

CHEMISTRY THAT MATTERS™



# PLASTICS IN THE AUTO INDUSTRY, TODAY AND INTO THE FUTURE

PRESENTATION TO THE NATIONAL ACADEMY OF SCIENCES, FUEL ECONOMY COMMITTEE

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## PREFACE

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In preparation for the NASEM Fuel Economy Committee – Phase 3, SABIC prepared the following information in response to the request to provide input on the **feasibility, cost, mass reduction, safety and research** required to bring mass saving technologies to widespread industry adoption.

These pages detail technologies available today and those in development to reduce vehicle mass, improve fuel economy and reduce green house gas emissions.

- An implementation timeline is used as a surrogate for **feasibility and research**.
- **Optimizing existing technologies** are applications that are in production today and are the focus off continuous mass optimization and parts integration
- **Short-term technologies** are applications that are in production today or could be in production within the next 3 years.

- **Medium-term technologies** are those that may be available between 3-7 years and may require additional research and development to reach full scale production.
- **Long-term technologies** may require more than 7 years to reach production and require extensive research and development.
- **Cost** is not discussed in this document, and is left to companies further down the supply chain.
- **Mass savings** are calculated from a combination of specific gravity difference between the incumbent materials and production materials, as well as, design dependent structural considerations and functional integration.
- Many, if not most, of the applications identified in this document require some level of **safety**. Detailed presentations can be provided at a later date if requested.

## GLOBAL AUTOMOTIVE MARKET TRENDS AND NEEDS

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CO2



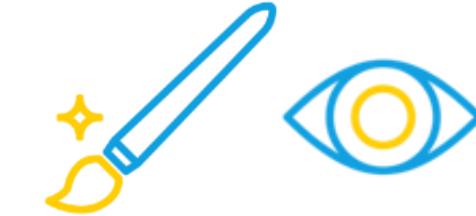
LIGHTWEIGHT



MEETING  
REGULATIONS



AESTHETICS



SAFETY



EV/HEV



AUTONOMOUS

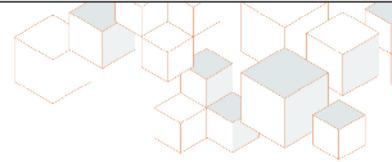


COST COMPETITIVE



Collaborate to reach the best balance between performance, weight and cost.

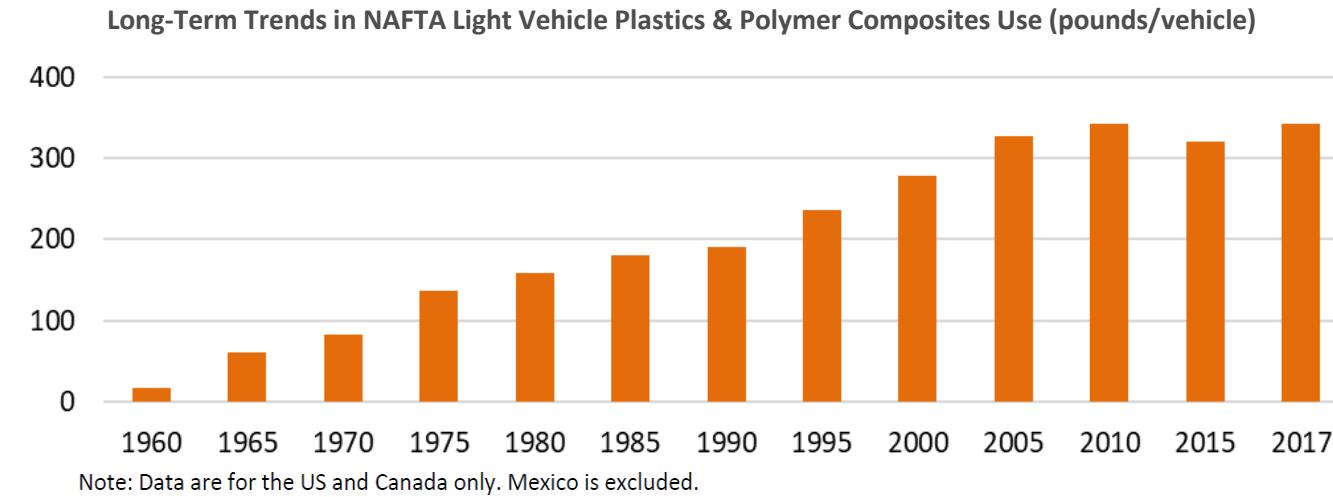
## GROWTH IN PLASTICS



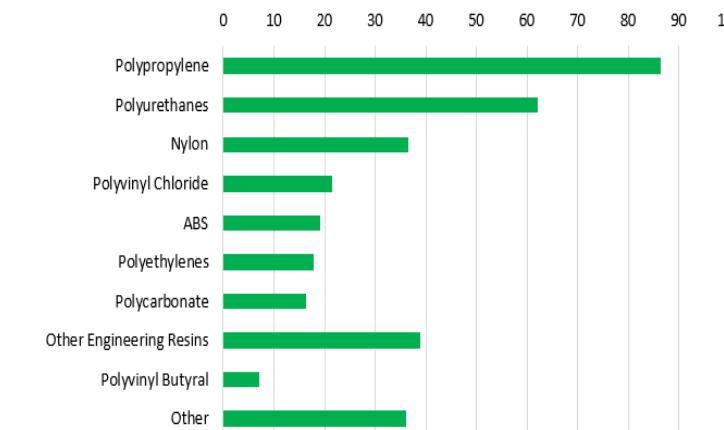
### Plastics and Polymer Composites in Light Vehicles

Economics & Statistics Department  
American Chemistry Council  
November 2017

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Average Plastics & Polymer Composites Use in North American (NAFTA) Light Vehicles in 2017 (pounds/vehicle)



## TECHNOLOGY OUTLINE

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### Optimizing existing applications

- Instrument panels
- Door modules
- Front end modules
- Tailgate inner structures
- Bumper fascias
- Exterior trim
- Interior trim
- Rear quarter window

### Short-term technologies

- Floor rocker reinforcement
- B-pillar reinforcement
- Battery protection solutions
- Instrument panel core back molding
- Moving side window
- Fixed front quarter window
- Panoramic roof
- Windscreen

### Mid-term technologies

- Instrument panel cross car structure
- Composite B-pillar
- Composite hybrid molding
- Backlight with defroster
- Fixed rear quarter window with integrated lighting
- All-plastic liftgate

### Long-term technologies

- Transparent front panel
- Retractable moon roof

PLASTICS IN THE AUTO INDUSTRY, TODAY AND INTO THE FUTURE

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# OPTIMIZING EXISTING TECHNOLOGIES

## OPTIMIZING EXISTING TECHNOLOGIES

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The technologies identified on the following pages represent automotive applications that:

- Have been produced for serial production with an automotive OEM

Mass savings from these applications are calculated from a combination of specific gravity difference between the incumbent materials and production materials, design dependent structural considerations, and functional integration

# WEIGHT SAVINGS FROM COMMERCIALIZED SEMI-STRUCTURAL PARTS

## Instrument panels

Existing



### Current design

Thermoplastic olefin (TPO)  
Mass = 2.8 kg

### Status - Commercial

Replaced TPO at 3.0 mm with LGF PP resin at 2.0 mm

### Mass savings

- Up to 30% mass savings
- 1 kg per vehicle savings

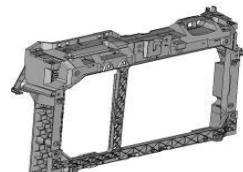
## Door modules

Existing



## Front end module

Existing



### Current design

Steel  
Mass = 6 kg

### Status - Commercial

Multiple vehicles on road with FEMs molded in LGF PP resin replacing multi-piece metal stamping parts

### Mass savings

- Up to 35% mass savings
- 2 kg per vehicle savings
- Reduced number of components from 17 to one

## Tailgate inner structure

Existing



### Current design

Metal (steel) stamping  
Mass = 6 kg tailgate inner

### Status - Commercial

Optimization of part geometry thru predictive simulation and using LGF PP resin

### Mass savings

- Up to 33% mass savings
- 0.5 kg per door
- 2.0 kg per vehicle savings
- 20 parts integrated into 1

### Status - Commercial

Commercialized in plastic tailgates and translated on partial plastic tailgate solutions (inner or outer)

### Mass savings

- Up to 40% weight savings compared to metal
- Component integration
- Inner trim panel
- Potential assembly cost savings

# WEIGHT SAVINGS FROM COMMERCIALIZED AESTHETIC AND TRIM PARTS

## Bumper Fascia

Existing



Current design  
Talc filled TPO  
Mass = 4.0 kg

### Status - Commercial

Bumper Fascia optimization continues to progress with thinwall, low density, and emission optimized mineral filled TPO's.

### Mass savings

- Up to 25% mass savings
- 1 kg per vehicle savings
- Can contribute to lightweighting, improved aero, lower emissions

## Exterior trim

Existing



### Current design

Steel  
Mass = 5 kg

### Status - Commercial

Advanced mineral fillers for PC/ABS enable low CLTE for metal replacement. Maintains OEM gap & flush requirements while meeting mechanical property and aesthetic requirements.

### Mass savings

- Up to 50% mass savings
- Up to 2.5 kg per vehicle savings

## Interior Trim

Existing



Current design  
Molded in Color TPOs  
PC/ABS and ABS Trim

### Status - Commercial

Part optimization continues with respect to thin-wall mass reductions for TPO and Engineering resins. Advanced materials enable further lightweighting through part consolidation

### Mass savings & innovation

- Up to 10% mass savings
- Low density high scratch TPO's for lightweight durability

## Rear quarter window

Existing



### Current design

Glass  
Mass = 2\*4.0=8.0 kg/vehicle

### Status - Commercial

OEM replaced glass with polycarbonate resin to achieve:

- weight saving
- integrated pillars
- aerodynamic functionality

### Mass savings

- 30% to 50% mass savings
- 3.2 kg/vehicle saving (40%) per vehicle savings

# SHORT-TERM TECHNOLOGIES

## 0-3 YEARS

## SHORT-TERM TECHNOLOGIES

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The technologies identified on the following pages represent automotive applications that:

- Have been produced for serial production, or
- Have been validated with an automotive OEM and meet the specifications of that OEM
- Are applications expected to be in production within the next 0-3 years

Mass savings from these applications are calculated from a combination of specific gravity difference between the incumbent materials and production materials, design dependent structural considerations, and functional integration

# WEIGHT SAVINGS FROM PARTS COMMERCIALIZED, VALIDATED OR PROTOTYPED FOR STRUCTURAL AND SEMI-STRUCTURAL APPLICATIONS

## Floor rocker reinforcement

Short term



### Current design

High strength steel  
Mass = 1.2 kg each x 2

### Status – Commercial

Innovative, lightweight and efficient energy absorbing plastic/metal hybrid elements for floor rocker reinforcement that can enhance side crash performance

### Mass savings

- Up to 45% mass savings potential
- 1.1 kg per vehicle savings
- Can improve assembly: E-coat capable, no structural adhesive

## B-pillar reinforcement

Short term



### Current design

High strength steel  
Mass = 1.6 kg each

### Status – Validated (prototype)

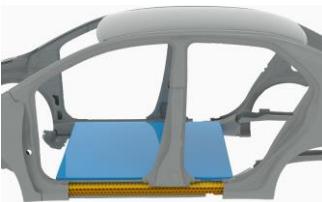
Innovative, lightweight and efficient energy absorbing plastic/metal hybrid elements for B-pillar reinforcement that can enhance side crash and roof crush performance

### Mass savings

- Up to 30% mass savings potential
- 0.5 kg per vehicle savings
- Can improve assembly: E-coat capable, reduced components, no adhesives

## Battery protection solutions

Short term



### Current design

High strength steel  
Mass = 40 kg per vehicle

### Status – Validated (prototype)

A structural hybrid solution, using both plastic and metal, to produce a lighter reinforcement part and one that can potentially improve crash performance

### Mass savings

- Up to 50% mass savings potential
- 20 kg per vehicle savings
- Can improve assembly: E-coat capable, reduced components, no adhesives

## Instrument panel core back molding

Short term



### Current design

Injection molded plastics  
Mass = 3.5 kg

### Status – Commercial

Injection Molding Structural Foaming with Core-back process. Molded at 1.9 mm before foaming to 4.0 mm

### Mass savings

- Up to 15% mass savings potential
- 0.5 kg per vehicle savings
- Low Volatile Emissions, meeting VDA 278 specification

# WEIGHT SAVINGS FROM PARTS COMMERCIALIZED, VALIDATED OR PROTOTYPED FOR GLAZING APPLICATIONS

## Moving side window

Existing



Current design  
Glass  
Mass = 7.8 kg

### Status – Commercial

OEM replaced glass with polycarbonate resin to achieve:

- First movable side window
- Weight saving
- Windows rail integration

### Mass savings

- Up to 33% mass savings potential
- 2.6 kg/vehicle saving per vehicle savings
- Can contribute to HVAC load reduction

## Panoramic roof

Short term



Current design  
Glass  
Mass = 10 kg each

### Status – Commercial

OEM replaced glass with polycarbonate resin to achieve:

- Weight saving
- Aero function
- 3D design

### Mass savings

- 30% to 50% mass savings potential
- 3.0 kg/vehicle saving per vehicle savings
- Can contribute to HVAC load reduction

## Fixed front quarter window

Short term



Current design  
Glass  
Mass = 1.0 kg

### Status – Validated

OEM replaced glass with polycarbonate resin to achieve:

- Weight saving

### Mass savings

- 30% to 50% mass savings potential
- 0.3 kg/vehicle saving per vehicle savings
- Can contribute to HVAC load reduction

## Windscreen

Short term



Current design  
Glass  
Mass = 15.0 kg

### Status – Validated

First front windscreens to replace glass with polycarbonate resin to achieve:

- Weight saving
- Improved aerodynamics

### Mass savings

- 30% to 50% mass savings potential
- 4.5 kg/vehicle saving (30%) per vehicle savings
- Can contribute to HVAC load reduction

PLASTICS IN THE AUTO INDUSTRY, TODAY AND INTO THE FUTURE

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# MEDIUM-TERM TECHNOLOGIES

## 2021-2025

## MEDIUM-TERM TECHNOLOGIES

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The technologies identified on the following pages represent automotive applications that:

- Are under development with an automotive tier supplier, and/or
- Are under development with an automotive OEM
- Have significant engineering data available (e.g. crash simulation, impact testing, etc.), such that validation and production launch could occur within the next 3-7 years

Mass savings for these applications are calculated from a combination of specific gravity difference between the incumbent materials and design intent materials, design dependent structural considerations, and functional integration

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# WEIGHT SAVINGS FROM COMPOSITE MATERIALS IN STRUCTURAL PARTS UNDER DEVELOPMENT

## Instrument panel cross car structure

Medium-term



### Status – Development

Composite, lightweight, cross car beam molded to replace steel, magnesium or aluminum. Integrated features for steering and center stack

### Current design

Steel = 10 to 12 kg  
Aluminum = 7 – 9 kg  
Magnesium = 5 – 7 kg

### Mass savings

- 30% to 60% mass savings potential
- 2.5 – 7 kg per vehicle

## Composite B-pillar

Medium term



### Status – Validated (CAE)

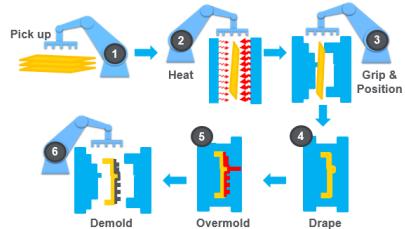
Lightweight composite B-pillar solution meeting side crash, roof crush and durability requirements

### Mass savings

- Up to 40% mass savings potential
- 3 kg per vehicle savings
- Can contribute to ease of assembly – E-coat, reduced number of components

## Composite hybrid molding process

Medium term



### Status – Technology available

Integrated molding of composite plastic hybrids solutions to reduced cycle time

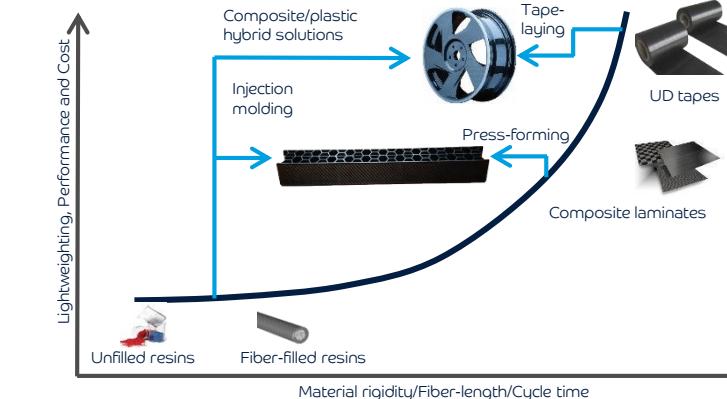
### Current Solutions

High pressure RTM for thermoset composites

### Advantages

- Reduced cycle time to 1 min
- In mold consolidation of composites

## Composite hybrid technology



### Advantages of Hybrids:

- High strength and stiffness
- High design freedom
- High functional integration
- High degree of automation
- Short cycle times
- Local reinforcement

# WEIGHT SAVINGS FROM PARTS UNDER DEVELOPMENT

## Backlite with defroster

Medium term



### Current design

Glass  
Mass = 8.0 kg/vehicle

### Status – Validated

Working with OEM to replace glass with polycarbonate resin to achieve:

- Weight saving
- Integrated spoiler
- Pillars / aero function
- Coming next: lighting integration

### Mass savings

- 30% to 50% mass savings potential
- 2.4 kg/vehicle saving (30%) per vehicle savings
- Can contribute to HVAC load reduction

## Fixed rear quarter window with integrated lighting

Medium term



### Current design

Material = Glass  
Mass =  $2 \times 4.5 = 9.0$  kg

### Status - Prototyped

OEM replaced glass with polycarbonate resin to achieve:

- Weight saving
- Integrated pillars
- Aero function
- Lighting integration

### Mass savings

- 30% to 50% mass savings potential
- 3.6 kg/vehicle saving (40%) per vehicle savings
- Can contribute to HVAC load reduction

## All-plastic tailgate & backlite

Medium term



### Current design

Steel, glass, plastic  
Mass = 28 kg per tailgate

### Status – Validation in process

Working with OEMs to replace glass with polycarbonate resin to achieve:

- Weight saving
- Integrated spoiler
- Pillars / aero function
- Lighting integration
- Backlit logo

### Mass savings

- Up to 30% mass savings potential
- 8.4 kg/vehicle saving per vehicle savings
- Can contribute to HVAC load reduction
- Component integration



## PLASTICS IN THE AUTO INDUSTRY, TODAY AND INTO THE FUTURE

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LONG-TERM >2025

## LOOKING FORWARD

## Global trends

Environmental challenges

Urbanization, population growth

Shifting global economy

Changing demographics

Consumer preferences

## Mobility challenges

Accidents

Congestion

Pollution

Consumption

Inequality

## 4 trends in automotive / mobility

**Autonomous**

Vehicles drive themselves and replace humans

**Connected**

Vehicles exchange data w/ infrastructure / other cars

**Electrification**

Electricity replaces gasoline and diesel fuels

**Shared**

Car- and ride-sharing compete w/ ownership

## LONG-TERM TECHNOLOGIES

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The technologies identified on the following pages represent automotive applications that:

- May require a longer time period to develop (more than 7 years)
- Require significant engineering data and validation in order to meet the specifications of automotive OEMs

Mass savings for these applications are calculated from a combination of specific gravity difference between the incumbent materials and design intent materials, design dependent structural considerations, functional integration

## WEIGHT SAVINGS FROM PARTS UNDER DEVELOPMENT

### Transparent Front Panel



#### Current design

Plated plastic & Mold in Color Grille

Long term

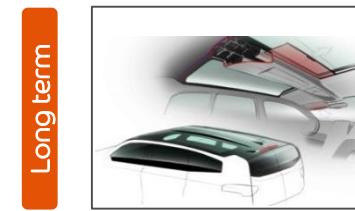
#### Status - Validation

Absence of ICE powertrain opens door to alternate front end concepts. Electric vehicle front panels incorporating transparent polycarbonate allow for light integration and differentiated styling

#### Innovation

- Eliminate grille
- Integrated lighting
- Enhanced styling
- Improve safety

### Retractable moon roof



Long term

#### Current design

Glass  
Mass = 15.0 kg/Vehicle

#### Status – Opportunity

Roof module tier1 working with polycarbonate resin to achieve:

- Weight saving
- Window rail integration
- Fixation integration

#### Mass savings

- 30% to 50% mass savings potential
- 4.5 kg/vehicle saving (30%) per vehicle savings
- Can contribute to HVAC load reduction

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