Trends in the automotive glazing market

Matthew Beecham
Associate editor, just-auto
Tuesday 10 July 2012
Trends in the automotive glazing market

- Large windshields
- Laminated side glazing
- Panoramic roofs
- Solar panel roofs
- Electric vehicle glazing
- Tomorrow’s glazing
Ford Model T
Large windshields

- Panoramic windshields
- Cielo windshields
- Some examples
Large windshield: Citroën C3

THE NEW CITROËN C3
Large windshield: Opel Astra GTC

New-look Astra Range; GTC BiTurbo, Astra VXR, Astra Hatch, Astra Sports Tourer

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Large windshield: Opel Astra GTC
Laminated glazing

• Benefits:
  – Driver comfort
  – Security

• Other issues
Laminated glazing: Driver comfort
Laminated glazing: Quieter cabin

Source: DuPont
Laminated glazing: Security

Source: DuPont
Laminated glazing: Security

Source: DuPont
Panoramic roofs

• Sunroof emerging as key styling feature
• Sunroof sizes increasing
• Some examples
Panoramic roof: Renault Espace

Espace 2011
27/10/10 For further information please call 01923 697653 or visit www.press.renault.co.uk
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Panoramic roof: Lincoln MKZ
Panoramic roof: Lincoln MKZ
Solar roof

- Already a reality
- Some examples
Solar roof: Toyota Prius

Toyota Prius with solar roof wins second BISVA Green Award

Issued 2011

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Solar roof: Smart Forvision
Electric vehicle glazing

- Renault Frendzy
- Audi A2
Renault Frendzy
Audi A2
Tomorrow’s glazing
LEXAN* POLYCARBONATE GLAZING
The Opportunity for the Automotive Industry

10 July 2012  MATTEO TERRAGNI - Segment Manager Automotive Glazing

CHEMISTRY THAT MATTERS™
SABIC IN NUMBERS

1976, our beginning
36 years of growth

2nd largest global diversified chemical company*
95th largest public company in the world*

88 B$ total assets
50 B$ annual revenue

33,000 employees
40 countries
6 Strategic Business Units

60 world-class plants worldwide
1 Corporate Research & Innovation Center
14 Technology Centers
3 Application Centers
150 new products each year
8,000 global patents
WE RANK AMONG THE TOP PRODUCERS WORLDWIDE

<table>
<thead>
<tr>
<th>#1</th>
<th>#2</th>
<th>#3</th>
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<tbody>
<tr>
<td>Mono-ethylene glycol</td>
<td>Methanol</td>
<td>Polyethylene</td>
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<tr>
<td>MTBE</td>
<td></td>
<td>Polypropylene</td>
</tr>
<tr>
<td><strong>Polycarbonate</strong></td>
<td></td>
<td>Polybutylene terephthalate</td>
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<tr>
<td>Polyphenylene</td>
<td></td>
<td>Engineering plastics and its compounding</td>
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<tr>
<td>Polyether imide</td>
<td></td>
<td></td>
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<tr>
<td>Granular urea</td>
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EXATEC*: ADVANCED GLAZING TECHNOLOGY

- 12 year leadership developing resins, coatings, part design and manufacturing technologies for automotive glazing

- A wide range of enabling technologies for polycarbonate glazing systems – including Exatec glass-like plasma coating

- 9,300 square meter Glazing Technology Development Center in Michigan (USA)

- Globally connected teams with localized application and development support

Enabling Automotive Industry Adoption of Polycarbonate Glazing
LEXAN® POLYCARBONATE GLAZING

VALUE PROPOSITION
APPLICATIONS - EXAMPLES

Wetcoated or Wetcoated & Plasma
Lexan* Polycarbonate everywhere you need performance
Side Window – Backlight – Roof

Seat Leon RQW
GM Corvette Roof
Honda Civic Backlite
BUS Protection Shields
1- WEIGHT REDUCTION - UP TO 50% VS GLASS

17.3 Kg Glazing weight savings

Potential average European fleet annual savings:

3100 million liters

7.2 million MT of CO2 ††

For every 10% reduction in vehicle mass, an increase in fuel economy of 6-7% may be achieved†

†Based on 210 million vehicles at 19,000 km driven per year, 14km/l average, 1150kg average vehicle weight, 10% vehicle weight reduction yields 7% fuel economy improvement.

† Massachusetts Institute of Technology, Laboratory of Energy and Environment report, “Factor of Two: Halving the Fuel Consumption of New U.S. Automobiles by 2035”; Cheah et-al; October 2007
2- DESIGN FREEDOM - UNIQUE STYLING… & AERODYNAMICS…
3- PARTS INTEGRATION - REDUCED COMPLEXITY

Rear Quarter Windows
- RQW wraps-around into roof
- Integrated rear lights
- Fixation elements
- Aerodynamics features

Front Quarter Windows
- FQW wraps-around
- Fixation elements
- Camera

Backlite
- backlight with 3D styling
- D-Pillar cladding integrated
- roof spoiler integrated
- 3rd brake light
- rear wiper foot
- handles
- logos
- Aerodynamics features

Roof
- Sun Blind fixation
- Rails for sunblinding
- Storage Fixation
3- PARTS INTEGRATION - REDUCED COMPLEXITY

Full-size (1.1m²) production capable demonstrator tool
2K Injection-compression process

EXATEC Backlight demonstrator
4- SCRATCH RESISTANCE - QUALITY & DURABILITY

Wet Coat Systems

- <10% Dhaze @ 500cy.
- Taber test (ECE R43) requirements
- No Wiper

Plasma over Wet Coat Systems

- <2% Dhaze @ 1000cy.
- Taber test (ECE R43) requirements
- With Wiper

Different Coating Opportunity for Different Requirements
4- SCRATCH RESISTANCE - QUALITY & DURABILITY

Dedicated team to study fundamentals of scratch damage mechanisms

- Taber®
- Wiper
- Surface wipe
- Car wash

Develop specifications for wiper and abrasion performance

→ Drives Next-Generation coatings development

5 year fleet data (Michigan, USA)
4- SCRATCH RESISTANCE - QUALITY & DURABILITY

Accelerated Wiper Testing

Lab-scale Test

Testing Conditions
Slurry Solution: 5% NaCl and 2.5% ASTM dust in DI water
Slurry Flow Rate: 90 ml/min
Wiper weight: 15 to 25 g/cm
Wiper velocity: 10 to 23 cm/s
Wiper Cycles: 25,000

Exatec E900 Coating insensitive to variations in wiper load & velocity

Load varies across wiper length and from vehicle to vehicle

Velocity varies across the wiper path
Comfort Aspect - Noise Transmission
Acoustic Wind Tunnel PC Glazing Evaluation

Noise transmission up to 1000Hz correlates to the mass

greater 2000Hz better damping behaviour of PC
Near-IR Absorbing Lexan* Resins – Definitions

Solar Energy Distribution

- UV: 200 – 400 nm
- VIS: 400 – 700 nm
- NIR: 700 – 2500 nm

Incident solar radiation

2° Heat transfer to the outside (q_e)

Direct Solar Reflection (DSR)

Direct Solar Absorption (A_s)

Direct Solar Transmission (DST)

2° Heat transfer to the inside (q_i)
Near-IR Absorbing Lexan* Applications

Since 2008...

Near-IR Absorbing PC Auto Glazing on: Spyker C8 Laviolette
6- THERMAL MANAGEMENT IRB - CO2 BENEFITS & COMFORT

Lexan* EXRL0505 Extended Near-IR Absorbing Resin

JUST TEST IT
7- THERMAL M. INSULATION - CO2 BENEFITS & COMFORT

- PC can be a 5x better insulator compared to glass‡‡
- Benefit for both hot and cold environments

Cabin Temperature

<table>
<thead>
<tr>
<th>Soak</th>
<th>Ambient</th>
<th>Comfortable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parked Car</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cabinet Temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; Ambient</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Moving Car

- HVAC
- ON

Moving Car

- Steady State cabin temperature < ambient

‡‡Thermal Conductivity:
- Glass: 1W/m·°K
- Polycarbonate: 0.2W/m·°K

**Analogy ...**

House insulation reduces utility bills

Glazing thermal insulation reduces steady state HVAC load
Lexan Glazing **Thermal Insulation Benefits**  
**Reduces Fuel Consumption by Reducing HVAC Load**

Lower thermal conductivity of Lexan compared to glass allows the vehicle to maintain temperature more easily and reduce HVAC (MAC) load.

- Translates to **fuel savings** and lower emissions for Petrol/Diesel vehicles
- Translates to **reduced battery drain** for Electric and Hybrid Vehicles

<table>
<thead>
<tr>
<th>SEASON (Location)</th>
<th>HVAC load (% change)</th>
<th>MAC indirect emissions (petrol vehicle) (D gCO₂/km)</th>
<th>Single Cycle electric range (% change)</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOLING (Phoenix, Apr - Oct)</td>
<td>-6.3%</td>
<td>-3.2 DgCO₂/km</td>
<td>+2.6%</td>
</tr>
<tr>
<td>HEATING (Minneapolis, Oct – Apr)</td>
<td>-7.1%</td>
<td>Benefit for Hybrids</td>
<td>+3.2%</td>
</tr>
</tbody>
</table>

**Thermal conductivity benefits are:**
- In addition to mass reduction benefits
- Comparable to mass reduction benefits and AC efficiency benefits
Lexan* Glazing Thermal Insulation Benefits & Moisture Effects

<table>
<thead>
<tr>
<th>Measured Parameter</th>
<th>Glass</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inside glazing temperature (°C), with ambient of 0 °C</td>
<td>12.4° C</td>
<td>17.2° C</td>
</tr>
<tr>
<td>Relative humidity (%) at which fogging begins</td>
<td>43.7%</td>
<td>53.4%</td>
</tr>
<tr>
<td>Relative humidity (%) at which fogging glazing is “strongly fogged”</td>
<td>48.8%</td>
<td>58.5%</td>
</tr>
</tbody>
</table>

PC’s low thermal conductivity provides moisture-related benefits

Dipl.-Ing. Manuel Lorenz - Darmstadt, Thermal-Managment
8- WATER CONTACT ANGLE - LESS WATER/ICE STICKINESS

Water Contact Angle

<table>
<thead>
<tr>
<th>Wet Coating</th>
<th>E900</th>
<th>Glass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Contact Angle</td>
<td>83°</td>
<td>73°</td>
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</table>
9- ENVIRONMENTAL - PC LCA - CO2 & ENERGY REDUCTION

Comparison Backlite Glazing - (1.0m²)

- 4.0 mm PC
- 3.2 mm glass

pellets  Molding  Wetcoat  Plasma  Backlite

21% reduction in CO₂, 23% reduction in energy

Comparison Roof Glazing - (1.2m²)

- 4.5 mm PC
- 3.85 mm glass

pellets  Molding  Wetcoat

29% reduction in CO₂, 31% reduction in energy
POLYCARBONATE GLAZING – OVERALL VALUE

1. Weight Reduction = *Lower density & Lower Part Count vs glass*
2. Design Freedom = *unique styling*
3. Parts Integration = *reduced complexity*
4. Scratch Resistance = *quality & durability*
5. Acoustic = *a new opportunity*
6. Thermal IR Management = *CO2 Benefits & Comfort*
7. Thermal Insulation = *CO2 Benefits & Comfort - low fogging tendency*
8. Higher Water contact angle = *less water/ice stickiness*
9. Environmental = *better LCA vs Glass*
FROM POLYCARBONATE GLAZING TO OEM’S OPPORTUNITY

<table>
<thead>
<tr>
<th>PC ATTRIBUTES</th>
<th>VEHICLE LEVEL</th>
<th>OEM’s OPPORTUNITY</th>
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<tbody>
<tr>
<td>Mass density</td>
<td>Weight</td>
<td>Customer</td>
</tr>
<tr>
<td>Thermal Conductivity</td>
<td>Insulation</td>
<td>Vehicle differentiation</td>
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<tr>
<td>Mechanical</td>
<td>Mechanical</td>
<td>Comfort</td>
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<td>Injection Moldable</td>
<td>Design</td>
<td>Fuel use</td>
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<tr>
<td>Additives and Coatings</td>
<td>Functionality</td>
<td>Ease of use</td>
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<td>Environmental</td>
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<td></td>
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<td>CO2 emission</td>
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<td>LCA</td>
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<td>Integration</td>
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<td>Parts reduction</td>
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<td>Assembly reduction</td>
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<td>Durability</td>
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<td>Impact Resistance</td>
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<td>Scratch Resistance</td>
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<td></td>
<td></td>
<td>Weathering</td>
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</tbody>
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Customer
Vehicle differentiation
Comfort
Fuel use
Ease of use

Environmental
CO2 emission
LCA

Integration
Parts reduction
Assembly reduction

Durability
Impact Resistance
Scratch Resistance
Weathering
SEVERAL POLYCARBONATE ATTRIBUTES SERVE MULTIPLE OEM STRATEGIES

ADOPTING POLYCARBONATE GLAZING SHOULD REFLECT CONSIDERATION OF ITS MANIFOLD BENEFITS

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