



Two-Session-Clustering Workshop

DATE | SESSION 2: Lightweight Thermoplastic Glazing Techniques for Windows

Presenter:

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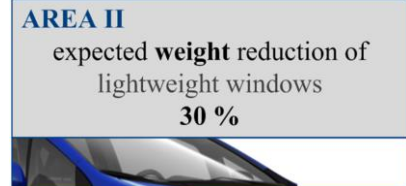
HONDA



Lightweight Thermoplastic Glazing Techniques for Windows

OBJECTIVES

- Development of **lightweight windows** for the QUIET reference vehicle (Honda Fit EV) with enhanced **thermal properties**
 - Specification of an innovative lightweight glazing set with improved thermal and weight aspects
- Searching and classifying different developers and suppliers of windshields
 - Manufacturing **fully functional demonstration parts** that can be installed on the demonstration vehicle
 - Measurement and simulation of the properties of the new windows
- Aimed results
 - Weight reduction e.g. **car glasses: -30 %** (from ~26 kg)
 - Better **insulation** and **lower thermal inertia**



Lightweight Thermoplastic Glazing Techniques for Windows

APPROACH

- Standard windscreen
 - LSG, laminated safety glass
 - Typical construction:
 - Glass: 2.1-2.5 mm, layer 1 + layer 2
 - Interlayer: 0.38-0.76 mm e.g. Polyvinylbutyral (PVB) or Polyurethane (PU)
- Side and rear glasses
 - Tempered safety glass (3-5 mm)
- In the EU 5 mm and 4 mm thick windscreens are used ~50:50
(source: Saint Gobain, 2013)

- Polycarbonate (PC) compared to glass: **50%** less weight, **70%** less thermal conductivity

	Glass	PC
Thermal conductivity [W/mK]	0.76	0.20
Thermal capacity [kJ/kgK]	0.70	1.17
Density [g/cm ³]	2.40	1.20

- Benefits:
 - **20%** less heating energy
 - Better condensation properties (fogging only at higher relative humidity)
 - Avoids “cold wall” effect
 - Hydrophobic properties

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APPROACH

- Weight reduction by new compositions as alternative to PC
- E.g.: AGP - American Glass Products „eGLASS ultralite plus“:



THINNER AND LIGHTER HYBRID COMPOSITIONS

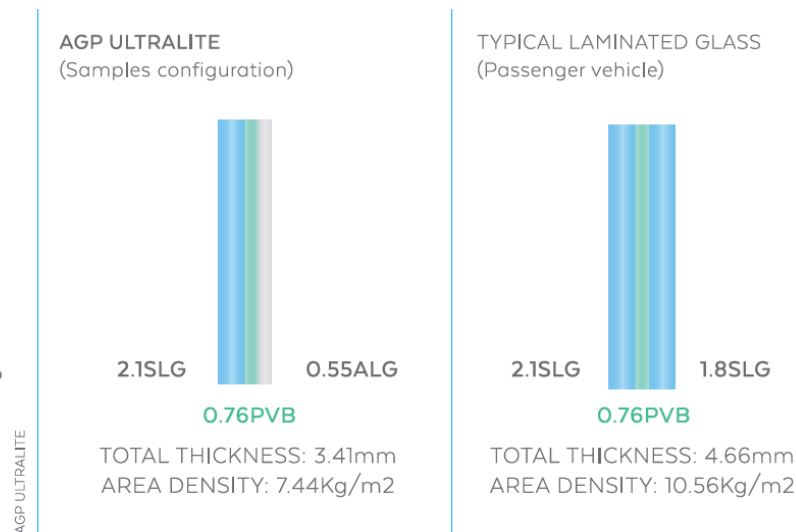
Are up to three times more resistant to stone impacts. AGP meets ANSI Z26, ECR43, and EN356 requirements for windscreens and sidelites.

**30 %
WEIGHT
SAVING**

(3.12Kg/m²)
(6.88Kg in a 2.2m²WS)

**X2.6
MORE
RESISTANT**

(226gr Ball Drop
10% probability)



- Drawback: thermal isolation and acoustic behaviour get even worse

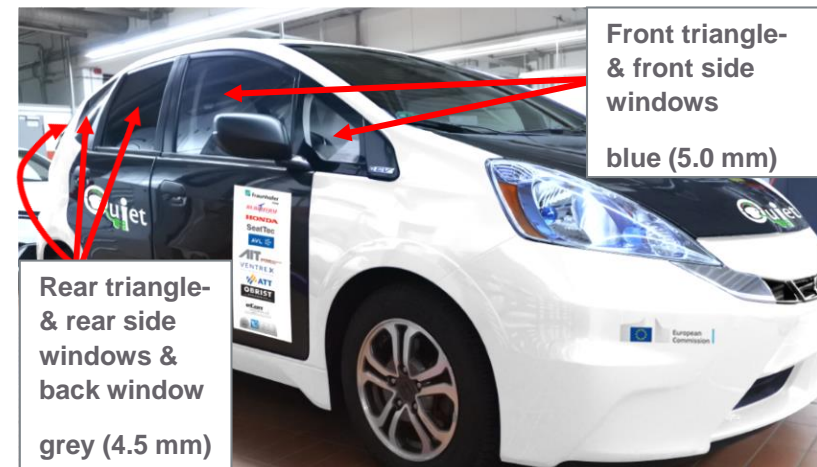
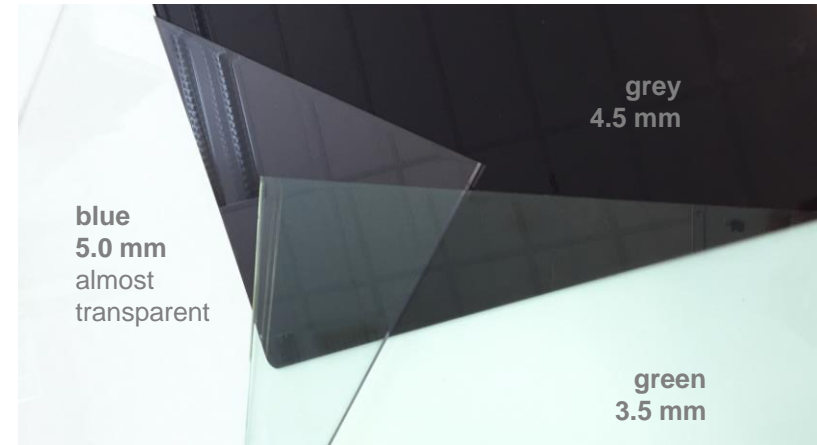
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RESULTS

- In total 16 material and component suppliers were considered/contacted
- AIT selected suppliers and negotiated with:

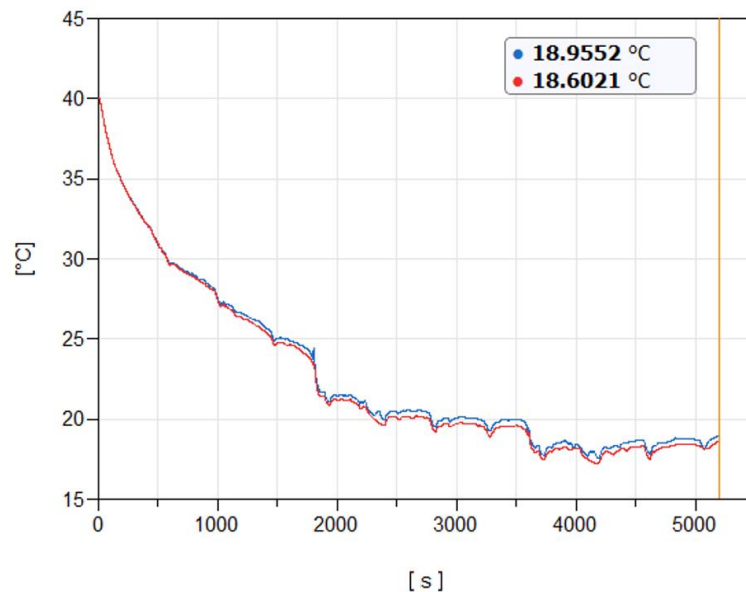


- Covestro
 - Provided different PC sheets
 - Different configurations possible
- Kirsch
 - Processed the PC sheets (e.g. thermoforming, hard coating)
 - Produced a whole set of new glazing, except the windshield



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RESULTS



- Cabin air temperature **simulation**: standard glazing (blue) vs. PC glazing (red)
- Results show, that **PC** can lead to **lower** cabin air **temperatures in summer** conditions by **~0.5 °C**
- **PC expensive** (1.2-2 €/kg) compared to standard glazing (~0.045 €/kg)
- **Final performance tests at JRC in March 2021**

Part	Glass* thickness	Glass weight	PC** target thickness	Weight reduction by material	Weight reduction absolute	Quantity per vehicle	Total weight reduction target
Front side windows	4.0 mm	3.7 kg	5.0 mm	-40 %	1.50 kg	2	3.00 kg
Front quarter light	3.5 mm	0.8 kg	5.0 mm	-31 %	0.25 kg	2	0.50 kg
Rear side windows	3.5 mm	2.5 kg	4.5 mm	-38 %	0.95 kg	2	1.90 kg
Rear quarter light	3.1 mm	0.9 kg	4.5 mm	-30 %	0.27 kg	2	0.54 kg
Rear windscreen	2.8 mm	3.5 kg	4.5 mm	-23 %	0.81 kg	1	0.81 kg
SUM							6.75 kg (-35 %)

* Density Glass $\rho_{glass} = 2.5 \frac{g}{cm^3}$

**Density PC $\rho_{PC} = 1.2 \frac{g}{cm^3}$

Part	Quantity per year	Estimated costs per vehicle [€]
Front side windows	> 10 000	~ 30
Front quarter light	> 10 000	~ 20
Rear side windows	> 10 000	~ 50
Rear quarter light	> 10 000	~ 30
Rear windscreen	> 10 000	~ 70
SUM		~ 200

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RESULTS

- Problems of plastic glazing
 - Cost
 - Glass is basically a cheap material, PC is an expensive plastic
 - UV-Stability
 - Material is prone for yellowing (additives improve the situation)
 - Abrasion resistance is critical
 - Coatings resolve the problem almost
 - Safety concerns
 - Because it doesn't break (problem for first aiders)
 - It is not allowed for windscreens

Thank you for your kind attendance.

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Get in touch with the QUIET consortium!

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