
Practical Experience / Integral Analysis for Human Safety
Practical Experience

Overview delivered plastic glazing from KRD for vehicles since 2001:

10,000 windscreens, monolithic, one-layer
1,500 windscreens, laminated

40,000 side and rear screens, one-layer
9,500 side and rear screens, laminated
Type approvals (German ABG; ECE-R43; DOT)

- Flexibility test
- Mechanical strength / Fracture behaviour
- Optics
- Weathering resistance test
- Adhesion properties
- Chemical resistance test
- Fire resistance test
- Resistance to humidity test
- Abrasion resistance test
UV accelerated weathering
UV accelerated weathering / Xenon test

- Spectrum: 295 – 400 nm
  - G26: 0,5 W/m²/nm@340nm -> 59,4 W/m²
    500 MJ/m²/59,4 W/m² = 8,4 \times 10^6 s = 2340 h \sim 14 \text{ weeks}
  - G26 mod.: 0,75 W/m²/nm@340nm -> 89,1 W/m²
    500 MJ/m²/89,1 W/m² = 5,6 \times 10^6 s = 1558 h \sim 9 \text{ weeks}

- 1 year Florida \sim 300 MJ/m² (295 – 400 nm)
  
  $\begin{array}{|c|c|c|}
  \hline
  & \text{G26} & \text{G26 mod.} \\
  \hline
  \text{1 year Florida} & 8,5 \text{ weeks} & 5,6 \text{ weeks} \\
  \text{3 years Florida} & 25 \text{ weeks} & 17 \text{ weeks} \\
  \text{5 years Florida} & 42 \text{ weeks} & 28 \text{ weeks} \\
  \hline
  \end{array}$

- Spectrum: 300 – 800 nm
  - Suntester: up to 765 W/m²; complete dipping into water
    DIN EN ISO 4892 procedure A: 550 W/m²
## Chemical resistance

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Concentration</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone</td>
<td>100 %</td>
<td>resistant</td>
</tr>
<tr>
<td>Benzene</td>
<td>100 %</td>
<td>resistant</td>
</tr>
<tr>
<td>Benzole</td>
<td>100 %</td>
<td>resistant</td>
</tr>
<tr>
<td>Chloroform</td>
<td>100 %</td>
<td>resistant</td>
</tr>
<tr>
<td>Ethanol</td>
<td>99 %</td>
<td>resistant</td>
</tr>
<tr>
<td>Soda lye</td>
<td>40 %</td>
<td>resistant</td>
</tr>
<tr>
<td>Diluent for cellulose lacquers</td>
<td>100 %</td>
<td>resistant</td>
</tr>
<tr>
<td>Nitric acid</td>
<td>65 %</td>
<td>resistant</td>
</tr>
<tr>
<td>Chloric acid</td>
<td>32 %</td>
<td>resistant</td>
</tr>
<tr>
<td>Sulfuric acid</td>
<td>98 %</td>
<td>resistant</td>
</tr>
<tr>
<td>Xylene</td>
<td>100 %</td>
<td>resistant</td>
</tr>
</tbody>
</table>

Exposure time 10 minutes, 18 – 22°C, the coating is alkali-proof up to pH 12
# Abrasion resistance (typical results)

<table>
<thead>
<tr>
<th>Abrasion resistance</th>
<th>Thickness PC</th>
<th>Thickness of layer</th>
<th>Siloxane lacquer X*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taber Test: CS10F wheels, 500g</td>
<td>Test results vary with Taber-wheel-batch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta ) Haze @100 rotations</td>
<td></td>
<td></td>
<td>4-6%</td>
</tr>
<tr>
<td>( \Delta ) Haze @500 rotations</td>
<td></td>
<td></td>
<td>9-12%</td>
</tr>
<tr>
<td>Last comparative measurement, adjustment of test conditions, same Taber-wheels:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta ) Haze @1000 rotations</td>
<td>3 mm</td>
<td>6-8 ( \mu )m</td>
<td>4-12%</td>
</tr>
</tbody>
</table>

Lacquer X*: Commercially available siloxane lacquers with SAE approval
Current development

SCS-V glazing (V = Verbund = laminated)
Automotive glazing with functional properties

UVIREX: protection against UV- + IR-radiation, heatable
Patent pending (construction process)

KASI®-abrasion resistant coating

PMMA with UV absorbers
Thin Wire
TPU foil
IR reflecting film
TPU foil
PC
Actual Situation

- Market requires increasingly individual vehicles
- Fatal accidents require integral analysis
- Materials for glazing (glass / plastics) aren´t comparably
- Public perception regarding crash-behavior of „GLAZING“ is reduced to brittle GLASS or „PLEXIGLASS“
- discussions regarding windscreens simplify:
  - plastic windscreens have to achieve glass requirements
  - and additional requirements.....

What if 2008 on the motorway A29 the windscreen in BMW was constructed with high impact-resistant plastics?
Tragic Experience: 23 March 2008, Motorway A29 (Germany)

- „Holzklotz – Prozess“
- 5,9 kg log of wood penetrates BMW-windscreen
- recurrent similar assaults

Source: Spiegel-online / dpa / AP
Proposals

- Same abrasion resistance test / analysis for all plastic glazings:
  - Combination Taber (delta-haze <10%) and other test method like e.g. „Amtec-Kistler-Test“ (ISO 20566)

- Same UV- Irradiation test / analysis for all screens:
  - delete existing method with <300 nm for laminated glazing

- Others / windscreen wiper test
  - use existing solutions based on High pressure cleaning Systems

- agree on penetration test method (---) KRD video)