



Solutions for a Better Tomorrow

Translucent & transparent material solutions enabling design for new mobility

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Translucent & transparent material solutions enabling design for new mobility

- **Design trend for exterior & interior**
- **Material properties**
- **PP material for automotive**
- **Existing Market Solution**
- **Translucent PP-Compound for automotive**
 - Special features & Sustainability
 - Applications examples
- **Conclusion & Step forward**

Design trend for exterior & interior

Exterior

Light signature
User communication



VW ID. LIFE Concept 2021 (IAA 2021)
Source: lyondellbasell internal



Volvo Truck Concept (2018)
Source: A2MAC1.com



Mini Concept Urbanaut (IAA 2021)
Source: A2MAC1.com



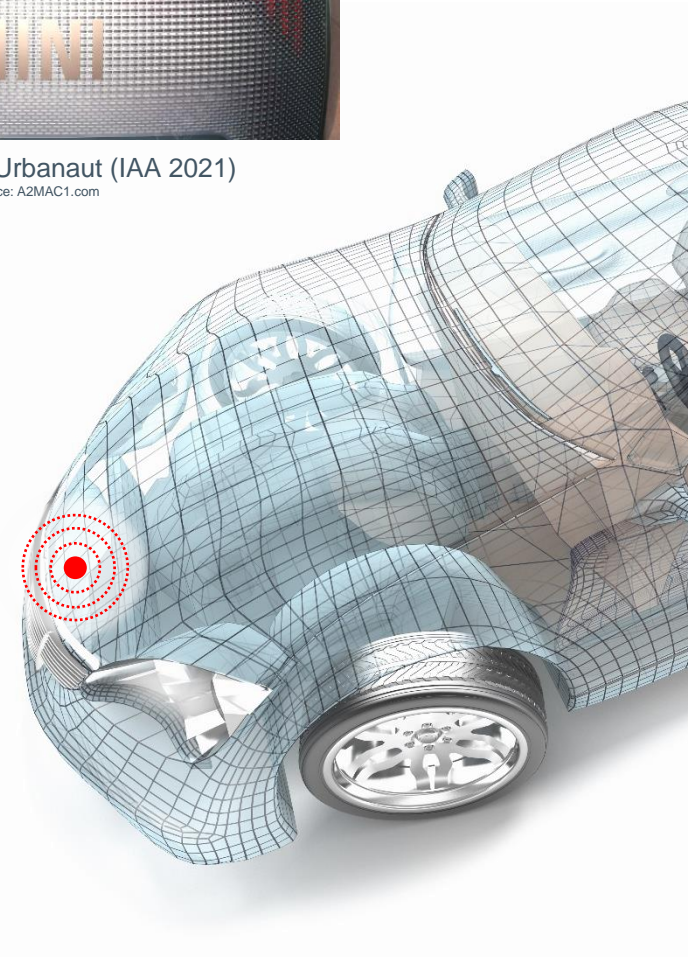
Cadillac Lyriq 2023
Source: A2MAC1.com



DS7 2023
Source: lyondellbasell internal



Hyundai Kona Electric 2023
Source: A2MAC1.com



Design trend for exterior & interior

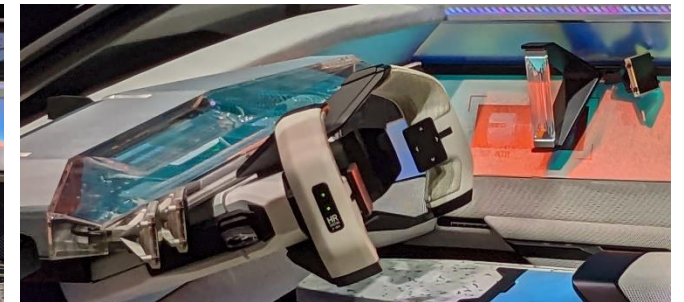
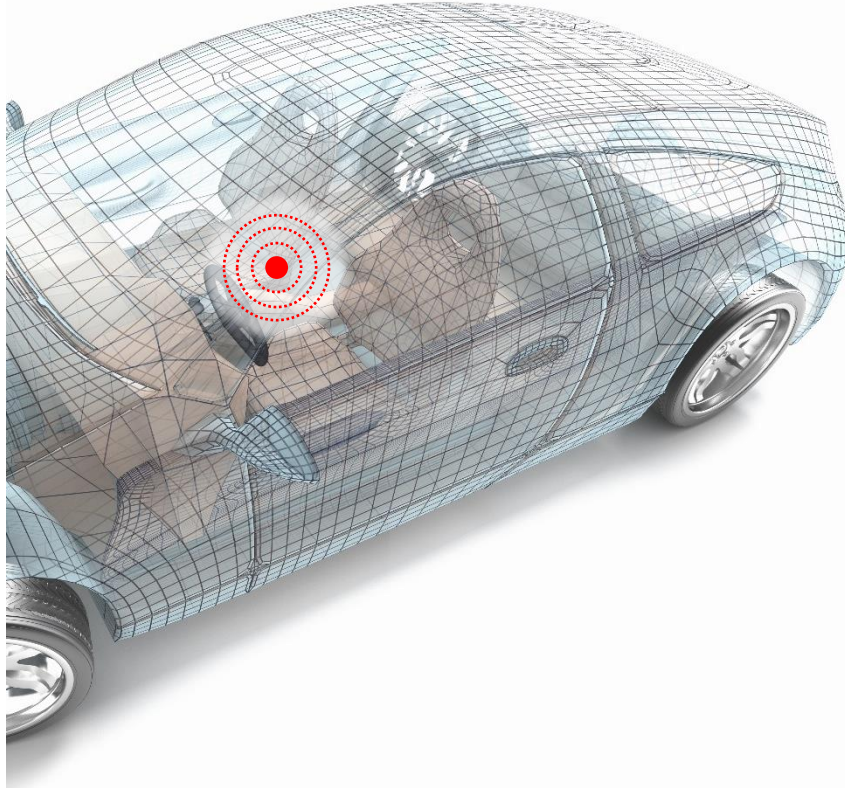
Interior

Ambient Lighting
User communication
Transparent design
Pleasant soft touch haptics



Hyundai concept 8 (IAA 2021)

Source: lyondellbasell internal



RENAULT SCENIC Vision Concept (Paris Mondial Auto 2022)

Source: lyondellbasell internal

PP material for automotive

- **Polypropylene PP & PP-Compound based on copolymer**

- The main Material used for exterior & interior automotive
- Bumper, Body Panel, Interior trims, Door panel...

- **Typical Features**

- Cost competitiveness
- Lightweight Material
- High quality finished part surfaces
- Ductility at low temperature to respect Impact requirements
- Paint-ability according to customer specifications
- Long Term Ageing aspect behavior (UV...)
- Perceived Quality of vehicles functions (Scratch, Creep, Dimensional stability...)
- Car users Health & Care (Fogging, VOC Emissions & Odour)

- **Drawback**

- Low or no transparency property

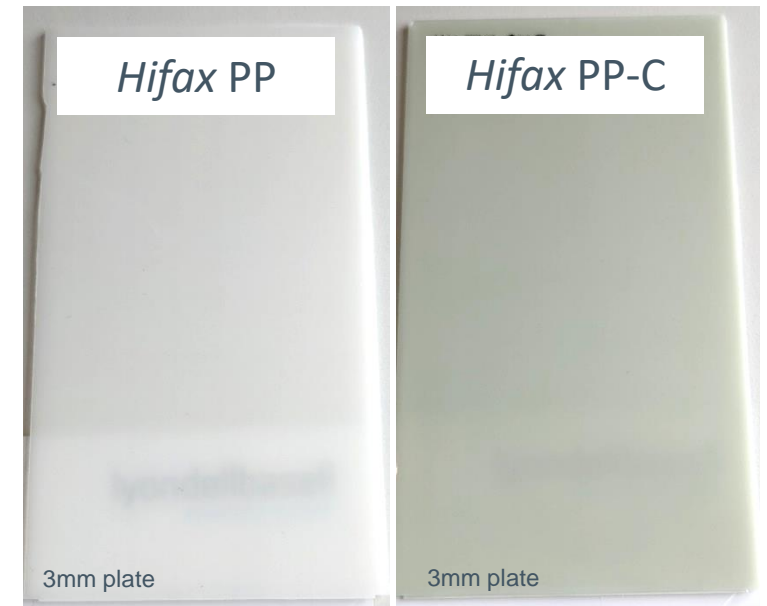


Volkswagen Golf V in 2003

Source: A2MAC1.com



Volkswagen ID.3 in 2023

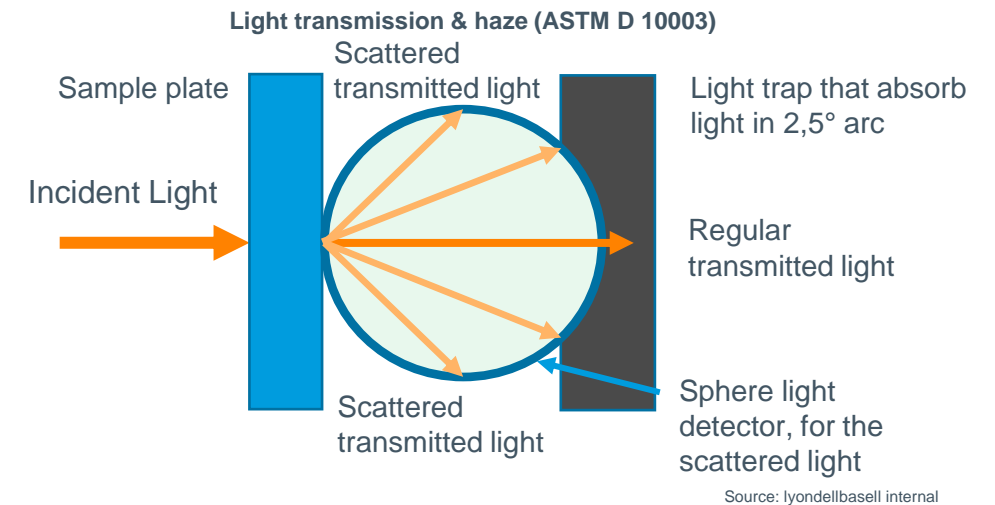
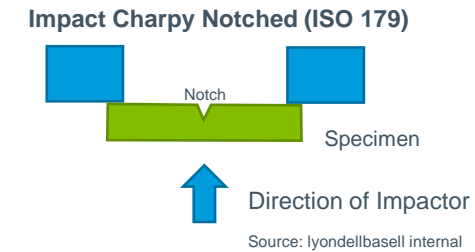
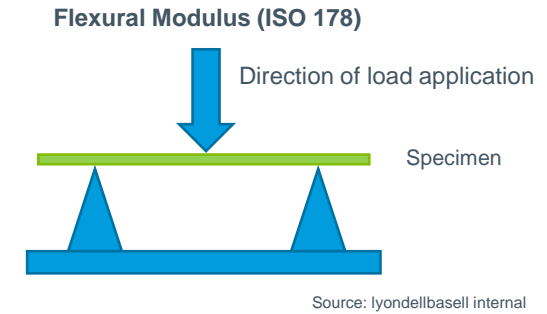


Source: lyondellbasell internal

Material mechanical & optical properties

Description of material properties used in this presentation

- **Density (ISO 1183)**
 - Defines the weight of a part
- **Tensile (ISO 527) & Flexural Modulus (ISO 178)**
 - Defines the rigidity of a part
- **Impact Charpy Notched (ISO 179) 23°C & -20°C**
 - Defines the Impact resistance of a part
- **Luminous Transmittance “light transmission”**
 - ASTM D 1003 definition : Define the amount of light that passes through a part (total light transmission). A material with 100% Luminous Transmittance is totally transparent
 - Also described in ISO 13468
- **Haze “light translucency”**
 - ASTM D 1003 definition : Haze measure the amount of light that passes through a part that is scattered more than 2,5°. A material with 100% haze is totally “milky” or “cloudy”.
 - Also described in ISO 14782



PP material for automotive

- **Polypropylene PP & PP-Compound based on copolymer**

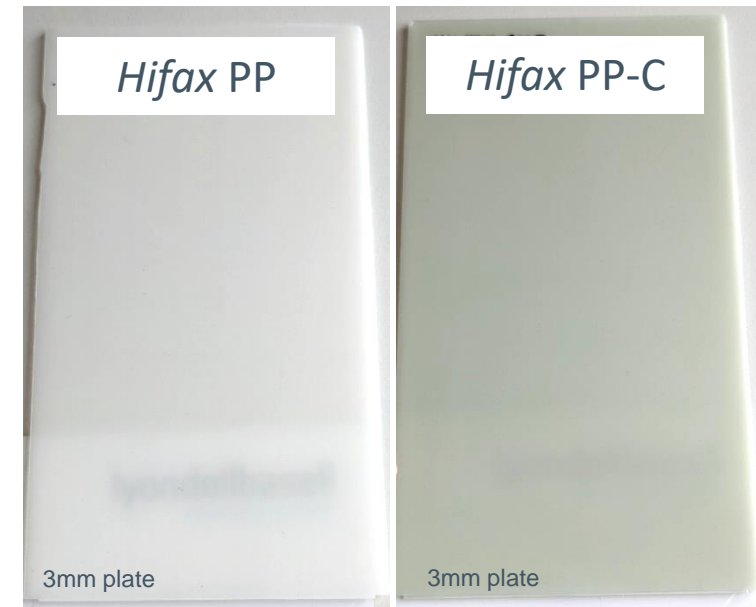
- The main Material used for exterior & interior automotive
- Exemple : Bumper

- **Typical Features**

PROPERTIES	Method	<i>Hifax PP</i> <i>Hifax EP3080</i>	<i>Hifax PP-C</i> <i>Hifax TYC 900P</i>
Density	ISO 1183	0.90	1.01
Flexural modulus at 23°C (MPa)	ISO 178	950	1550
Charpy notched impact at 23°C (KJ/m ²)	ISO 179	65	40
Charpy notched impact at -20°C (KJ/m ²)	ISO 179	15	6
Light Transmission on 3mm plate (%)	ASTM D 1003	15	10
Haze on 3mm plate (%)	ASTM D 1003	100	100

- **Drawback**

- Low or no transparency property



Source: lyondellbasell internal

Existing Market Solution

- **PolyCarbonates (PC) & PolyMethylMetAcrylate (PMMA)**
 - Amorphous engineering plastics that are currently used in almost all optical or lighting application
- **Typical customer applications :**
 - Automotive : Exterior Headlights / Rear lights & Interior light guides
- **Typical Features**
 - Very high transparency / very low haze as well as excellent mechanical properties
- **Drawback**
 - High density , Need UV/Chemical protection ; No co-molding with PP

PROPERTIES	Method	PMMA Typical properties	PC Typical properties
Density	ISO 1183	1,16	1,20
Flexural modulus at 23°C (MPa)	ISO 178	2400	2400
Charpy notched impact at 23°C (KJ/m ²)	ISO 179	3	65
Charpy notched impact at -20°C (KJ/m ²)	ISO 179	1	12
Light Transmission on 3mm plate (%)	ASTM D 1003	92	88
Haze on 3mm plate (%)	ASTM D 1003	1,5	1



DS7 2023
Source: lyondellbasell internal



Hyundai Kona Electric 2023
Source: A2MAC1.com

Existing Transparent PP : RAndom COpolymers (RACO)

- **Polypropylene PP RAndom COpolymers (RACO)**

- Thermoplastic resins produced through the polymerization of propylene, with ethylene bonds introduced in the polymer chain.

- **Typical customer applications :**

- Packaging for household & food

- **Typical Features**

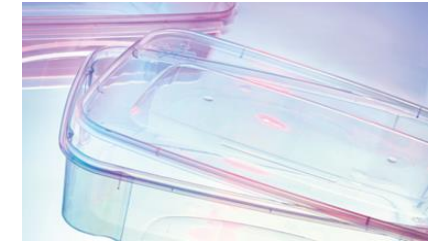
- Good transparency & aesthetic characteristics

- **Drawback**

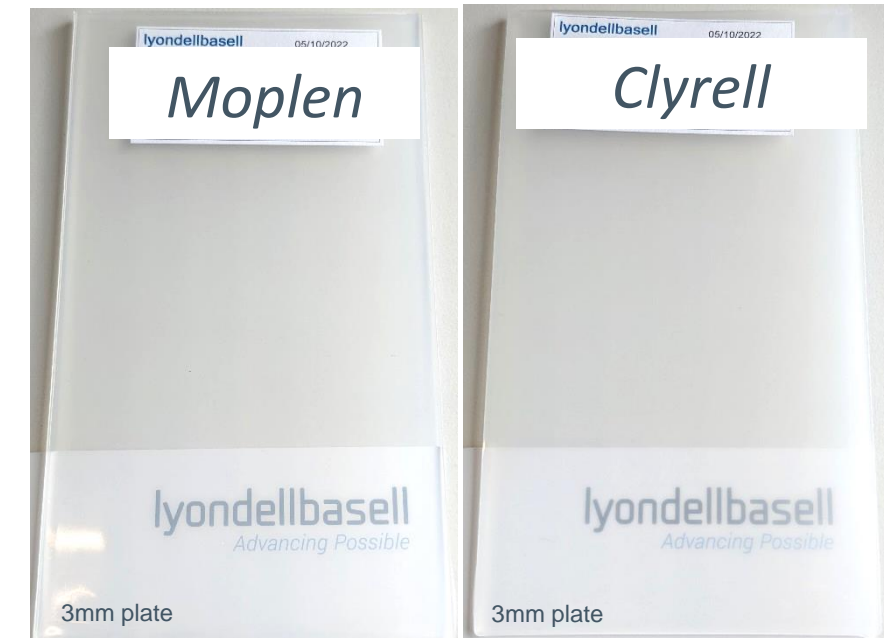
- Limited modulus & low notched impact resistance



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PROPERTIES	Method	<i>Moplen</i> Typical properties	<i>Clyrell</i> Typical properties
Density	ISO 1183	0,90	0,90
Flexural modulus at 23°C (MPa)	ISO 178	1150	1500
Charpy notched impact at 23°C (KJ/m ²)	ISO 179	6	2,5
Charpy notched impact at -20°C (KJ/m ²)	ISO 179	1	1
Light Transmission on 3mm plate (%)	ASTM D 1003	75	70
Haze on 3mm plate (%)	ASTM D 1003	50	70

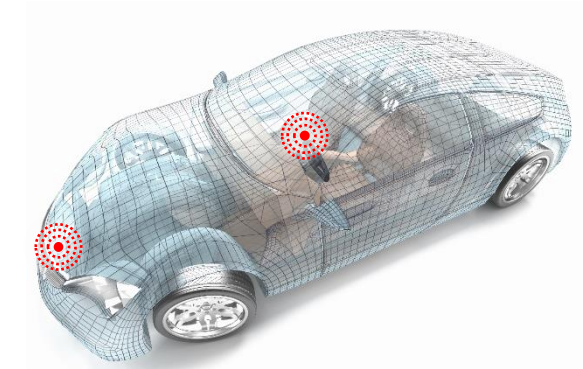
New solution: Translucent PP-Compound

▪ Translucent PP-Compound

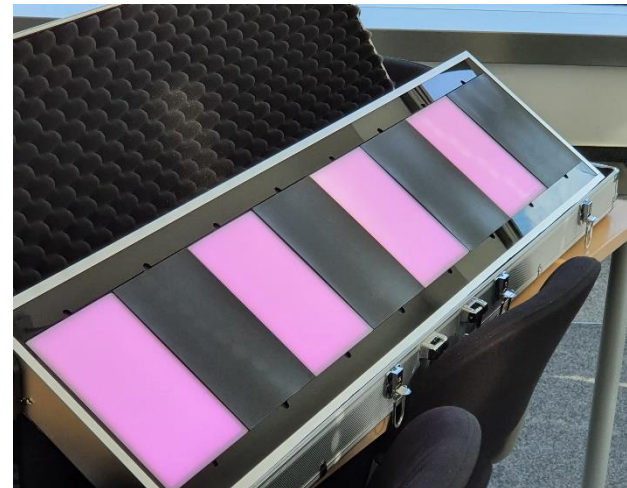
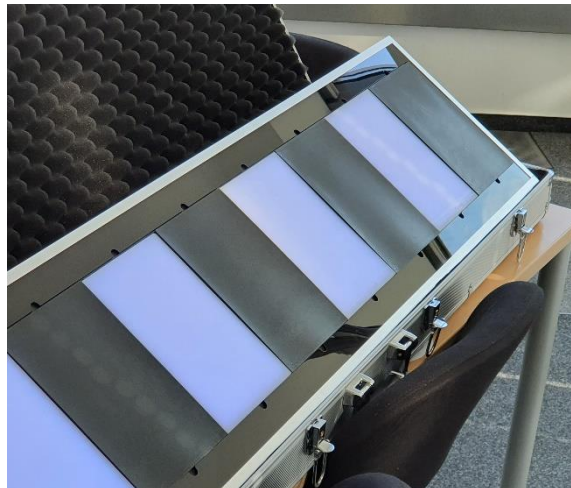
- Advanced compounding technology allows to combine good optical properties & better mechanical properties

▪ Typical Features

- Low density / High Rigidity or High Impact can be achievable
- Good transparency / Medium or high haze (good light diffusion)
- No stress whitening
- UV resistance without coating (interior) / low yellowness
- Impact Multiaxial good performance
- Sustainability can be achieved with *Circulen*Renew



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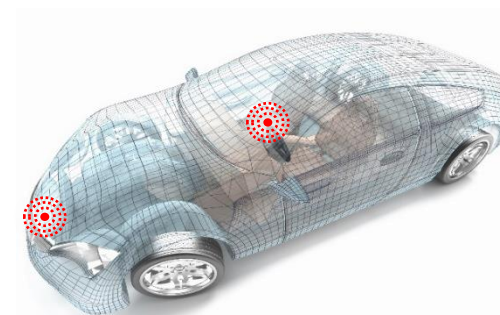
New solution: Translucent PP-Compound

- **Translucent PP-Compound**

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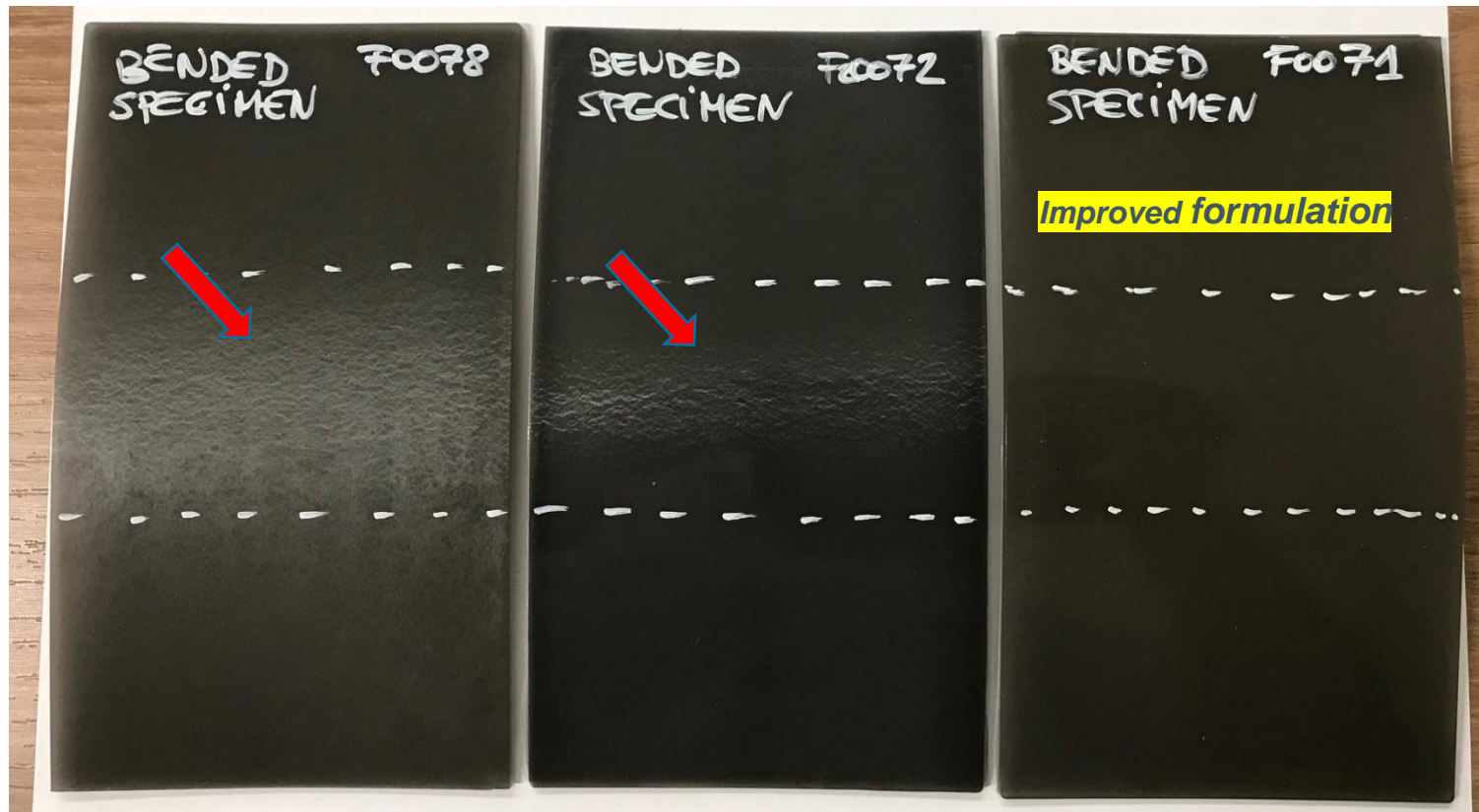
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PROPERTIES	Method	Hostacom EXP 559 CD2032G01	Hifax TRG 2659X CB1732G43	Hostacom TRG 2509Y BF1532G84	Hifax TRS 2526X F22321
Density	ISO 1183	0,95	0,99	0,99	0,91
Flexural modulus at 23°C (MPa)	ISO 178	1400	1200	1800	650
Charpy notched impact at 23°C (KJ/m ²)	ISO 179	25	45	20	45
Charpy notched impact at -20°C (KJ/m ²)	ISO 179	4	6	4	8
Light Transmission on 3mm plate (%)	ASTM D 1003	67	57	70	72
Haze on 3mm plate (%)	ASTM D 1003	100	100	100	77
Remarks		Medium Profile	High impact Profile	High rigidity Profile	High transparency Profile

New solution: Translucent PP-Compound

- **No stress whitening**

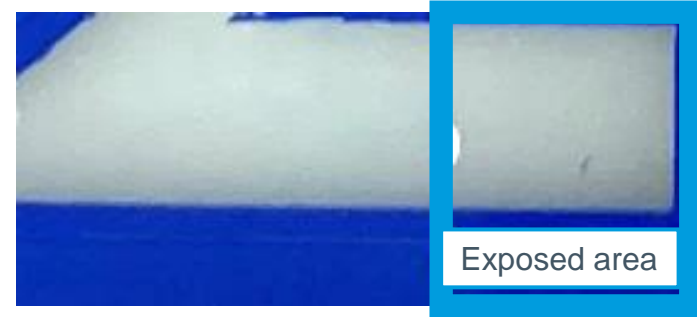
- Stress-whitening is a typical PP defect that occurs when there is a physical constraint on the part
- Translucent PP-Compound are optimized to avoid stress whitening that can be bad for optical properties during the lifetime of a part
- Below *Hifax* translucent plaques bended by hand with some black pigment (to see the defect)



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New solution: Translucent PP-Compound

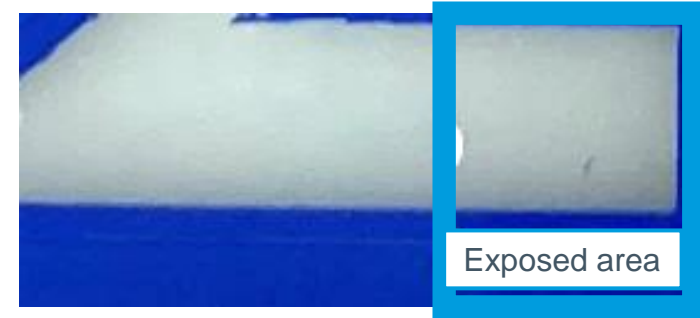
- **UV resistance without coating (interior)**
 - Translucent PP-Compound are optimized to pass typical UV test
 - UV interior test (Weather-O-Meter) 900h/100°C acc. RNES-B-20085
 - Beside Hifax translucent plaque no color/gloss degradation



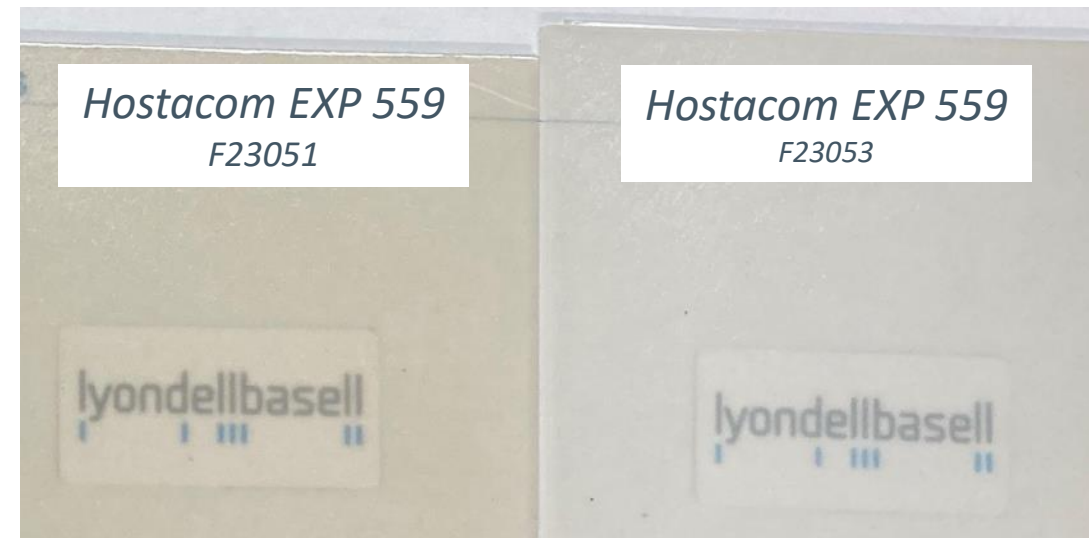
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New solution: Translucent PP-Compound

- **UV resistance without coating (interior)**
 - Translucent PP-Compound are optimized to pass typical UV test
 - UV interior test (Weather-O-Meter) 900h/100°C acc. RNES-B-20085
 - Beside Hifax translucent plaque no color/gloss degradation
- **Yellowness improvement**
 - Last development of Translucent PP-Compound are improved to decrease yellowness



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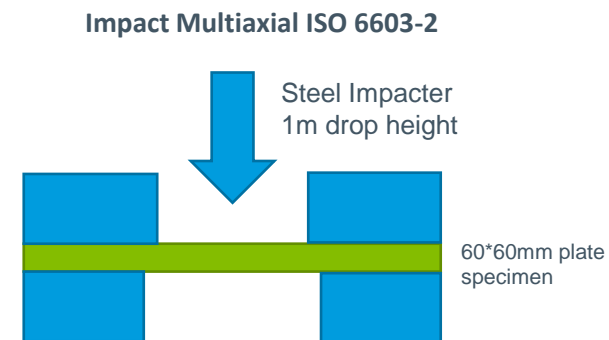
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New solution: Translucent PP-Compound

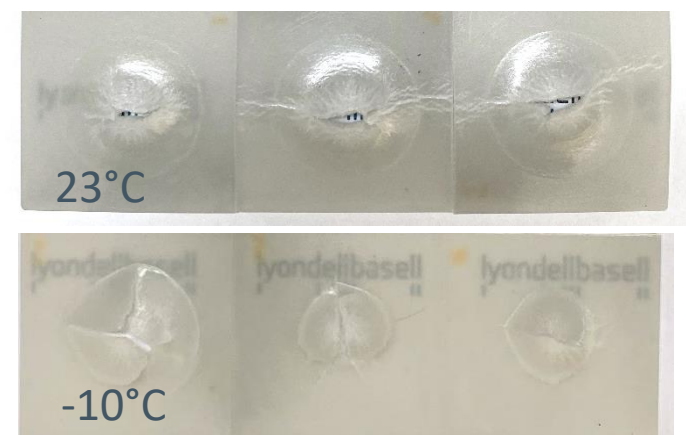
Impact Multiaxial good performance

- This Impact test is more representative for the automotive industry to assess the crash resistance of a material
- We can see that LYB PP-C Translucent pass this test at 23°C and keep 70% of ductility at -10°C

Characteristic	Method	Hifax PP-C Hifax TYC 900P	Hifax TRG 2659X F21412
Density	ISO 1183	1.01	0,99
Charpy notched impact at 23°C (KJ/m ²)	ISO 179	40	40
Charpy notched impact at -20°C (KJ/m ²)	ISO 179	6	6
Multiaxial impact at 23°C, type of break	ISO 6603-2	100% Ductility	100% Ductility
Multiaxial impact at -10°C, type of break	ISO 6603-2	100% Ductility	70% Ductility



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New solution: Translucent PP-Compound

- **Sustainability**
 - Translucent PP-Compound can be available with *CirculenRenew*, Bio-based via mass-balance approach



Polymers made from **renewable feedstocks** such as used cooking oil*

- At least 210% lower GHG emissions for renewable-based PE and PP** compared with virgin-based feedstocks
- One to one Virgin Quality
- Drop in solution
- Life Cycle Analysis ISO 14040-14044 compliant for PP grades – peer reviewed externally



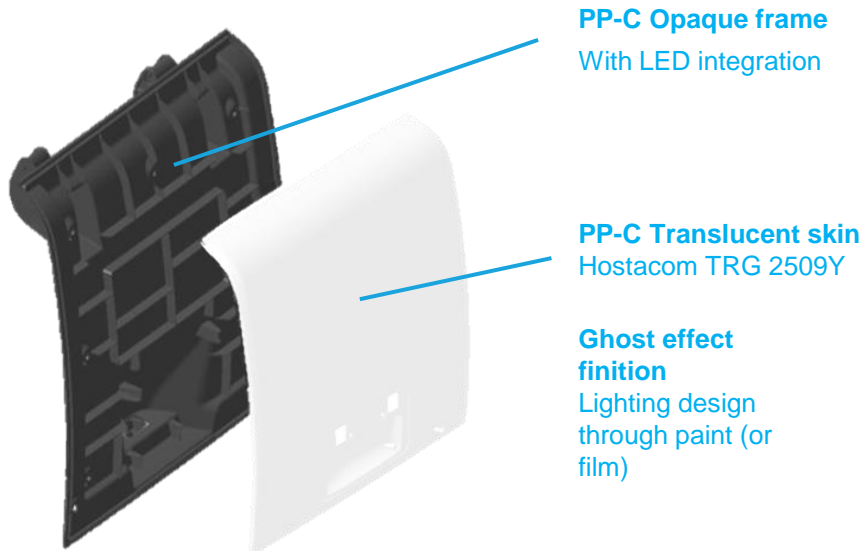
*These polymers are created based on a mass balance approach

**Cradle-to-gate LCA calculations based on a feedstock composed of waste and residue oils, when taking a waste like approach to all raw materials in the feedstock including palm fatty acid distillates (PFAD). PFAD are a production residue from the refining process of palm oil. Taking this approach for PFAD implies that neither upstream burdens nor process burdens for refining of palm oil are attributed to PFAD. Compared to fossil alternatives when using incineration as end-of-life scenario.

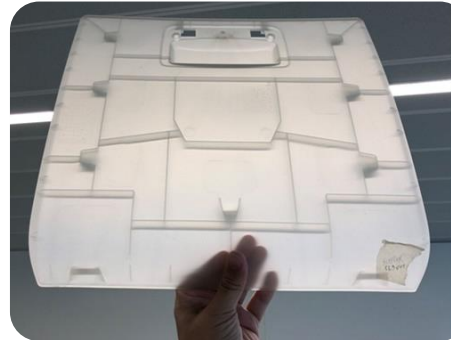
Application example (prototype)

Interior application : Backlighting storage door

- ✓ Injection of PP-C Translucent on existing PP-C mold
- ✓ Assembly with current PP-C material frame
- ✓ LED system inside
- ✓ Painting with ghost effect (effect not visible when the light is off)



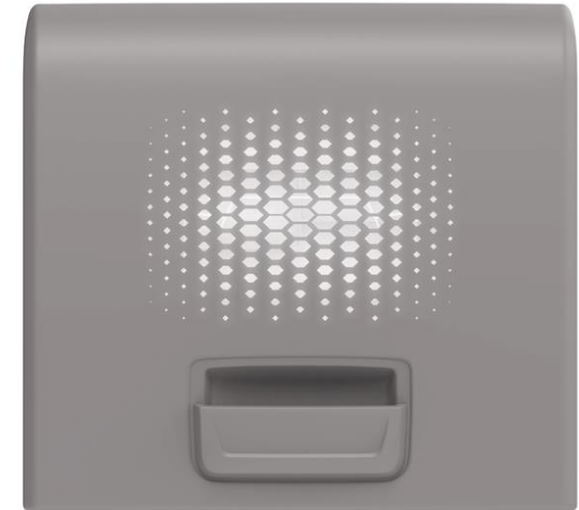
STS Group (APG group) & LyondellBasell collaboration



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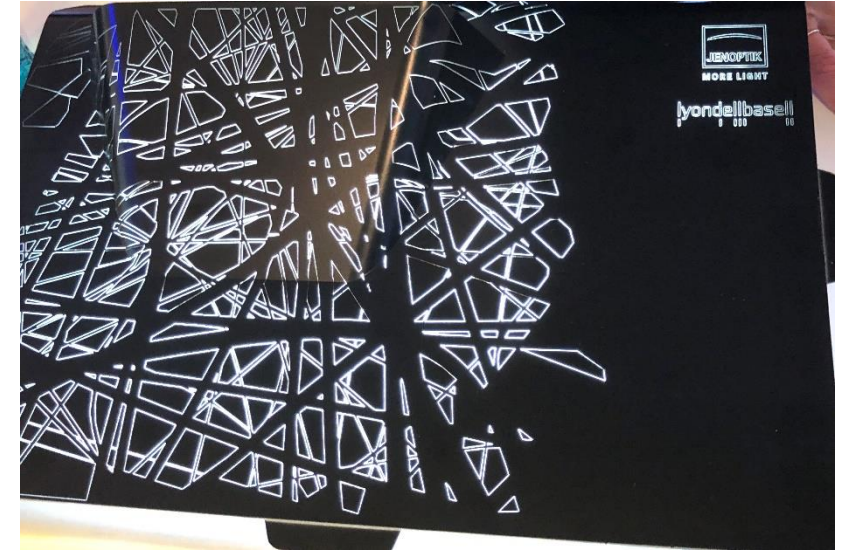
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Application example (prototype)

- **Other application proposals**
 - **Painting + Laser removal concept**
 - ✓ Prototype part molded with *Hostacom* TRG 2509Y
 - ✓ Paint + Laser removal tested
 - Can be also achievable with an In-Mold decoration film



Jenoptik & LyondellBasell prototype

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Application example (prototype)

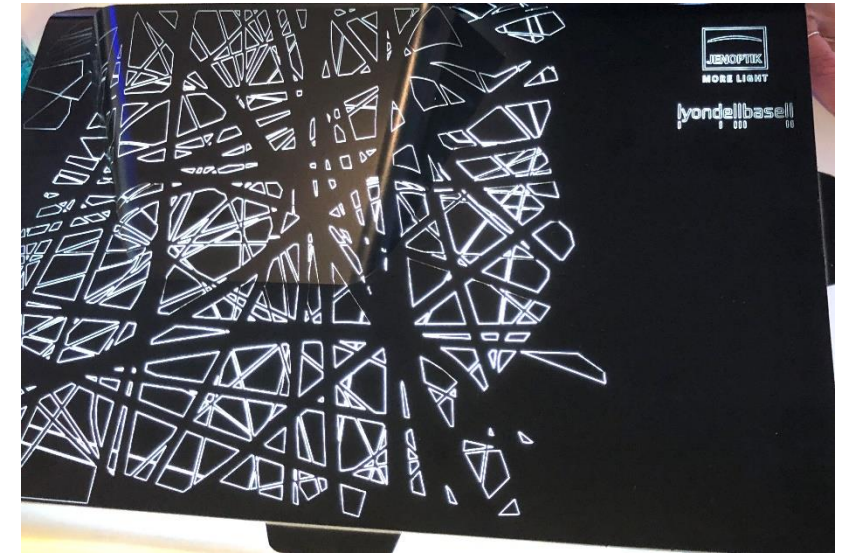
Other application proposals

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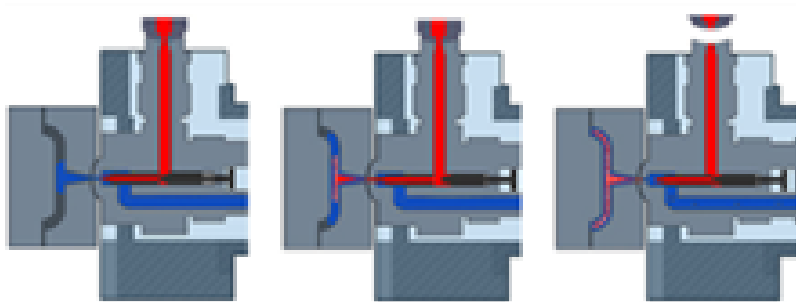
Co-molding concept

- PP-C Translucent can be co-molded with standard automotive PP-C in order to achieve functional & Decorative part at the same time
- Pleasant soft touch haptics as mono material solution
- As same base material this ensure also good recyclability



Jenoptik & LyondellBasell prototype

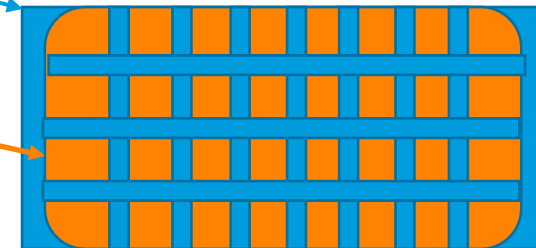
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Standard PP-C

Translucent PP-C

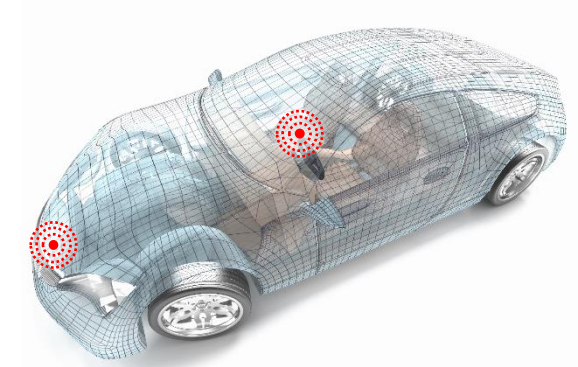


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Conclusion and next steps

Conclusion

- PP Compound material with optical & mechanical properties
- Enabler for new design in automotive interior & exterior
- Pleasant soft touch haptics as mono material solution
- Low density & sustainable solution



Challenges & next steps

- Further optical & colorimetric measurement
- Further durability tests

LyondellBasell is ready to work with customers & OEMs on this topic



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