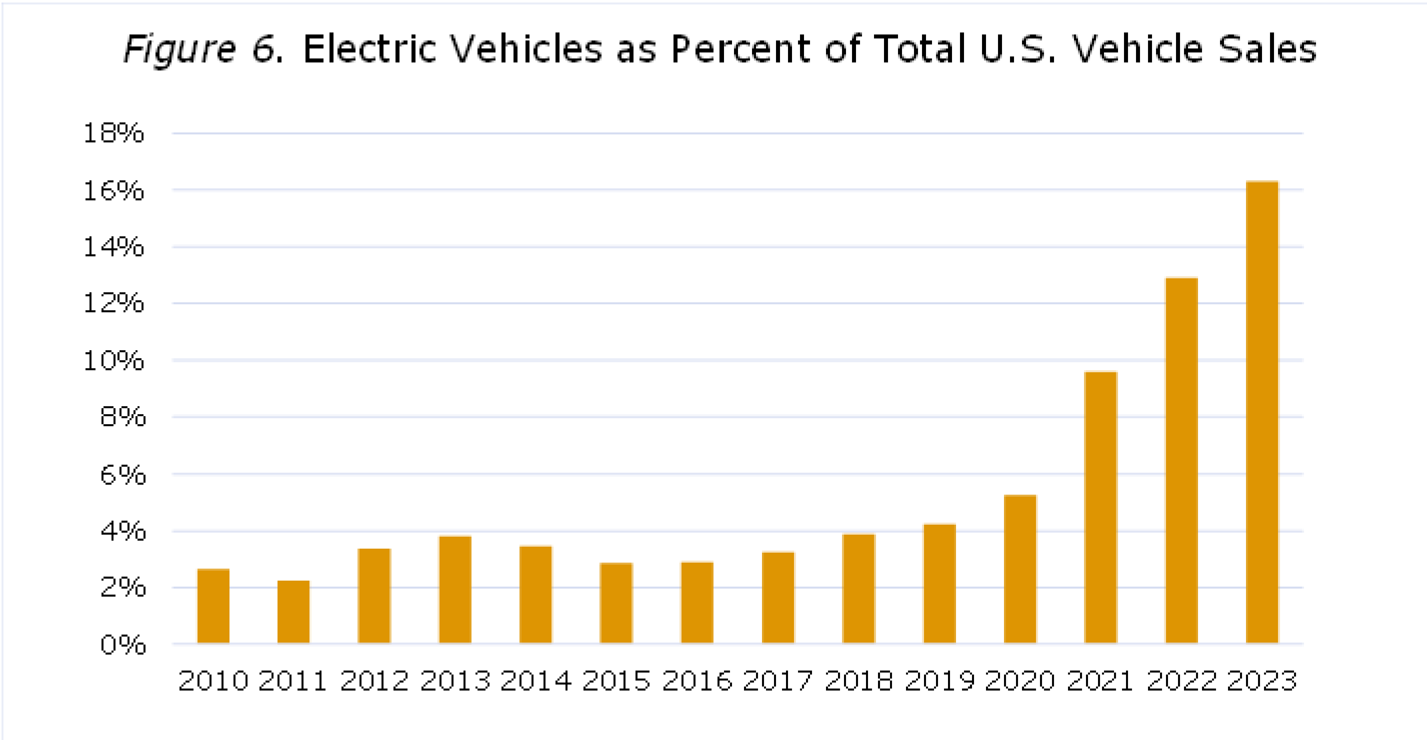
### *Electric and Hybrid Vehicles*

The rising popularity of hybrids, electric vehicles (EVs), plug-in hybrid electric vehicles (PHEVs), and fuel cell vehicles (FCVs) is another factor that influences statistics related to the weight and materials composition of an average automobile. In general, EVs are significantly heavier than their gasoline-powered counterparts, primarily due to the battery weight. As an example, the GMC Hummer EV's battery alone weighs around 2,800 pounds.[ii]

However, given their relatively lighter weight, plastics and polymer composites can help to offset added weight from the introduction of autonomous and advanced propulsion mechanisms, including batteries and hydrogen fuel cells. The desirable conductive properties of certain plastics and polymer composites make them sought-after materials for various components of electric vehicle batteries, including battery casings and enclosures. Additionally, plastics and polymer composites can be formulated to withstand high heat and can also reduce the risk of thermal runaway (when the battery overheats).

Since the launch of the Toyota Prius—the world's first mass-produced hybrid passenger vehicle—in 1997, the market for hybrid and electric vehicles has grown exponentially.[iii] In 2000, just over 9,000 hybrid and electric vehicles were sold in the U.S. (around 2% of sales); in 2023, hybrid and EVs accounted for more than 16% of sales (around 1.6 million vehicles).

The North American electric vehicle industry is anticipated to continue to grow in coming years, although there is little consensus on the rate of growth. The share of EVs (and hybrids) as a percent of total U.S. vehicle sales has more than quadrupled over the past decade, but it is unlikely the market will continue that growth trajectory. In the U.S., in particular, the EV/hybrid industry faces some challenges, including the need to expand the charging infrastructure and the higher prices point of most EVs as compared to their internal combustion engine (ICE) counterparts.




Source: U.S. Department of Energy, International Energy Agency
Note. Data reflect vehicle sales, not production. Includes hybrid vehicles.

### *Chemistry Content in ICE Vehicles vs. EVs*

As production of EVs and hybrids increases, there will be an increased need for many chemistries and plastics, including those that have only played a minor role in the manufacture of ICE vehicles. The use of chemistries such as polycarbonates, carbon fiber, flame retardants, and electronic chemicals, used in the operations and manufacture of hybrid, PHEVs, and EVs will likely increase in the automotive industry. Based on ACC estimates, an average mid-size EV could contain 450 pounds of plastics and polymer composites—140 more than mid-size ICE vehicle—and 250 pounds of synthetic rubber and elastomers, 85 more pounds.

The use of semiconductors and electronic chemicals is also much more significant in EVs and hybrids. In addition to enabling technologies that are used in many ICE vehicles, such as navigation systems, automatic breaking, and camera systems, EVs and hybrids rely on semiconductors to manage battery systems, motor control, and power distribution, as well as to help maximize energy efficiency. In fact, according to data from USITC, "hybrid electric vehicles can contain up to $1,000" of semiconductor content and, according to Polar Semiconductor, newer EVs can have as many as 3,000 semiconductor chips compared to the 300-1,000 chips in today's average vehicle.[iv, v]

The following table shows the estimated weight, and percent of weight, of key materials in a mid-size ICE vehicle as compared to a similarly sized electric vehicle. The biggest difference in the weight of the vehicles is the weight of the battery, which can account for 25% of an EVs weight compared to less than 2% of an ICE vehicle's weight. An EV battery is actually a battery pack containing hundreds—or thousands—of individual battery cells. There are various types of batteries used in electric vehicles; some of the most common include lithium-ion batteries, nickel-metal hydride batteries, and lead-acid batteries. As such, metals such as lithium, nickel, manganese, and cobalt, which have minimal (to no) use in ICE vehicles, have a significant presence in many EVs. However, companies continue to innovate and explore other battery materials, which will impact the need for various materials. For example, Northvolt, a company based in Sweden, recently developed a sodium-ion battery and some domestic manufacturers are starting to use lithium iron phosphate (LFP) batteries.[vi]

### EV Battery Materials

The primary components in an EV battery are the electrodes, the electrolyte, the separator, and the housing (or casing). The cathode (positive electrode) and anode (negative electrode) carry the electric current that powers the vehicle and account for the bulk of the battery's weight (between 40-75% depending on the specific battery). The anode is typically made of graphite (or graphite materials) and the primary material in the cathode is a metal oxide. The specific metals are what determines the type of battery: in a lithium-ion battery, common cathode materials include lithium cobalt oxide, lithium manganese oxide, lithium iron phosphate, and lithium nickel manganese cobalt oxide; in a nickel-metal hydride battery, the cathode is nickel hydroxide; and in a lead-acid battery, the cathode is lead dioxide.

The electrolyte is the conductive material through which the electrodes flow. In a lithium-ion battery, the electrolyte is generally a lithium salt dissolved in a solvent; as with the cathodes, the materials used in electrolytes vary depending on the type of battery. The separator is a physical barrier to separate the cathode from the anode and is often made of plastic such as polyethylene or polypropylene. The housing (or casing) protects the inner workings of the battery and is generally made of steel or aluminum.[vii]

Other metals like copper and magnesium play a much larger role in the manufacture of EVs than their ICE counterparts: an average EV could contain over 200 pounds of copper compared to 35 pounds in an ICE vehicle. According to the Copper Development Association Inc., in addition to batteries, EVs use copper in electric motors, inverters, and wiring. In fact, "a pure electric vehicle can contain more than a mile of copper wiring in its stator windings."[viii] Magnesium can be used in EV batteries but also in the body of a vehicle as it is a lightweight metal.

Carbon fiber is another material that is has significant use in EVs. Carbon fiber is five times stronger than steel, but significantly lighter, making it a good material for structural components of EVs, such as chassis and body panels. Carbon fiber is often blended with plastic resins such as PVC or epoxy to create carbon fiber reinforced polymers (CFRP), or carbon fiber composites. These composites often have qualities that are superior to carbon fiber alone, such as corrosion resistance and moldability.

**Table 9. Materials in an Average Mid-Size ICE vs. EV (lbs./vehicle)**

| | Mid-Size ICE Vehicle | | Mid-Size EV | |
|---|---|---|---|---|
| | **Pounds** | **% of Total** | **Pounds** | **% of Total** |
| **Total Vehicle Weight** | **3,300** | | **4,500** | |
| Battery Weight | 40 | 1.2% | 1,100 | 24.4% |
| | | | | |
| Steel | 1,580 | 47.9% | 1,800 | 40.0% |
| Aluminum | 380 | 11.5% | 650 | 14.4% |
| Plastics & Composites | 310 | 9.4% | 450 | 10.0% |
| Synthetic Rubber/Elastomers | 165 | 5.0% | 250 | 5.6% |
| Fluids and Lubricants | 150 | 4.5% | 60 | 1.3% |
| Iron | 250 | 7.6% | 190 | 4.2% |
| Textiles | 80 | 2.4% | 110 | 2.4% |
| Glass | 80 | 2.4% | 110 | 2.4% |
| Natural rubber | 70 | 2.1% | 55 | 1.2% |
| Coatings | 40 | 1.2% | 50 | 1.1% |
| Magnesium | 25 | 0.8% | 40 | 0.9% |
| Copper | 35 | 1.1% | 215 | 4.8% |
| Zinc | 45 | 1.4% | 60 | ¤ 1.3% |
| Lead | 25 | 0.8% | 15 | 0.3% |
| Carbon Fiber/Graphite* | 0.3 | 0.0% | 210 | 4.7% |
| Lithium | - | - | 50 | 1.1% |
| Nickel | - | - | 55 | 1.2% |
| Manganese | - | - | 55 | 1.2% |
| Cobalt | - | - | 55 | 1.2% |
| Other Materials | 65 | 2.0% | 19 | 0.4% |

*Both carbon fiber and graphite are forms of carbon; sometimes these materials are used as a composite with other materials. As such, for this analysis, the volume and value of carbon fiber and graphite materials is combined.
Note. See *Data and Methodology* for data sources.
It should be noted that the data in this table is intended to be representative of a mid-sized ICE vehicle and a mid-size EV and is not comparable to data on average weights presented in presented elsewhere in this report.

*Value of Chemistry in EVs*

In addition to containing more plastics and other products of chemistry by weight, the value of chemistry content in an EV is estimated to be nearly twice that of a similarly sized ICE vehicle. Materials such as semiconductors and carbon fiber (and composites) are expensive and contribute significantly to the value of chemistry in an EV: a mid-size EV could contain $1,000 in semiconductors and electronics chemicals—more than twice its ICE counterpart—and nearly $1,500 in carbon fiber, which accounts for perhaps $10 in chemistry value in an ICE vehicle.

Additionally, a mid-size EV could contain $730 in plastics and polymer composites, $730 in synthetic rubber and elastomers, and $180 in adhesives and sealants. All told, the chemistry value in a mid-size EV could be nearly $6,000 – 85% more than a mid-size ICE vehicle.

*Figure 7.* Materials Comparison
*Difference Between EV and ICE Vehicles*

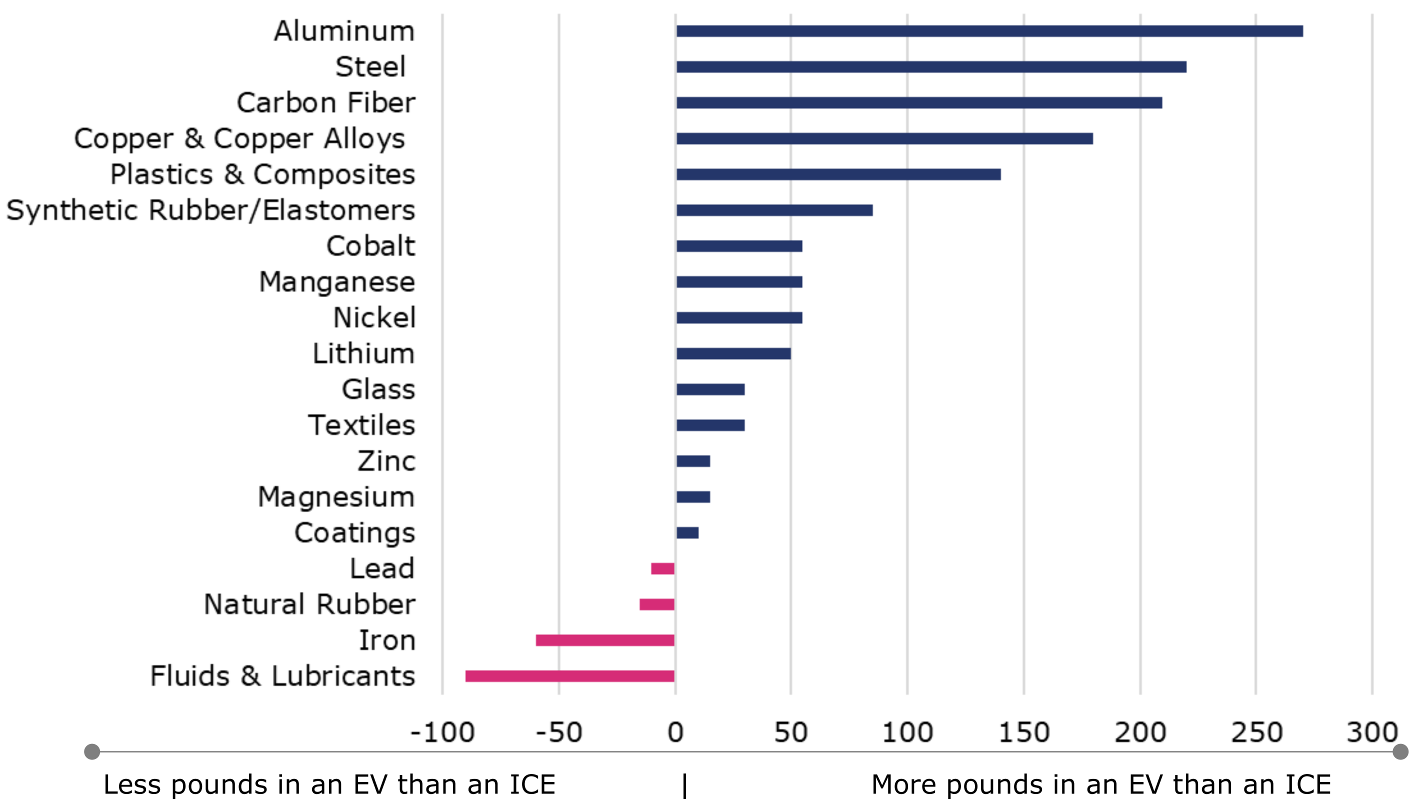


**Table 10. Estimated Value of Chemistry in an Average Mid-Size ICE vs. EV ($/vehicle)**

| | Mid-Size ICE | Mid-Size EV |
|---|---|---|
| Plastics & Polymer Composites | 500 | 730 |
| Synthetic Rubber/Elastomers | 490 | 730 |
| Semiconductors & Electronic Chemicals | 420 | 1,000 |
| Carbon fiber | 10 | 1,470 |
| Textiles | 250 | 340 |
| Fluids & Lubricants | 210 | 90 |
| Automotive Catalysts | 130 | 50 |
| Adhesives & Sealants | 130 | 180 |
| Paints & Coatings | 140 | 170 |
| Plastics Compounding | 90 | 140 |
| Plastics Additives | 70 | 100 |
| Rubber Processing Chemicals | 50 | 80 |
| Other Chemistry | 750 | 870 |
| **Total Chemistry Value ($)** | **$3,240** | **$5,950** |

Note. See *Data and Methodology* for data sources.
It should be noted that the data in this table is intended to be representative of a mid-sized ICE vehicle and a mid-size EV and is not comparable to data on average weights presented in presented elsewhere in this report.

## *Autonomous Vehicles*

While fully autonomous vehicles have not yet infiltrated the automobile market, many of today's vehicles include semi-autonomous features, such as lane-keeping systems and adaptive cruise control. The cameras and sensors that enable these features use plastics in wiring, harnesses, and connectors—as well as in the cameras and sensors themselves.

Plastics contribute to enhanced safety in self-driving cars, enabling seat belts, airbags, side-curtain bags, windshield inner-layers, pedestrian collision protection safety features, and padded dashes. Brake boosters can be programmed to stop the vehicle and telematics, the coordination between cellular and GPS signals, will need weather resistant composite materials for connection harnesses, housings, and wiring.[ix] Indeed, chemistry will remain a critical element in vehicles of the future.

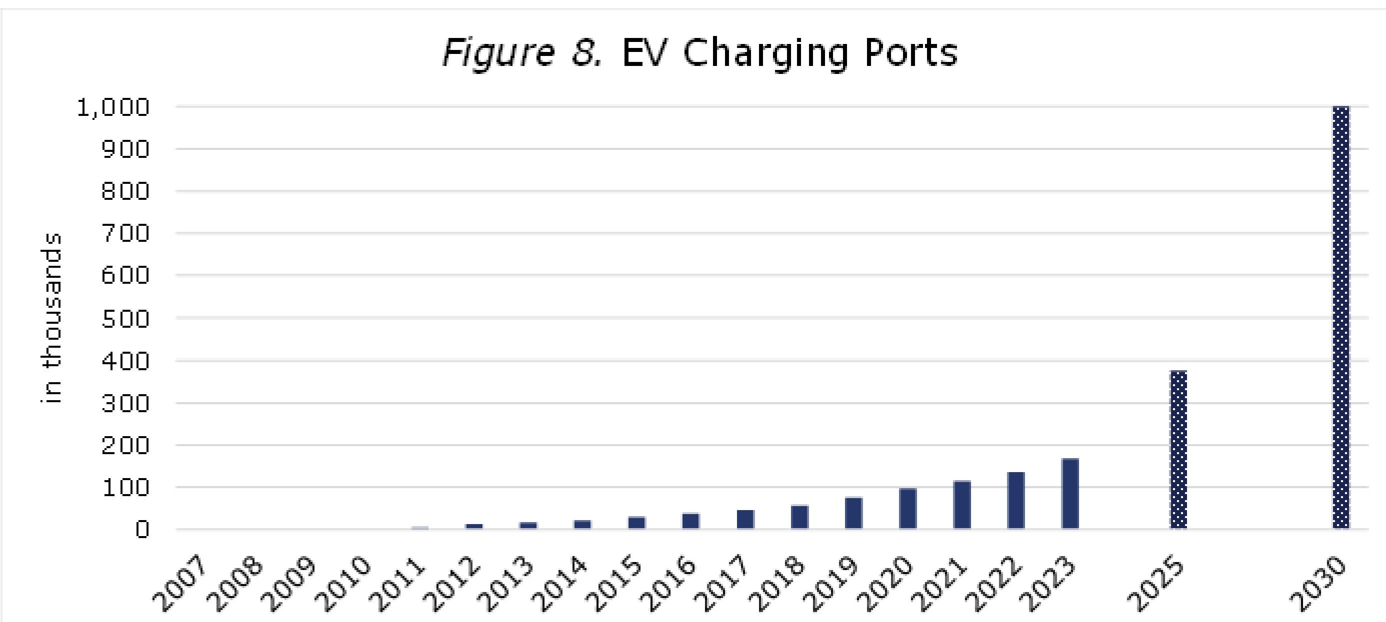
## *EV Infrastructure*

In addition to the chemistry and plastics used directly in electric and hybrid vehicles, chemistry is a key component of the associated infrastructure needed to keep electric vehicles (and plug-in hybrids) on the road. Plastics and other products of chemistry are used for a wide array of components within the larger structure of alternative fueling stations and electric vehicle charging ports, such as charger housings, covers over front displays or touchscreens, lenses, connectors, light guides, wiring, and other components.

The housing for the charging station, or the external structure, protects the power source. Because charging stations tend to be located outside, properties such as UV resistance, the ability to withstand both high and low temperatures, water resistance, and impact resistance are essential. Polybutylene terephthalate (PBT), which has excellent electrical capabilities and low moisture absorption, is commonly used in EV charger housing.

Polycarbonate, which offers glass-like transparency, is used in touchscreens and displays, as well as lighting. The charging gun, which connects the vehicle to the power source, may use advanced nylon polymers which can be formulated with chemical and UV resistance, as well as flame retardant characteristics.

As use of EVs and hybrids continues to grow, the need for EV charging ports will also increase. National Renewable Energy Laboratory (NREL), in the report *The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure*, estimated there could be more than one million publicly accessible EV charging ports in the U.S. by 2030, which is six times the number of publicly accessible EV charging ports in 2023.[x] And as the need for EV charging ports increases, so will the chemicals and polymers used to make them.




*Source: National Renewable Energy Laboratory*

# Conclusion

The automotive industry's pursuit of lighter, more fuel-efficient, and safer vehicles is greatly enabled by the use of plastics and other products of chemistry. In today's average automobile, plastics and polymer composites generally make up 50% or more of the volume of but less than 10% of the weight. Chemistry also plays a pivotal role as electric vehicles and hybrids become a larger share of the automobile market.

The chemistry value in an average automobile was nearly $4,400 in 2023, up 31% compared to a decade ago. With over 15.8 million passenger automobiles and light-duty trucks manufactured for sale in the United States, Canada, and Mexico, the chemistry value in the North American automobile market reached nearly $70 billion in 2023. However, the value of chemistry in an EV could be as much as 85% higher than an ICE vehicle, suggesting the value of chemistry in the automobile market could increase significantly as more EVs and hybrids enter the market.

Many of the innovations in how vehicles are designed, manufactured, and used—both the vehicles of today and those of the future—are made possible by products of chemistry. As the automotive industry continues to evolve, plastics and other products of chemistry will enable manufacturers to respond to advances in automotive technology and changing consumer preferences.

# Data and Methodology

This report presents the results of updated data and methodology regarding the primary materials, particularly the products of chemistry, used in the manufacture of automobiles in North America (the United States, Canada, and Mexico). For the purposes of this analysis, the term “automobile” includes passenger automobiles and light-duty trucks. Since the size, components and features of automobiles vary significantly, this report presents estimated data based on an average automobile.

For many years, the American Chemistry Council (ACC) published an annual *Chemistry and Light Vehicles* report, built upon research on automotive high-tech materials initiated during the 1980s by Dr. TK Swift, who has since retired from ACC. This report, which is in its second year of publication, is not an update to the previously published reports; rather, it is a new analysis of the chemistry and other materials used in the manufacture of automobiles using updated data sources and methodology. As such, the tables and figures in this report are not comparable to data included in the *Chemistry and Light Vehicles* reports.

This report presents analyses of the materials volume and value in automobiles from 2010 through 2023. Production volumes are based on data from United States Department of Transportation’s National Transportation Statistics (NTS), the Canadian Vehicle Manufacturers' Association, and the National Institute of Statistics and Geography (INEGI) supplemented by data and information from the Alliance for Automotive Innovation, the International Organization of Motor Vehicle Manufacturers (OICA), and S&P Global.

Data on materials composition and weight were developed from a range of industry sources including ACC's Plastics Industry Producers Statistics Group, the Aluminum Association, the American Coatings Association, the American Iron and Steel Institute (AISI), Fortune Business Insights, Glass.com, the Association of the Nonwoven Fabrics Industry (INDA), the International Copper Association, the International Organization of Motor Vehicle Manufacturers (OICA), Kloeckner Metals Corporation, Lenntech Water Treatment, Markham Metals, S&P Global, the U.S. Department of Energy, the U.S. Geological Survey (USGS), and the U.S. Tire Manufacturer Association.

Data on the value of chemistry per vehicle were developed based on data and information from sources including ChemAnalyst, Federal Reserve Economic Data, FocusEconomics, NexantECA, S&P Global, the Semiconductor Industry Association (SIA), the U.S. Geological Survey (USGS), and the U.S. International Trade Commission (USITC), as well as various industry and trade publications.

The methodology used to develop weights and values for individual components varied based on the available data. In some instances, there were existing data (or range of data) on the weight and value of a given material in an average automobile. In other instances, data was only available for one aspect (weight or value) and then that data was used to develop the other data point, often using supplemental data. For some materials, only data for the given industry as a whole was available; in those instances, the industry level data was compared to the automotive industry data to develop a per-vehicle figure. The final data includes reasonable assumptions and estimates.

In developing data to compare the materials components of internal combustion engine (ICE) vehicles with the materials components of electric vehicles (EVs), estimates were developed based on the footprint of a hypothetical mid-size vehicle. Since the materials components of EVs vary widely among models and historic data on EVs is limited, these figures are intended to be representative in nature and do not reflect any specific make or model.

Considerable effort has been made in the preparation of this publication to provide the best available information. However, neither the American Chemistry Council, nor any of its employees, agents or other assigns makes any warranty, expressed or implied, or assumes any liability or responsibility for any use, or the results of such use, of any information or data disclosed in this material.

# ACC's Economics & Data Analytics Department

The Economics & Data Analytics Department provides a full range of statistical and economic analysis and services for ACC and its members and other partners. The group works to improve overall ACC advocacy impact by providing statistics on the chemical industry as well as preparing information about the economic value and contributions of the chemical industry to the economy and society.

The lead author of this report was Heather Rose-Glowacki, Senior Director, Industry Intelligence & Analysis.

## *Department Staff*

Martha Gilchrist Moore
Chief Economist & Managing Director
202.249.6182
martha_moore@americanchemistry.com

Keith Belton
Senior Director, Policy Analysis & Statistics
202.249.6219
keith_belton@americanchemistry.com

David Lan
Director, Policy Analysis & Statistics
202.249.6188
david_lan@americanchemistry.com

Heather Rose-Glowacki
Senior Director, Industry Intelligence & Analysis
202.249.6184
heather_rose@americanchemistry.com

Emily Sanchez
Director, Economics & Data Analytics
202.249.6183
emily_sanchez@americanchemistry.com

End Notes:

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[i] Automotive glass presents unique challenges for manufacturing and recycling (acs.org)

[ii] https://insideevs.com/news/668428/hummer-ev-battery-teardown-reveals-excessive-complexity-weightGMC Hummer EV Battery Teardown Reveals Excessive Complexity, Weight (insideevs.com)

[iii] https://global.toyota/en/prius20th/evolution/

[iv] The Automotive Semiconductor Market: Key Determinants of U.S. Firm Competitiveness (usitc.gov)

[v] https://polarsemi.com/blog/blog-semiconductor-chips-in-a-car/

[vi] Northvolt develops state-of-the-art sodium-ion battery

[vii] EV Batteries: How They're Made, Managed, Discarded, and More (justenergy.com)

[viii] https://www.copper.org/publications/pub_list/pdf/A6192_ElectricVehicles-Infographic.pdf

[ix] https://www.automotiveplastics.com/mobility-trends/autonomy/

[x] https://www.nrel.gov/docs/fy23osti/85970.pdf