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

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 greenhouse 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

CO2

LIGHTWEIGHT

MEETING REGULATIONS

AESTHETICS

SAFETY

EV/HEV

AUTONOMOUS

COST COMPETITIVE

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

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
OPTIMIZING EXISTING TECHNOLOGIES
OPTIMIZING EXISTING TECHNOLOGIES

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**

*Current design*
Thermoplastic olefin (TPO)
Mass = 2.8 kg

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

**Status - Commercial**
Replaced TPO at 3.0 mm with LGF PP resin at 2.0 mm

**Door modules**

*Current design*
Steel stamping
Mass = 1.5 kg

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

**Front end module**

*Current design*
Steel
Mass = 6 kg

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

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

**Tailgate inner structure**

*Current design*
Metal (steel) stamping
Mass = 6 kg tailgate inner

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

**Status - Commercial**
Commercialized in plastic tailgates and translated on partial plastic tailgate solutions (inner or outer)
### Bumper Fascia

**Status - Commercial**  
Bumper Fascia optimization continues to progress with thinwall, low density, and emission optimized mineral filled TPO’s.

**Current design**  
Talc filled TPO  
Mass = 4.0 kg

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

### Exterior trim

**Current design**  
Steel  
Mass = 5 kg

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

**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.

### Interior Trim

**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

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

SHORT-TERM TECHNOLOGIES

0-3 YEARS
SHORT-TERM TECHNOLOGIES

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**

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

- **Current design**
  High strength steel
  Mass = 1.2 kg each \(\times 2\)

- **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**

- **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

- **Current design**
  High strength steel
  Mass = 1.6 kg each

- **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**

- **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

- **Current design**
  High strength steel
  Mass = 40 kg per vehicle

- **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**

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

- **Current design**
  Injection molded plastics
  Mass = 3.5 kg

- **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

**Current design**
Glass
Mass = 7.8 kg

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

**Status – Commercial**
OEM replaced glass with polycarbonate resin to achieve:
- First movable side window
- Weight saving
- Windows rail integration

### Fixed front quarter window

**Current design**
Glass
Mass = 1.0 kg

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

**Status – Validated**
OEM replaced glass with polycarbonate resin to achieve:
- Weight saving

### Panoramic roof

**Current design**
Glass
Mass = 10 kg each

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

**Status – Commercial**
OEM replaced glass with polycarbonate resin to achieve:
- Weight saving
- Aero function
- 3D design

### Windscreen

**Current design**
Glass
Mass = 15.0 kg

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

**Status – Validated**
First front windscreen to replace glass with polycarbonate resin to achieve:
- Weight saving
- Improved aerodynamics

### Short term

- Fixed front quarter window
- Panoramic roof
- Windscreen
- Moving side window
MEDIUM-TERM TECHNOLOGIES
2021-2025
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
WEIGHT SAVINGS FROM COMPOSITE MATERIALS IN STRUCTURAL PARTS UNDER DEVELOPMENT

Instrument panel cross car structure

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

Status – Validated (CAE)
Lightweight composite B-pillar solution meeting side crash, roof crush and durability requirements

Current design
High strength steel
Mass = 3.8 kg each

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

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**

**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**

**Current design**
Material = Glass
Mass = 2*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**

**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
LONG-TERM >2025
### LOOKING FORWARD

<table>
<thead>
<tr>
<th>Global trends</th>
<th>Mobility challenges</th>
<th>4 trends in automotive / mobility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental challenges</td>
<td>Accidents</td>
<td>Autonomous</td>
</tr>
<tr>
<td>Urbanization, population growth</td>
<td>Congestion</td>
<td>Vehicles drive themselves and replace humans</td>
</tr>
<tr>
<td>Shifting global economy</td>
<td>Pollution</td>
<td>Connected</td>
</tr>
<tr>
<td>Changing demographics</td>
<td>Consumption</td>
<td>Vehicles exchange data w/ infrastructure / other cars</td>
</tr>
<tr>
<td>Consumer preferences</td>
<td>Inequality</td>
<td>Electrification</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electricity replaces gasoline and diesel fuels</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shared</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Car- and ride-sharing compete w/ ownership</td>
</tr>
</tbody>
</table>
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**

**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

**Current design**
Plated plastic & Mold in Color Grille

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**Retractable moon roof**

**Status – Opportunity**
Roof module tier1 working with polycarbonate resin to achieve:
- Weight saving
- Window rail integration
- Fixation integration

**Current design**
Glass
Mass = 15.0 kg/Vehicle

**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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