

Science For A Better Life

UN ECE - GRSG - IGPG
5th Meeting

Update on Taber Abrasion Test as agreed with Dr. Dümmler (MPA) and Dr. Schmitz (KRD)

2012-09-05 Dr. Frank Buckel

Status Taber Test Discussion in ISO

TC22 SC11 “Road vehicles - Safety glazing materials”

ISO 3537 und ISO 15082 both describing the Taber test are currently under revision

- currently **no** technical description for abrasive wheels *
- currently **two** abrasive wheel types with different abrasive particles and binder material in use **

➢ decided to qualify wheels via **reference materials**

- a glass reference alone is not sufficient to define wheels for plastic glazing ***

➢ decided to separate test procedures for glass and plastic glazing materials

To do: define a reference material for plastic glazing testing

* modified Taber wheels in contrast to former CS 10F wheels do no longer fulfill “former” technical description (surface hardness)

** CS 10F from Taber & C180 OFX from Daiwa

***based on the results of the ISO round robin test (revealed different results on plastic using the two available wheel types and a poor reproducibility for both wheels on plastic)

Results ISO Taber Round Robin Test

from 2011 / 2012 with Taber and Daiwa Wheels

ISO round robin test:

- two different types but only one lot per type of abrasive wheels*
- ten participating test laboratories
- pre-agreed test protocol **
- two different material types ***
- numbers of cycles: 1000 (glass) 100, 500 (100+400) and 1000 (coated PC)
- using a set of three samples per condition.

* Taber wheel CS10-F Lot: ER08D1 and Daiwa wheel C180 OFX Lot: 1106274; only preselected wheels coming all from one production lot and preselected refacing stones were used)

** round robin was performed according to ISO TC22 SC11 document N573

*** glass and coated polycarbonate

Material	no. of cycles	average ẍ	standard deviation s_x	repeatability standard deviation s_r	reproducibility standard deviation s_R	repeatability r	reproducibility R
Glass (Taber)	1000	0,7330	0,2131	0,0892	0,2252	0,25	0,63
Glass (Daiwa)	1000	0,5570	0,2110	0,0796	0,2207	0,22	0,62
PC (Taber)	100	1,1623	0,6864	0,2958	0,7277	0,83	2,04
PC * (Taber)	500 (100+400)	4,2226	1,4213	1,1449	1,7011	3,21	4,76
PC ** (Taber)	1000	4,1913	1,3638	1,6162	1,8978	4,53	5,31
PC (Daiwa)	100	0,9871	0,3210	0,2356	0,3742	0,66	1,05
PC (Daiwa)	500 (100+400)	3,6183	1,0874	0,4535	1,1488	1,27	3,22
PC (Daiwa)	1000	5,7857	1,6424	0,6772	1,7329	1,90	4,85

* and ** high delta haze results not included in the statistical analysis; including high result would change the values as follows: * repeatability 20,11 and reproducibility 21,46; ** repeatability 10,14 and reproducibility 10,88

Results ISO Taber Round Robin Test

from 2011 / 2012 with Taber and Daiwa Wheels

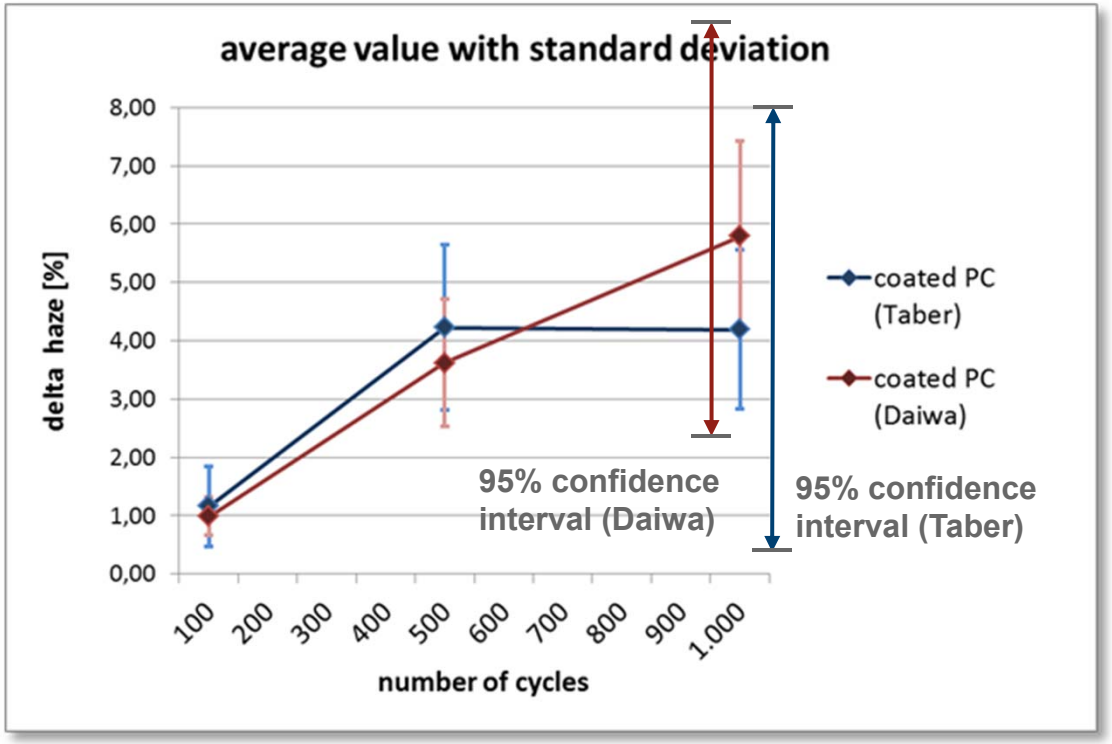
Summary:

glass

- **both wheel types** lead to **similar** average values, as well as repeatability and reproducibility standard deviations

coated PC

- results **depend on the used wheel type**, even more the “average vs. no. of cycles” function for the two wheel types is completely different *
- the **repeatability and reproducibility** of both wheel types is quite **poor** ** and the 95% confidence interval in the case of 1000 cycles covers delta haze values from almost invisible to milky



* linear for the Daiwa wheel and with a limiting value after 500 revolutions for the Taber wheel

** especially under the ideal situation that all wheels of one type came from the same production lot

Taber Abrasion Test Precision

ISO vs. IGPG Round Robin Results

	cycle no.	coated PC		requirement	glass	
		Δ haze	max. Δ haze *		Δ haze	max. Δ haze
ISO *best case* with only one wheel lot **Daiwa C180 OFX**	100	0,99	1,74	<4%		
	500	3,62	5,92	<10%		
	1000	5,79	9,25	<2%	0,56	1,00
ISO *best case* with only one wheel lot **Taber CS 10F**	100	1,16	2,62 **	<4%		
	500	4,22	7,62	<10%		
	1000	4,19	7,99 ***	<2%	0,73	1,18
IGPG *real case* (**CS 10F** different lots)	1000	10,52	37,58	<2%	1,17	1,95

* max. Δ haze is the upper limit of the 95% confidence interval (average Δ haze + 2 x reproducibility standard deviation)

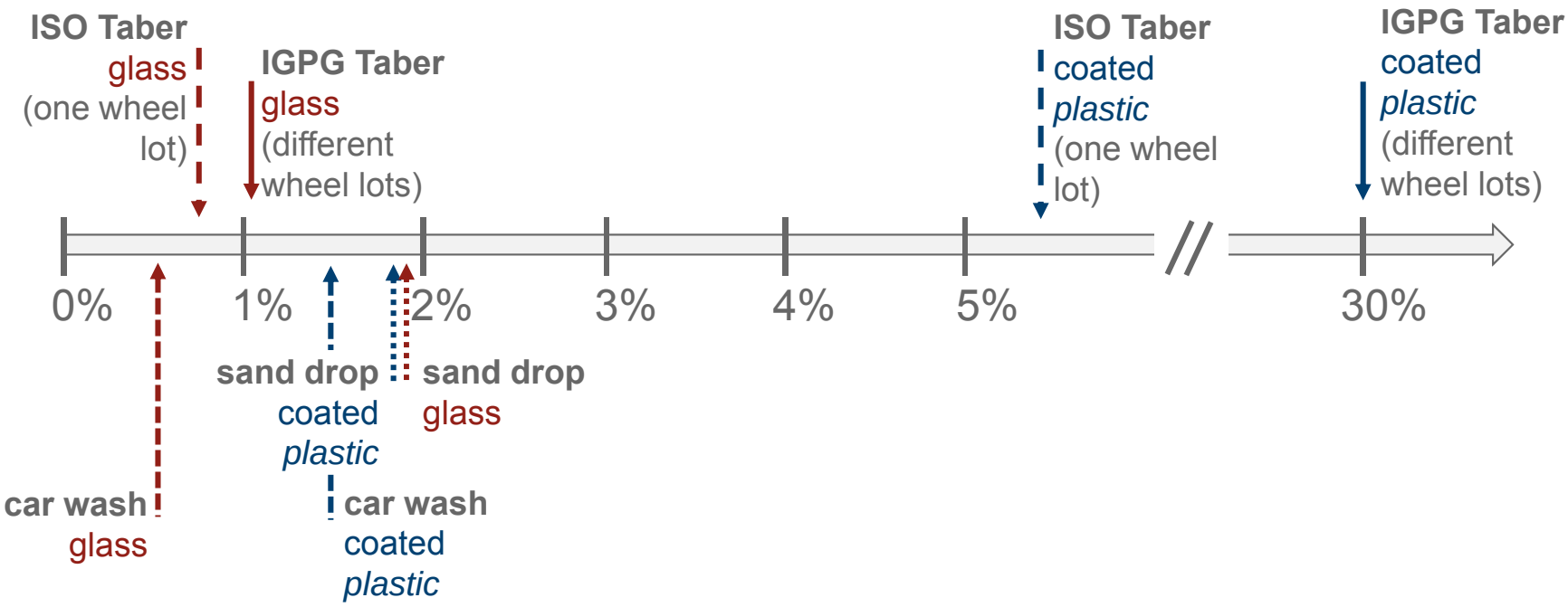
** even at 1% haze values and only using one Taber wheel lot the test accuracy on plastic is that poor that a 2% limit is not reached reliably

*** even in the unlikely case that all Taber wheel lots are identical the difference between average and max. value for plastics is above the 2% limit, which is therefore not reachable due to test accuracy (EVEN for average values of 0%)

Abrasion Tests

Comparison of Precision of Test Methods

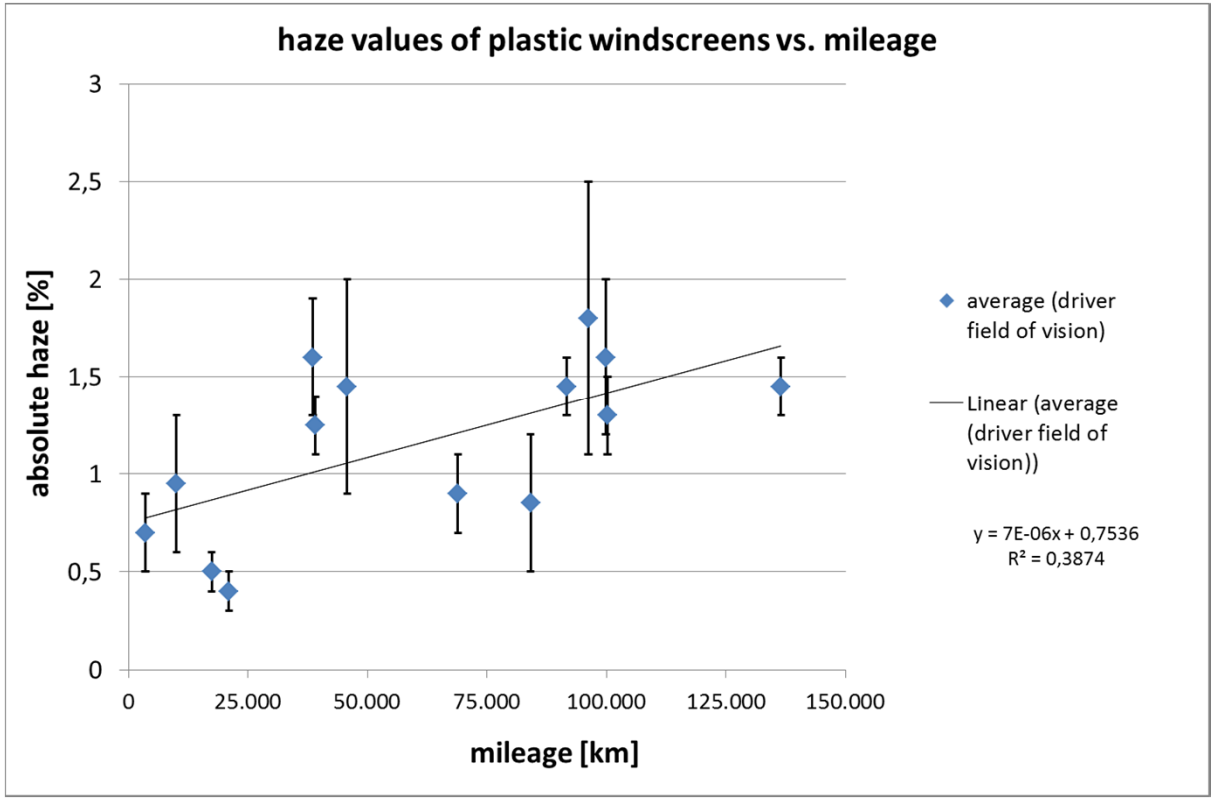
Reproducibility R * allows to compare the precision of different test methods directly
(width of distribution independent from the average haze values)



* **Definition of reproducibility R:** In comparing two results for the same material, obtained by different operators using different equipment, the results should be judged as *not equivalent* if they *differ by more than the R value* for that material and condition. R = 2.8 x reproducibility standard deviation (max. Δ haze = average Δ haze + 0,7 x R)

Plastic Windscreens

Haze Values of Plastic Windscreens from KRD*



* data from IGPG-04-02

- **plastic windscreens** with “on-road” experience are already **available** (police cars in Germany)
- **haze values** of these used windscreens are on a **low level** having only “some” dependency to the mileage

➢ investigation of the surface deterioration leading to these haze values and comparison to abrasion tests

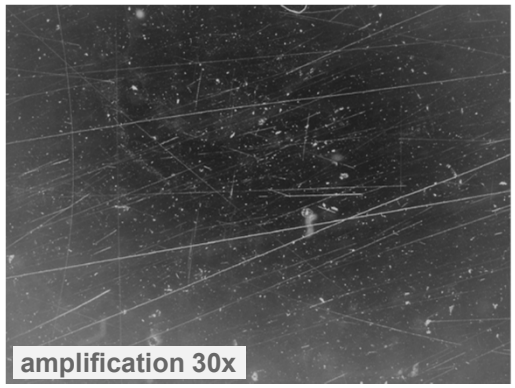
Plastic Windscreens

Comparison of Microscopic Images with Abrasion Tests

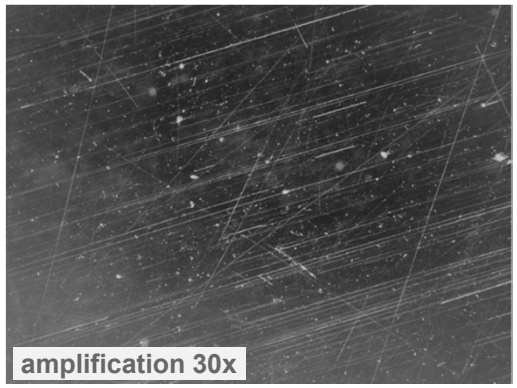
plastic windscreens from KRD (IGPG-04-02)

- mileage: **136452 km**
- haze values: 1,3-1,6% (driver field of vision) and 0,9-1,0% (front-seat passenger side)

driver field of vision

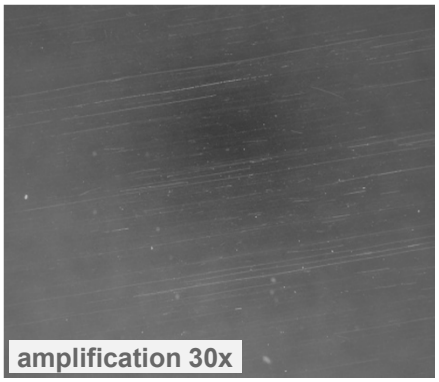


front-seat passenger side

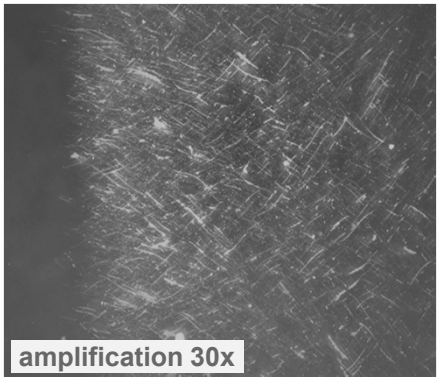


abrasion tests on samples from KRD (same coating)

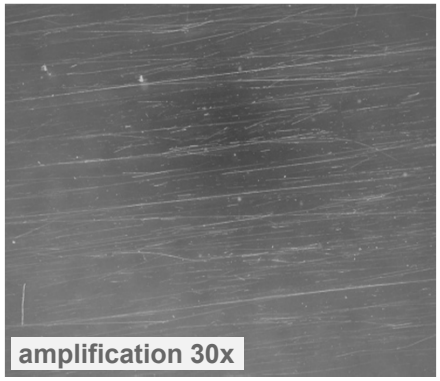
wiper test - 1000 wipe cycles



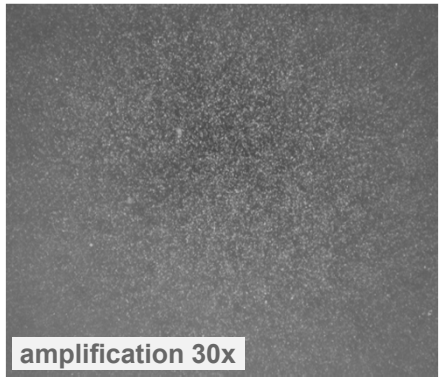
Taber - 1000 cycles



car wash test



sand drop test



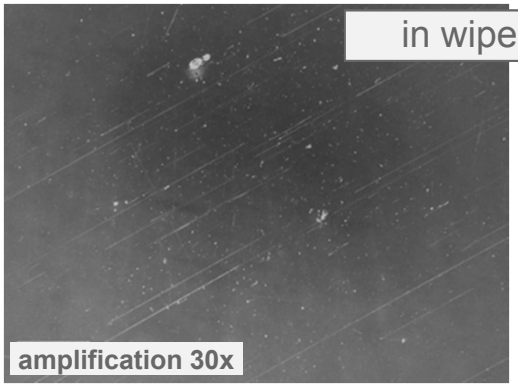
Plastic Windscreens

Comparison of Microscopic Images with Abrasion Tests

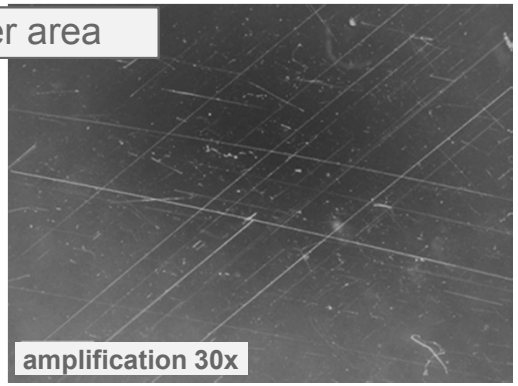
plastic windscreen from KRD with a mileage of **21000 km**

abrasion tests on samples from KRD (same coating)

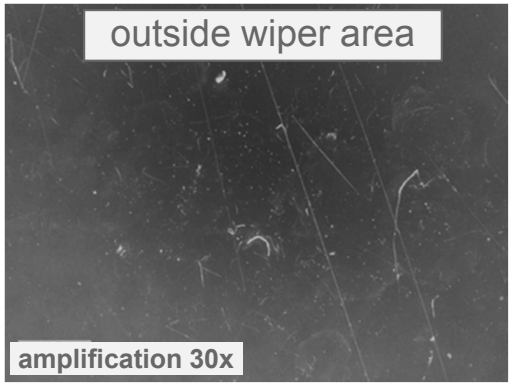
driver field of vision



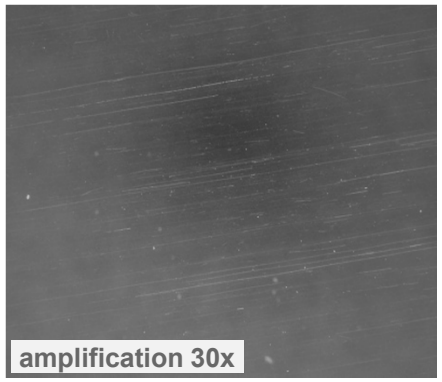
center of the screen



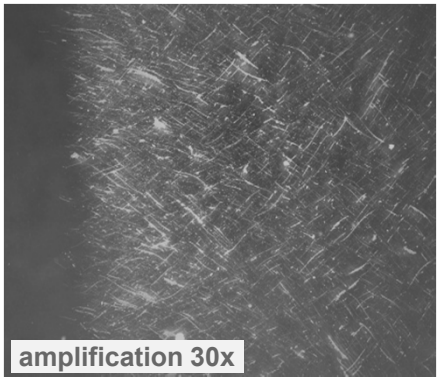
front-seat passenger side



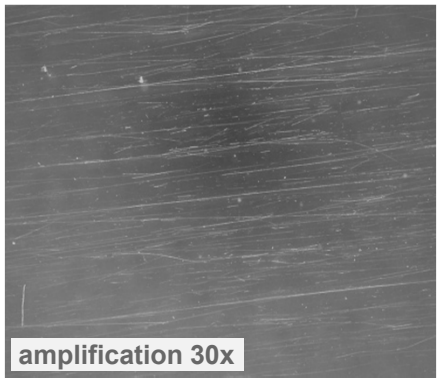
wiper test - 1000 wipe cycles



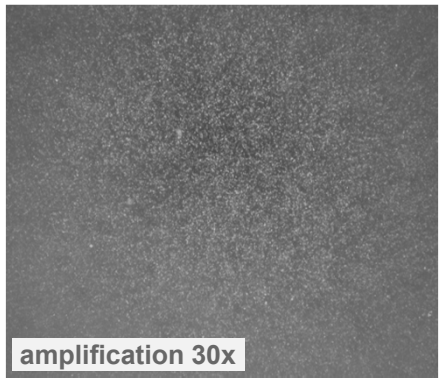
Taber - 1000 cycles



car wash test



sand drop test



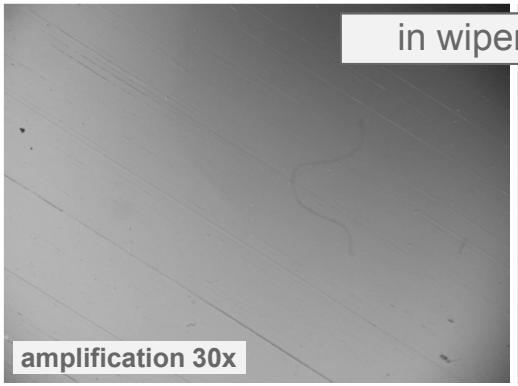
Glass Windscreens

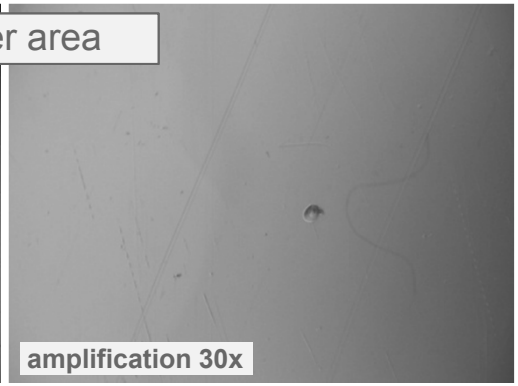
Comparison of Microscopic Images with Abrasion Tests

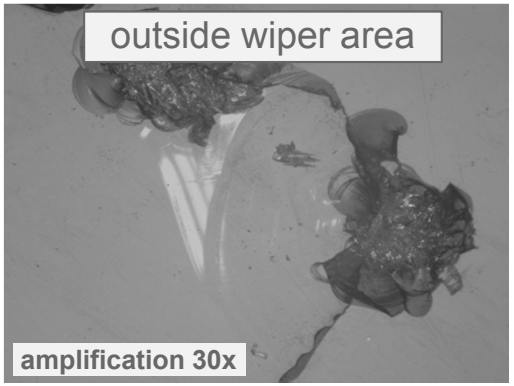
laminated glass wind-screen with a mileage of **105000 km**

abrasion tests on glass samples

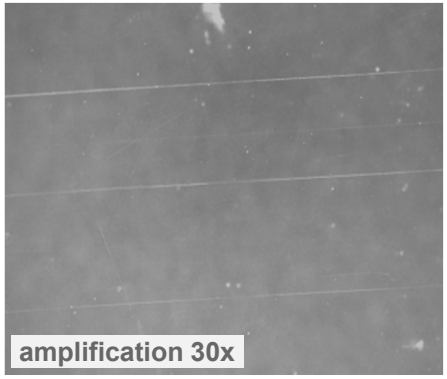
driver field of vision	center of the screen	front-seat passenger side
in wiper area		outside wiper area

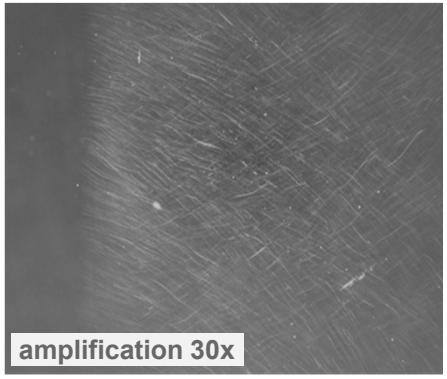


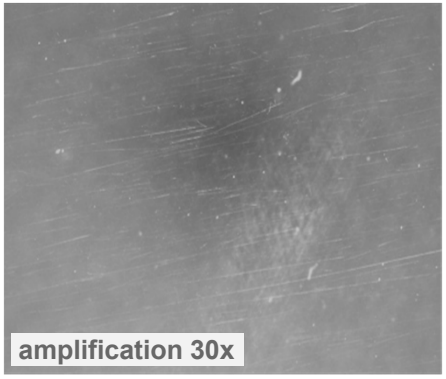


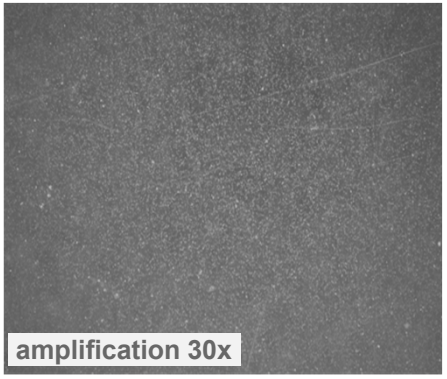


wiper test - 1000 wipe cycles	Taber - 1000 cycles	car wash test	sand drop test





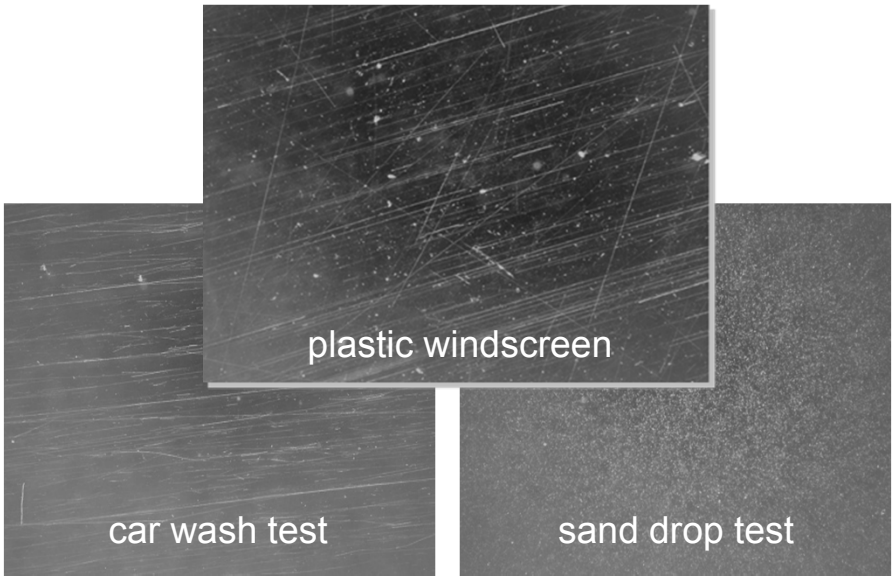


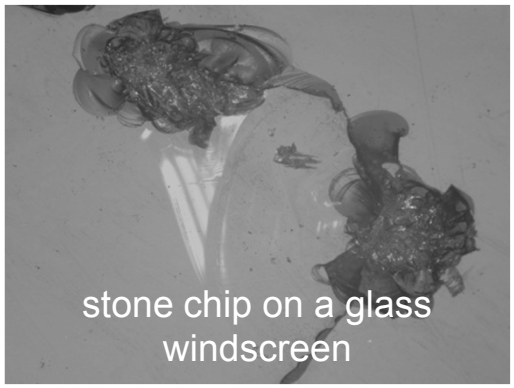


Windscreens

Summary of Comparison of Microscopic Images

- used plastic windscreens show depending on the location (within the wiper area or not) **scratches and some small pits**
- similar **microscopic images** are created by the car wash test respectively a wiper test and to some extend by the sand drop test
- for plastic windscreens there is **no similarity to the image created by the Taber test**





- most sever surface damage on **glass windscreens** result from **stone chipping**

Taber Abrasion Tests

Summary of Test Characteristics

	characteristics of the Taber abrasion test	consequence	implication for plastic glazing approval	possible adjustment of the test to solve issue
real part testing	can only be performed on absolutely flat 100mm x 100mm samples	it is not possible to test a finished plastic glazing part due to its shape (only on a reference sample)	the abrasion performance of a finished plastic glazing part will not be checked	no
correlation to on road use	two wheels consisting of abrasive particles in a resilient binder are placed with 500g load each on a rotating sample for 1000 cycles	there is no similarity to real "on-road" abrasion actions	no correlation between tested abrasion performance and real "on-road" wear performance	no
technical descrip-tion of abrading part	no technical details describing the abrasiveness of the wheels	intended or unintended change of the publicly unknown wheel recipe by the manufacturer can change the results	approval depend on pre-delivery quality inspection of the wheel manufacturer	qualifying wheels via reference materials
precision of the test method	round robin test revealed a very low precision for testing plastic samples	haze results for plastics will vary from almost invisible to milky based on test accuracy	approvals not only depend on sample performance	defining target values for reference materials including correction formula

- even if ISO solves these issues it is still not possible to assess the real wear of a finished plastic part

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Thank you!

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