UNECE – GRSG - IGPG
TF Wiper SG2 - final report

2014-03-25 Dr. Frank Buckel
Agenda

- history & time frame
- TF wiper sg2 lab / approval test (basic requirements & description)
- TF wiper sg2 round robin results (incl. table of equivalence)
- correlation of lab test with road or life time data (microscope images & haze values)
- summary of TF wiper sg2 work
TF wiper history

03./04.09.12  05./06.09.12  22./23.01.13  18./19.06.13  21.08.13  07.10.13  29.01.14
05./06.09.12  22./23.01.13  18./19.06.13  21.08.13  07.10.13  29.01.14  12.03.14

5th IGPG meeting Paris

TF wiper sg2 pre-meeting Paris

preparing timeline for test development

testing with different devices and protocols

experience exchange and ISO equipment check

TF wiper sg2 2nd meeting Darmstadt

TF wiper sg2 meetings in Ingolstadt

TF wiper sg1&2 meeting Wolfsburg

TF wiper sg1&2 meeting Paris

joint elaboration of test protocol for 1st round robin test with ISO equipment

discussion of all data generated

preparation of final / 2nd round robin test with ISO equipment

TF wiper sg2

6th IGPG meeting Brussels

7th IGPG meeting Mannheim

8th IGPG meeting Paris

9th IGPG meeting Paris

03./04.09.12  28./29.11.12  22.03.13  29.05.13  22.03.13  07.10.13  22.03.13  07.10.13
05./06.09.12  22./23.01.13  18./19.06.13  21.08.13  27./28.11.13  22.03.13  07.10.13  29.01.14
20./21.09.12  22./23.01.13  18./19.06.13  21.08.13  27./28.11.13  22.03.13  07.10.13  29.01.14
20./21.09.12  22./23.01.13  18./19.06.13  21.08.13  27./28.11.13  22.03.13  07.10.13  29.01.14
TF time frame

Draft Schedule of Informal Group on Plastic Glazing

<table>
<thead>
<tr>
<th>General Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Informal face-to-face meeting</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phase 1</th>
<th>Development of ToRs Draft Working Paper on Plastic Glazing Discussion of Work Items</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Phase 2</th>
<th>Exchange of information based on Research Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>UV stability (radiation test) Weathering test Abrasion test Chemical test Durability test Vulnerable road users</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phase 3</th>
<th>Decision on Test Procedures Decision on Requirements and Limits Preparation of Draft Amendment Text</th>
</tr>
</thead>
</table>

Source: GRSG-104-42e

- Decision on test procedure as well as requirements and limits this month

(1) GRSG 106th session 05.-09.May 2014
(2) GRSG 107th session 30.Sep.-03.Oct. 2014

9th IGPG meeting (25./26.03.2014 in Berlin)
10th IGPG meeting (17./18.06.2014)
basic requirements for a approval test

- ensures the use of “safe” glazing types
  - test procedure needs to be realistic in the kind and amount of “incidents” (in order to mimic real life)
  - … needs to be reproducible (all approval test houses yield similar results)
  - the limit should allow approval of suitable and exclude unsuitable types within the range of reproducibility (to avoid differences between “initial” approval and conformity of production due to test accuracy)

Here: get an additional reproducible and realistic test for wiper action as alternative (together with sand drop and car wash) to Taber abrasion method for testing plastic glazing

6. General requirements

6.1. All glazing materials, including glazing material for the manufacture of windscreens, shall be such that, in the event of shattering, the danger of bodily injury is reduced as far as possible. The glazing material shall be sufficiently resistant to the incidents likely to occur in normal traffic, and to atmospheric and temperature conditions, chemical action, combustion and abrasion.

Source: ECE R43
TF wiper sg2 lab / approval test

description

1 wiper carriage assembly moving back and forth
2 self-supporting arm
3 wiper blade holder
4 wiper blade
5 sample box working as test sample holder and as container for the aqueous suspension
6 test sample
7 spacer plaque to adjust height of the sample to the level of the bottom surface of the sample box
8 adhesive tape to fix sample and to seal the gap between sample and its box
9 aqueous suspension filled into the box
10 adhesive aluminium tape to fix the sample box onto the stainless steel tray (11 water filled into the stainless steel tray ((avoids penetration of aqueous suspension underneath the test sample)))
12 stainless steel tray

detailed test description used for Feb 2014 round robin
TF wiper sg2 lab / approval test

<table>
<thead>
<tr>
<th>selected lab test parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>equipment:</strong> scrub resistance tester (ISO 11998) with additional wiper blade holder and sample box</td>
</tr>
<tr>
<td><strong>test sample:</strong> flat with a size of 150 x 100 mm</td>
</tr>
<tr>
<td><strong>wiper blade:</strong> CR grade with special profile (Bosch H-Stoff P6.3)</td>
</tr>
<tr>
<td><strong>stroke length:</strong> 130 ± 5 mm (half a wipe cycle)</td>
</tr>
<tr>
<td><strong>wipe speed:</strong> 160 ± 15 mm/s (average)</td>
</tr>
<tr>
<td><strong>wipe load:</strong> 15 g/cm</td>
</tr>
<tr>
<td><strong>test mixture:</strong> 2,5% test dust (ISO 12103-1) A4 in water</td>
</tr>
<tr>
<td><strong>no. of wipe cycles:</strong> 10,000 / 20,000</td>
</tr>
</tbody>
</table>
TF wiper sg2 round robin results

- **First round robin** took place in Nov. 2013 (results after 5,000 and 10,000 wipe cycles already reported at the last IGPG meeting)
- Further test improvements discussed in Ingolstadt (29.01.2014)
- **Second round robin** in Feb. 2014
  - More homogeneous scratch distribution on single test samples (standard deviation of the measurement points per sample lower)
  - Deviation within the three replicates per lab and sample type lower
  - Reproducibility not improved (even slightly worse)

![Graph showing standard deviation of haze measurement on individual samples (10,000 wipe cycles)]
TF wiper sg2 round robin results

standard deviation of the haze measurement on individual samples (20,000 wipe cycles)

- laminated glass
- float glass (Nov. 2013)
- polysiloxane coating A (Nov. 2013)
- polysiloxane coating B (Nov. 2013)
- UV curable coating (Nov. 2013)
TF wiper sg2 round robin results

Standard deviation of the average delta haze for the three replicates

10,000 wipe cycles

20,000 wipe cycles

- Laminated glass
- Float glass (Nov. 2013)
- Polysiloxane coating A
- Polysiloxane coating A (Nov. 2013)
- Polysiloxane coating B
- Polysiloxane coating B (Nov. 2013)
- UV curable coating
- UV curable coating (Nov. 2013)
### TF wiper sg2 round robin results

<table>
<thead>
<tr>
<th>Wipe cycle no.</th>
<th>Sample</th>
<th>Average (\bar{x})</th>
<th>Standard deviation (s_x)</th>
<th>Repeatability standard deviation (s_r)</th>
<th>Reproducibility standard deviation (s_R)</th>
<th>Repeatability (r)</th>
<th>Reproducibility (R)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>10.000</strong></td>
<td>laminated glass</td>
<td>0.0659</td>
<td>0.0395</td>
<td>0.0478</td>
<td>0.0555</td>
<td>0.13</td>
<td>0.16</td>
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<tr>
<td></td>
<td>polysiloxane A</td>
<td>0.2846</td>
<td>0.2633</td>
<td>0.2626</td>
<td>0.3396</td>
<td>0.74</td>
<td>0.95</td>
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<tr>
<td></td>
<td>polysiloxane B</td>
<td>0.4491</td>
<td>0.6180</td>
<td>0.1573</td>
<td>0.6312</td>
<td>0.44</td>
<td>1.77</td>
</tr>
<tr>
<td></td>
<td>UV curable</td>
<td>5.4128</td>
<td>4.9837</td>
<td>0.8660</td>
<td>5.0336</td>
<td>2.42</td>
<td>14.09</td>
</tr>
<tr>
<td><strong>20.000</strong></td>
<td>laminated glass</td>
<td>0.1338</td>
<td>0.0286</td>
<td>0.0783</td>
<td>0.0783</td>
<td>0.22</td>
<td>0.22</td>
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<tr>
<td></td>
<td>polysiloxane A</td>
<td>0.7849</td>
<td>0.8271</td>
<td>0.6498</td>
<td>0.9826</td>
<td>1.82</td>
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<td>polysiloxane B</td>
<td>1.1662</td>
<td>1.2815</td>
<td>0.3277</td>
<td>1.3091</td>
<td>0.92</td>
<td>3.67</td>
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<tr>
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<td>UV curable</td>
<td>7.9357</td>
<td>4.4393</td>
<td>0.7172</td>
<td>4.4778</td>
<td>2.01</td>
<td>12.54</td>
</tr>
</tbody>
</table>

#### Nov. 2013 round robin test – 10.000

- Repeatability: 0.14
- Reproducibility: 0.09

#### Nov. 2013 round robin test – 20.000

- Repeatability: 0.29
- Reproducibility: 0.83

#### Feb 2014 round robin test

- Repeatability: 1.02
- Reproducibility: 4.26

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## TF wiper sg2 round robin results

<table>
<thead>
<tr>
<th>test method</th>
<th>glass</th>
<th>plastic with siloxane based wet coat</th>
<th>plastic with UV curable wet coat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Δ haze (%)</td>
<td>max Δ haze (P=95%) (%)</td>
<td>Δ haze (%)</td>
</tr>
<tr>
<td><strong>Taber 1000 cyclen (IGPG)</strong></td>
<td>1,17</td>
<td>1,95</td>
<td>10,52</td>
</tr>
<tr>
<td><strong>Taber 1000 cyclen (ISO 2012)</strong></td>
<td>0,73</td>
<td>1,18</td>
<td>4,19</td>
</tr>
<tr>
<td><strong>Taber 1000 cyclen (ISO 2013)</strong></td>
<td></td>
<td></td>
<td>4,17</td>
</tr>
<tr>
<td><strong>Sand drop (IGPG)</strong></td>
<td>3,38</td>
<td>4,78</td>
<td>3,06</td>
</tr>
<tr>
<td><strong>Amtec Kistler (IGPG)</strong></td>
<td>0,19</td>
<td>0,63</td>
<td>0,74</td>
</tr>
<tr>
<td><strong>wiper test (IGPG TF) 10.000 cycles</strong></td>
<td>0,07</td>
<td>0,18</td>
<td>0,28</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0,45</td>
</tr>
<tr>
<td><strong>wiper test (IGPG TF) 20.000 cycles</strong></td>
<td>0,13</td>
<td>0,29</td>
<td>0,78</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1,17</td>
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</tbody>
</table>
Correlation of lab test with road or life time data

How to correlate lab wiper test data with on road test or life time data?

- kind of abrasion action
  - comparison of microscope images

Source: IGPG-05-04e
Correlation of lab test with road or lifetime data

- degree of abrasion action
  - comparison of values acc. to following schema

- initial haze
- wiper abrasion action
- other abrasion action

- delta haze
- final haze

lab test only wiper action
on road test with different duration
life time data only wiper action

accelerated test
real-time test

Do all system have the same correlation factor
(or do the conditions show different severity for different systems)?
Microscope Images after 20,000 cycles wiper abrasion in the lab test

- laminated glass
- polysiloxane coating B: only relatively short scratches
- polysiloxane coating A
- UV curable coating

Amplification 30x
BMS experimental data using an existing rear window wiper

1. Rear window wiper system (semi-circular movement; 35 cycles (back and forth) per min)
2. Fixed substrate (45° to normal)
3. Water / slurry supply (pump delivery rate 5 l/s)
4. Different wipe speeds across the substrate
Microscope Images after 1,100,000 wipe cycles with a rear window wiper

laminated glass

polysiloxane coating B

laminated glass after wipe abrasion in the lab test

polysiloxane coating B after wipe abrasion in the lab test

amplification 30x
Comparison of life time data with lab test for glass and polysiloxane coating B

life time data using a rear window wiper system after 1 Mio. wipe cycles

absolute haze

0.5 %

1.0 %

wiper lab test

polysiloxane coating B

laminated glass

cycle no. 10.000

cycle no. 20.000

initial haze

wiper abrasion polysiloxane coating B

wiper abrasion laminated glass
BMS experimental data using an existing rear window wiper

haze vs. wipe cycles for a rear window wiper (polysiloxane B vs. laminated glass)

- ▲ haze at a wiper speed of 130 cm/s (polysiloxane B)
- ◇ haze at a wiper speed of 40 cm/s (polysiloxane B)
- △ haze at a wiper speed of 130 cm/s (laminated glass)
- ● haze at a wiper speed of 40 cm/s (laminated glass)
Comparison of police car windscreens with lab test results

![Graph showing haze values of plastic windscreens vs. mileage]

- **haze values of plastic windscreens vs. mileage**
  - Mileage [km] on the x-axis, absolute haze [%] on the y-axis.
  - Data points with error bars indicating variation.
  - Linear trend line with equation: \( y = 7E-06x + 0.7536 \) and \( R^2 = 0.3874 \).
  - Single sample result highlighted.

Source: IGPG-05-04e
Comparison of images under special light conditions

VW T5 police car with PC windscreen “mid of the screen” (68.903km)

VW T5 police car with PC windscreen “driver side top” (39.123km)

Sand drop test

wiper lab test (20,000 wipe cycles)
Comparison of images under special light conditions

highest severity in this kind of images under special light conditions have stone impacts
Summary of TF wiper sg2 work

- lab wiper abrasion test was developed which is
  - realistic (similar abrasion kind)
  - shows good reproducibility for 10,000 wipe cycle (slightly worse for 20,000 wipe cycle)
  - allows to clearly differentiate between different coating systems (UV curable or different polysiloxane ones) after short test time

 ➢ task of sg 2 is fulfilled

*Further gathered information:*

- the conditions selected are more severe for the hydrophobic coatings (water contact angle approximately 90°) compared to glass due to the use of wiper blades optimized for glass (hydrophilic nature) and wiping action under water
  - longer scratches (leading to higher haze values)
  - chatter marks can appear

➢ different correlation factor for hydrophilic and hydrophobic surfaces

➢ haze values after 20,000 wipe cycles for the coatings are already higher than the values gained after 52,000 wipe cycles in the on-road test (including sand impact)
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Thank you!

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