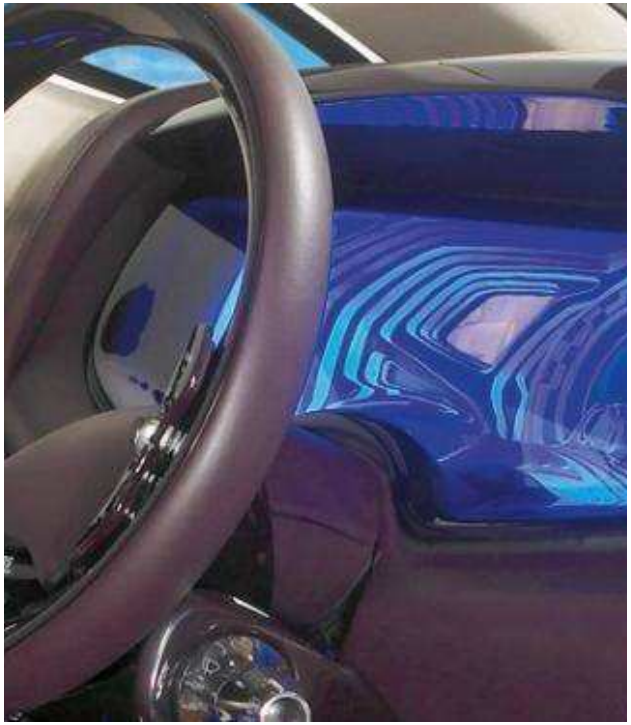




Science For A Better Life

Polycarbonate-Blends in Automotive

Agenda

- Product Portfolio
- Color Competence
- Interior Application
- Exterior Application
- Lighting Application

Polycarbonate and its Blends
Outstanding Combination of Properties

Transparency

Glass like:
88-90 % in 2 mm thickness

Toughness

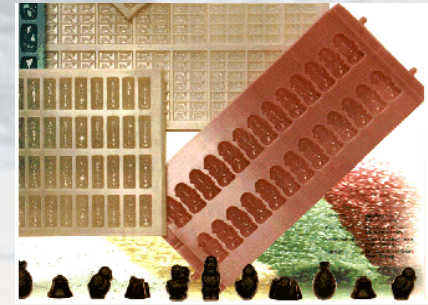
notched impact resistance:
(IZOD ISO180A, 23 ℃, 3.2 mm)
60-90 kJ/m²

High flame retardance

UL94 V-0,V2, HB …
Glow wire ≥ 850 ℃

Heat resistant

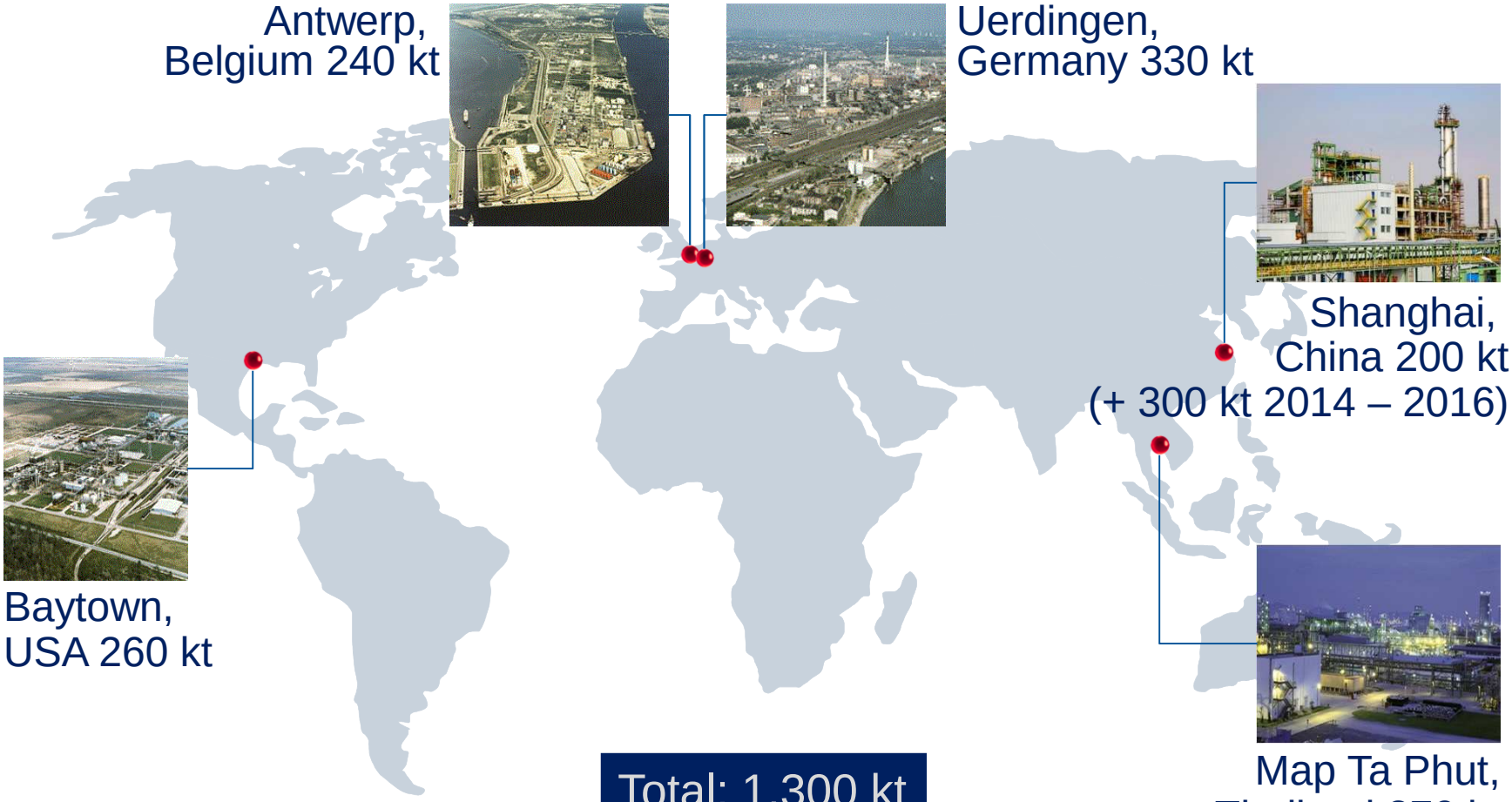
Tg ≃ 150 ℃ (DSC)
Vicat (ISO 306) ~ 145 ℃



Products

MAKROLON®	PC Polycarbonate	high transparency, high toughness, high heat resistance, high flame retardance, good electrical properties
APEC®	PC High Heat Polycarbonate	high transparency, high toughness, tailor-made Vicat up to 205 ℃, good electrical properties
BAYBLEND®	PC/ABS-Blends Polycarbonate / Acrylonitrile-Butadiene-Styrene copolymer	high toughness even at low temperatures, high heat resistance, good paint ability, good flowability / good processing behavior
MAKROBLEND®	PC/Polyester-Blends PBT – Polybutylene terephthalate PET – Polyethylene terephthalate	good resistance to chemicals, high toughness even at low temperatures, high heat resistance, good paint ability

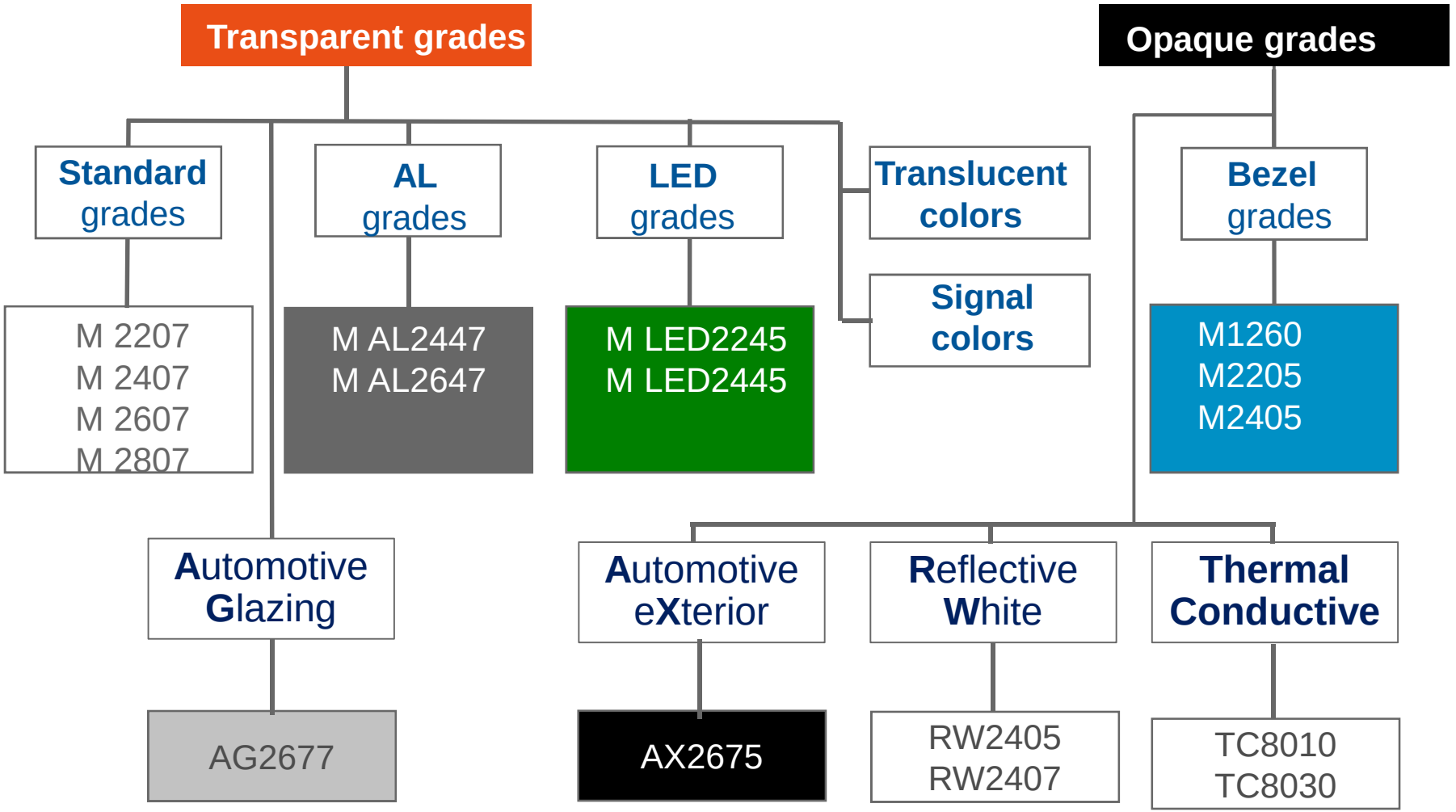
Makrolon®
Nameplate Capacity Year End 2010



Polycarbonates and Blends

Compounding Network & Plant Overview 2010

Product overview Makrolon® automotive



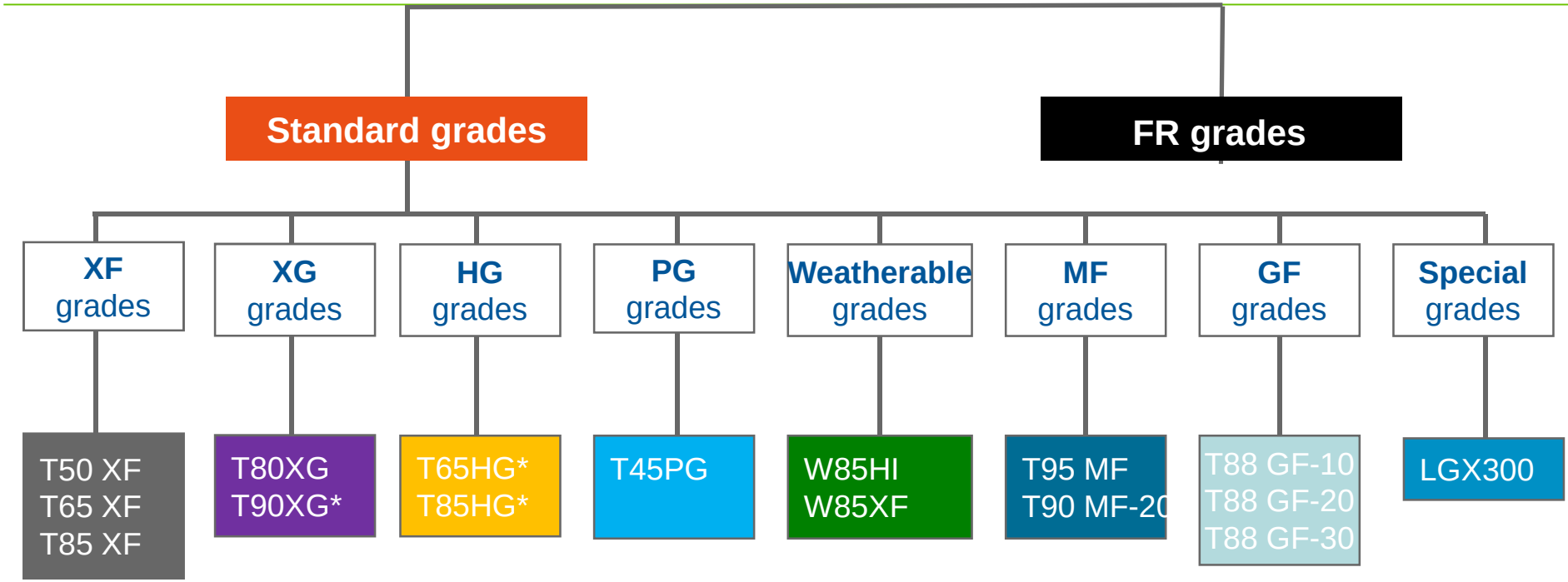
Product overview Apec® automotive

Vicat – Softening Temp. [℃]	158	173	183	203
Easy flow, easy release	1695	1795	1895	2095 1)
Easy flow, easy release + UV stabilized	1697	1797	1897 2)	2097
Basic grade + UV stabilized	1603 2)	1703 2)	1803 2)	
Easy flow, reflective white	RW1697	RW1795		

1) Not available in crystal clear (551022)

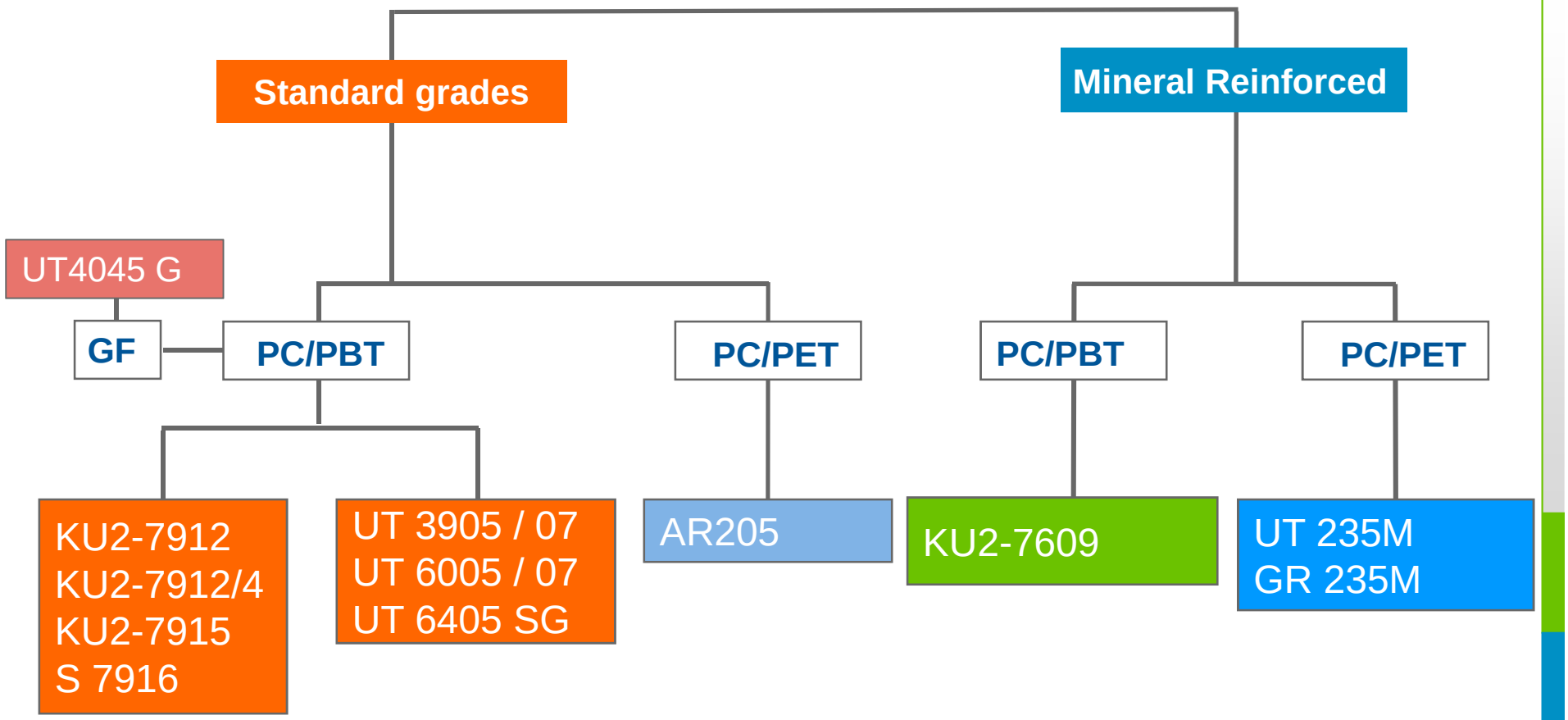
2) AMECA approval

Product Overview
Standard Grades – Bayblend® T



** New development*

Product Overview
Makroblend® automotive



Agenda

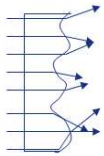
- Product Portfolio
- Color Competence
- Interior Application
- Exterior Application
- Lighting Application

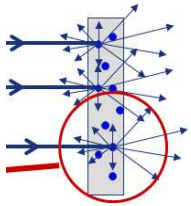
Color Competence World Map: Colors can be developed in several sites close to customers

Once a color is developed, it can be transferred in all the regions within a short time

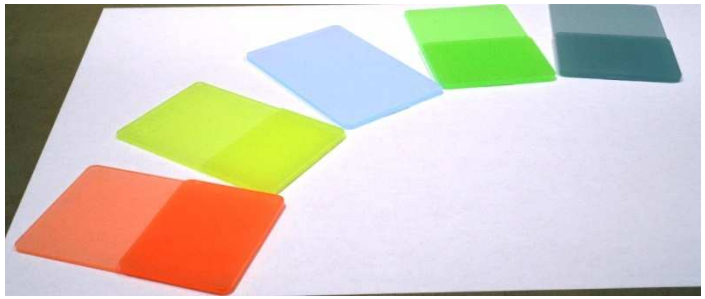
Classic Colors: ROYGBV

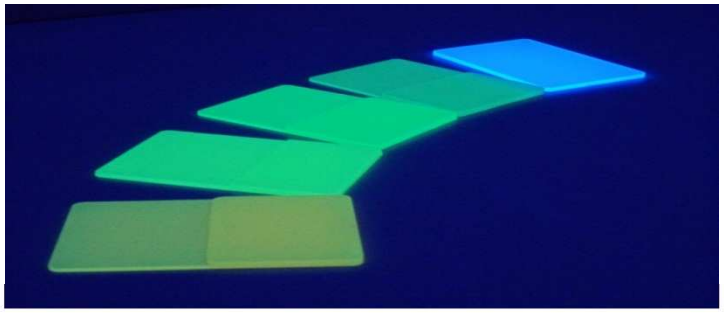
Classic Colors: Translucency

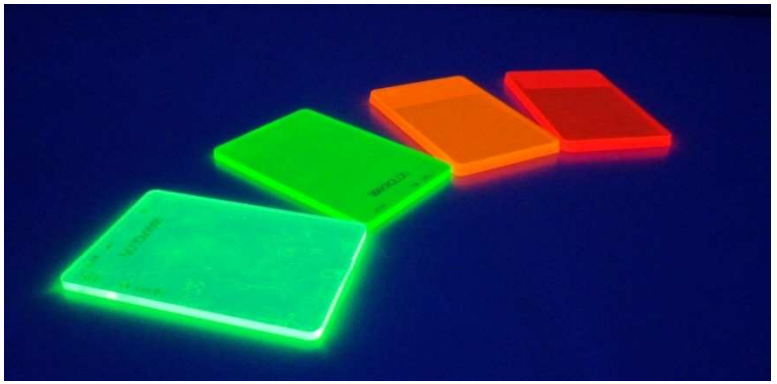




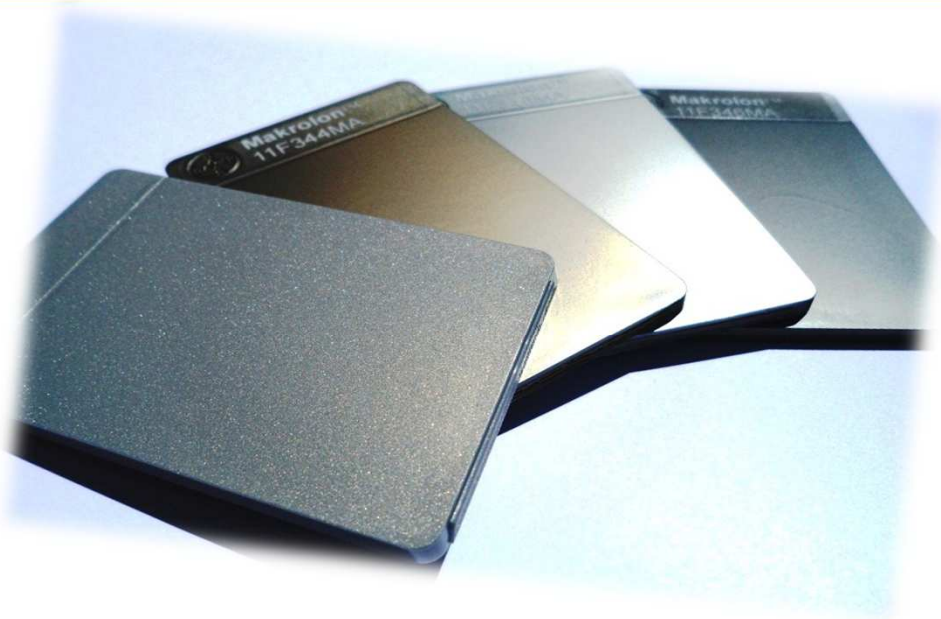
Color effects: Absorbing and Reemitting Light

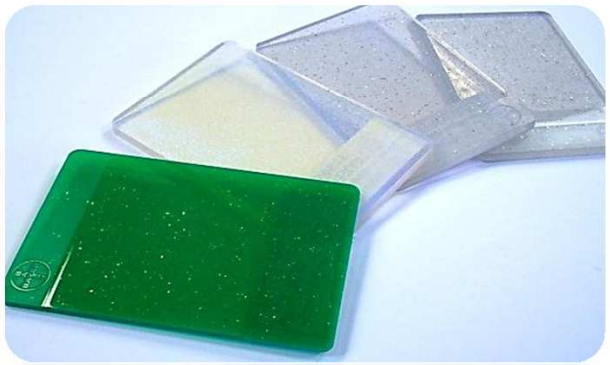






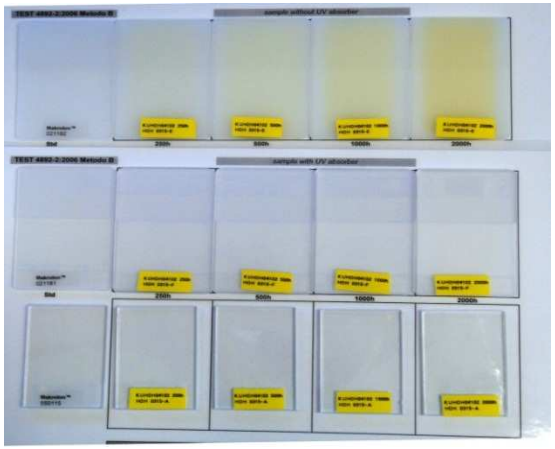
Color effects: Metallic and Sparkle





Beyond visible properties
Role of UV : Light fastness

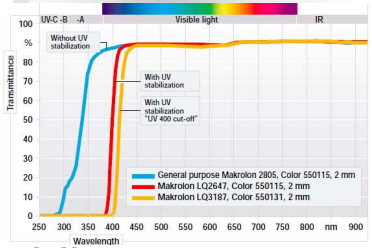
ASTM G26
ASTM G151
ASTM G155
DIN EN ISO 4892 - 2
SAE J2412 (J1885)
SAE J2527 (J1960)
VDA 75202



Beyond visible properties: Role of UV and IR

Absorption optimization

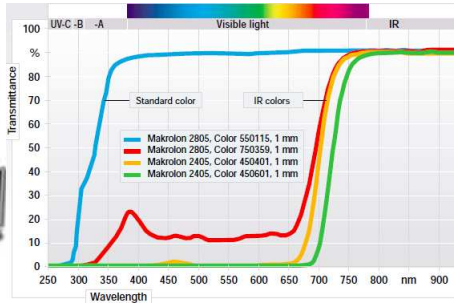
Heat reduction & protection: for glazing and safety goggle/shield

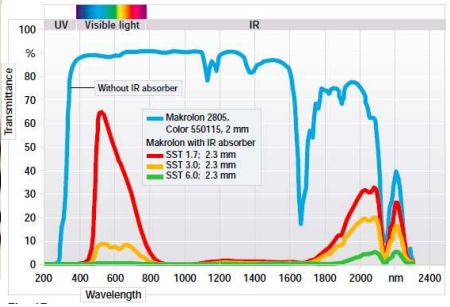


Heat generating: for laser marking/welding

Transmission optimization

Free transmission IR wavelenght: for data transfer and night vision





Understanding
Bayer Color Numbers

All Bayer color numbers are composed of six digits

$X_1 X_2$ $Y_3 Y_4 Y_5 Y_6$

Classification digits (visual appearance)

Administrative digits (random numbers)

X_1 identifies the color as follows:
0 = white, 1 = yellow…8 = brown and 9 = black
Natural is 000000 and colorless Makrolon® polycarbonate is identified with X_1X_2 = 55

X_2 indicates that the color is opaque, translucent, metallic, transparent, etc.

source: www.plastics.bayer.com • contact: plastics@bayer.com • April 2014

Bayer MaterialScience

Agenda

- Product Portfolio
- Color Competence
- Interior Application
- Exterior Application
- Lighting Application

Bayblend® T grades, non-reinforced

Basic Properties

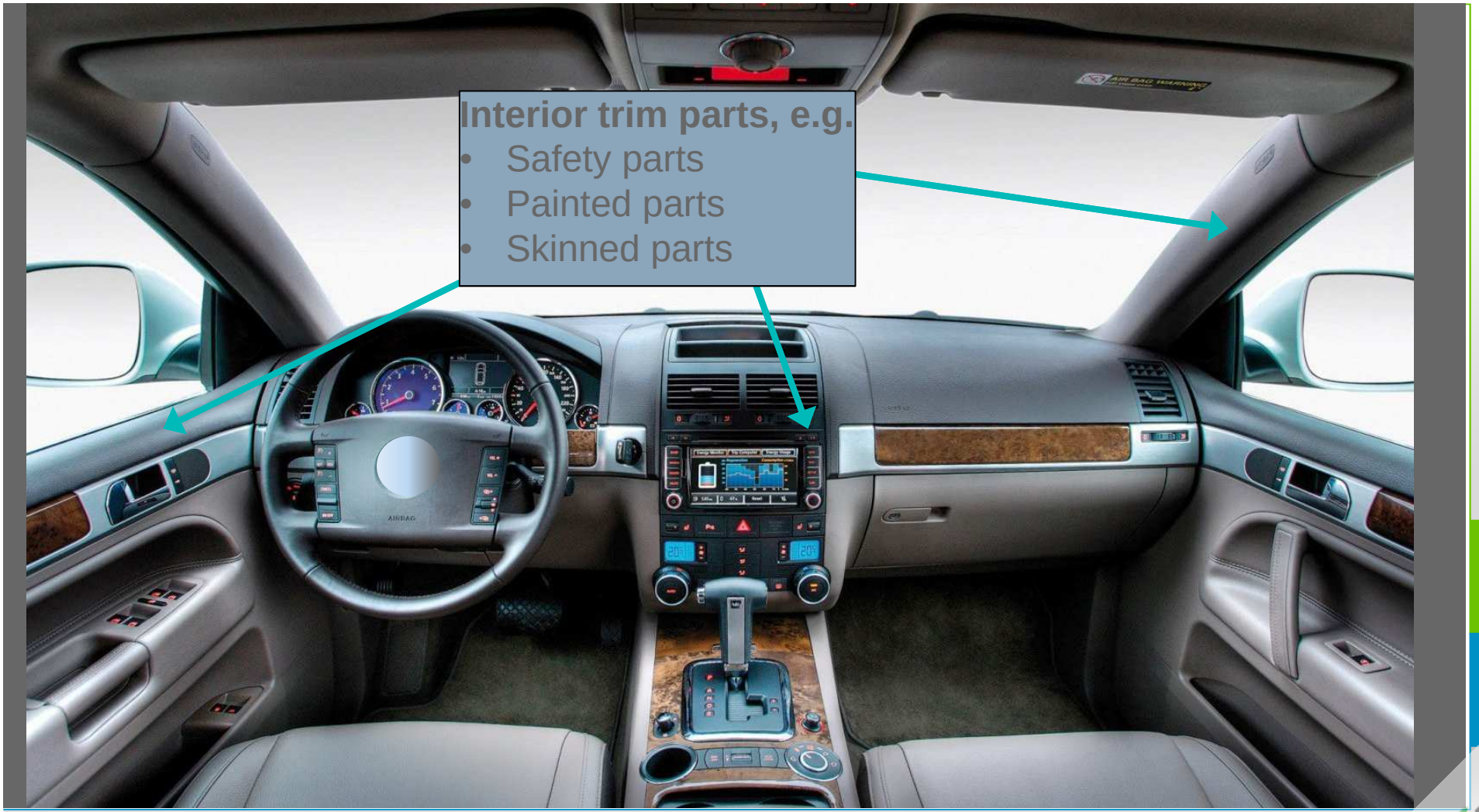
- Excellent notched and multiaxial impact strength, even at low temperatures
- Excellent processing behavior and finished part accuracy
- Amorphous material, nearly constant E-modulus over relevant temperature range → excellent dimensional stability
- Excellent surface finishing properties for painting, foaming and skinning, typically without surface activation or primering
- Low quantitative emissions (VOC) and very competitive odor level

Emission and Smell Behavior

Emissions according to VDA 277
Automotive Grades: Bayblend®

Test plates molded under recommended conditions	µg C/g
Bayblend® T65 XF (Vicat B/120: 120 °C)	< 20
Bayblend® T85 XF (Vicat B/120: 131 °C)	< 20
Limit VW (Audi, Volvo)	max. 50 (30)
Smell behavior	≤ 3 (VDA 270)

Bayblend® T65 XF / T85 XF



Bayblend® HG Generation

- New specialty product generation (T65 HG and T85 HG) with the same overall property profile compared to Bayblend XF, including in particular low-temperature ductility, low-emission behavior and paintability.
- New products are especially designed to add value by
  - Processing-stable high gloss on unpainted surfaces
  - Improved colorability (particularly suitable for dark and brilliant colors)
  - Suitable for unpainted combined high-gloss / low-gloss parts due to excellent reproduction of micro-textured injection molding tools

Bayblend® HG vs. XF

	T65 XF	T65 HG*	T85 XF	T85 HG*
ak Izod ISO 180A RT [kJ/m²]	45	50	48	50
Vicat B/120 [℃]	120	120	130	130
MVR 260℃/5 kg [cm ^{3}/10 min]	18	17	19	17
Shear viscosity 260℃/1000 s $^{-1}$ [Pa*s]	200	210	250	260
Tensile modulus [MPa]	2400	2300	2300	2250
Gloss level @ 20° (260℃/80℃)	90	97	90	100
Gloss level @ 20° (300℃/80℃)	70	97	50	100

*preliminary product description; data are based on limited production statistics and thus shall not be interpreted to anticipate any future product specification

Individual designs and colors, easy and cost efficient realized

Molding of 3D LaserEngraving structures with cyclic mold temperature

- High gloss and matt on one surface
- Natural scratch protection by structures
- Reproducible design and mapping towards close parts using Laser Engraving technology

Partner:

J.&F. KRÜTH FORM-ÄTZ-TECHNIK SOLINGEN, gwk

Individual designs and colors, easy and cost efficient realized

Bayblend HG:

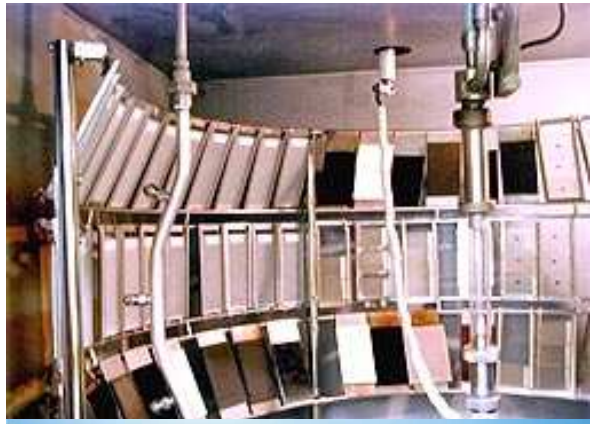
- ❑ good flowability and high mold temperature enable good casting of mold
- ❑ Good thermostability
- ❑ high impact strength at lower temperatures
- ❑ High gloss level using PC, PC+ABS

Bayblend® W

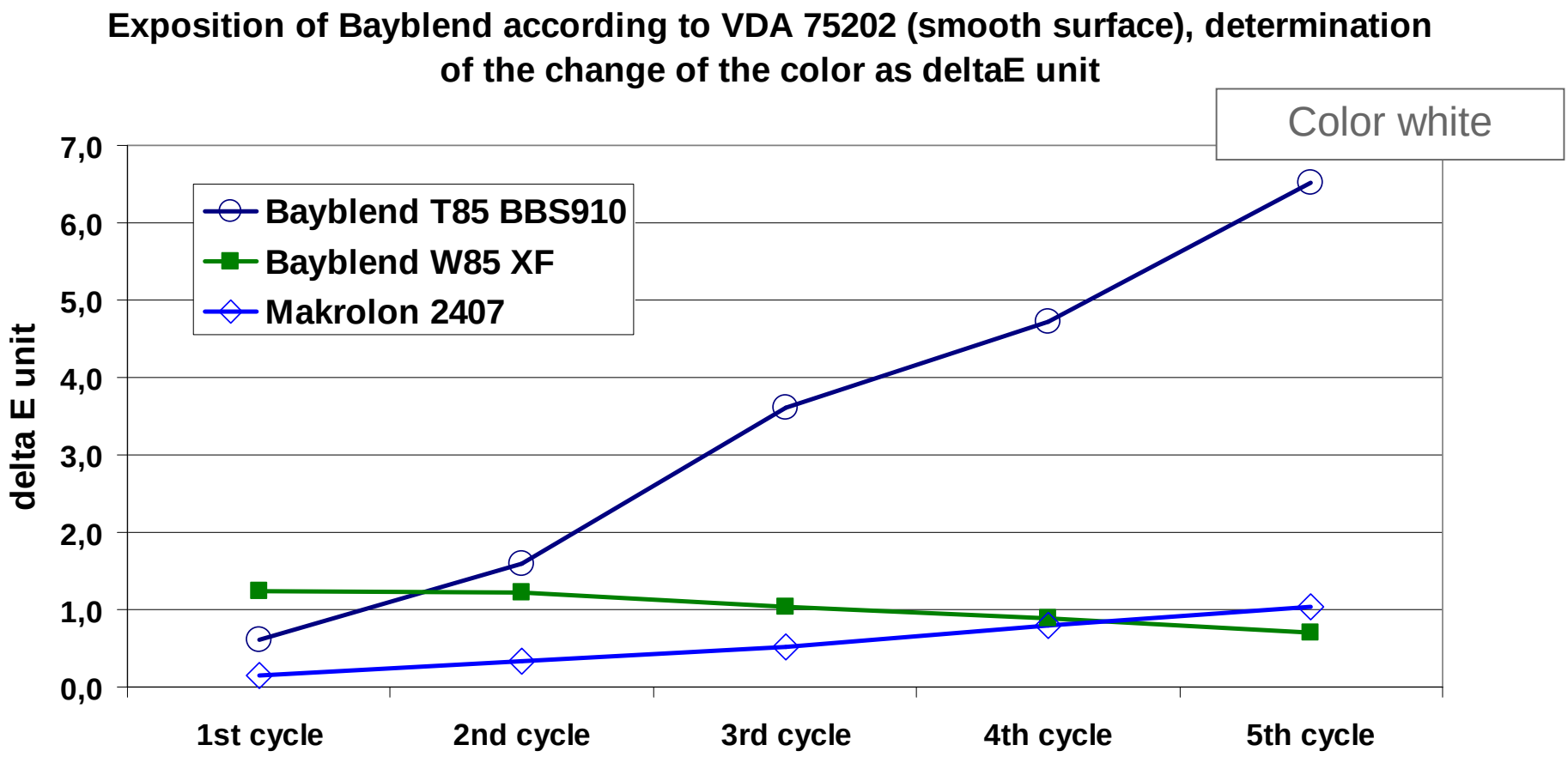
PC/ASA blend tailored for non-painted exterior and interior automotive applications requiring superior light aging stability or weatherability

- High heat resistance
- melt flow comparable to Bayblend® T
- High impact strength
- enhanced tensile modulus
- compliant with European automotive OEMs‘ low-emission standards
- good surface cosmetics
- customer specific color developments on request

Interior light stability tests
e.g. DIN EN ISO 105-B06, VDA 75202, PV 1303, SAE J1885, TSL0601 G Method E



Bayblend® W85 XF
light fastness (interior)



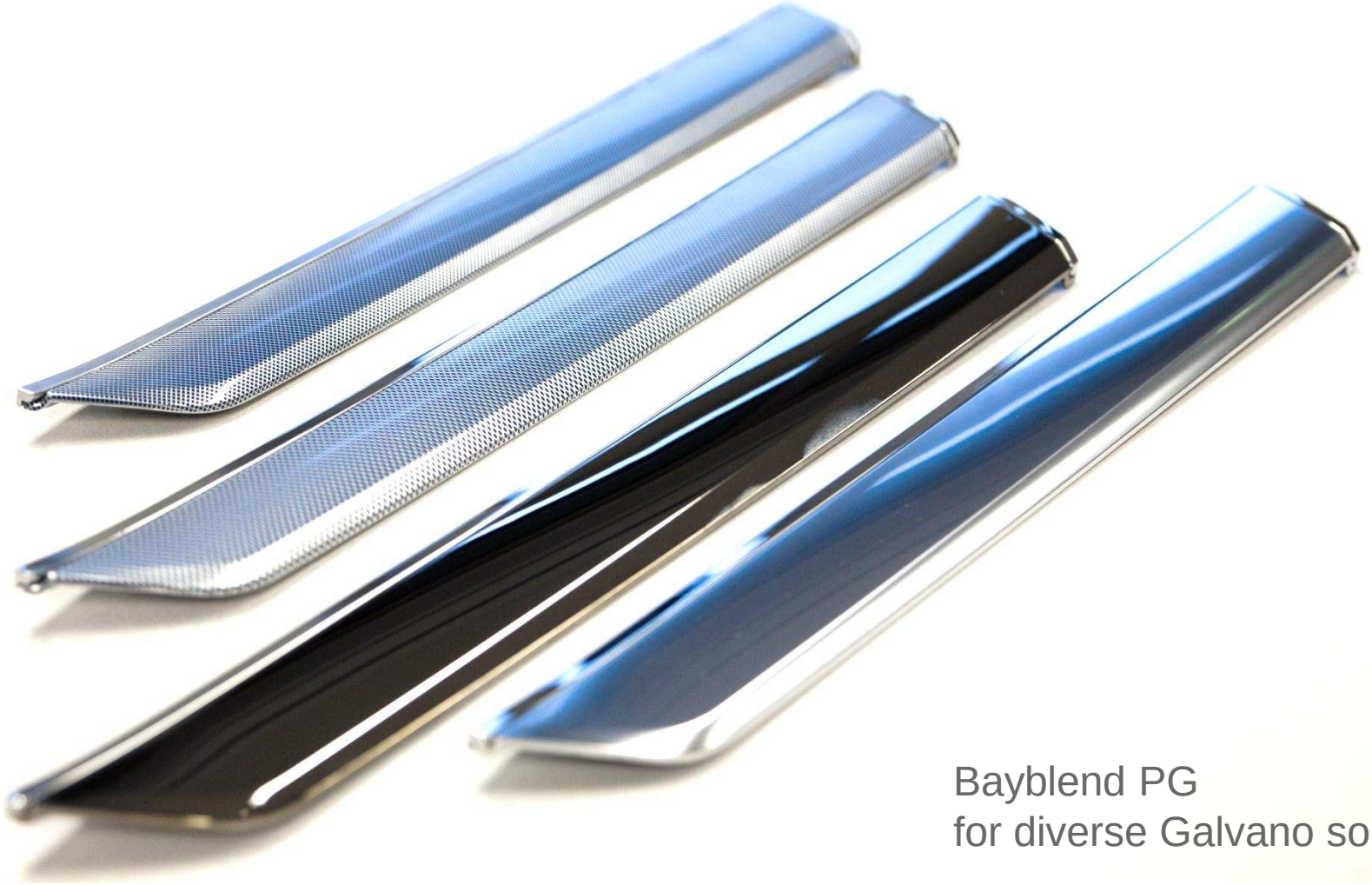
Bayblend® T45 PG

Electroplating applications

door handle

front grille frame

Chrom- and Strukturchrom® -Versions on Bayblend® T45 PG



Bayblend PG
for diverse Galvano solutions

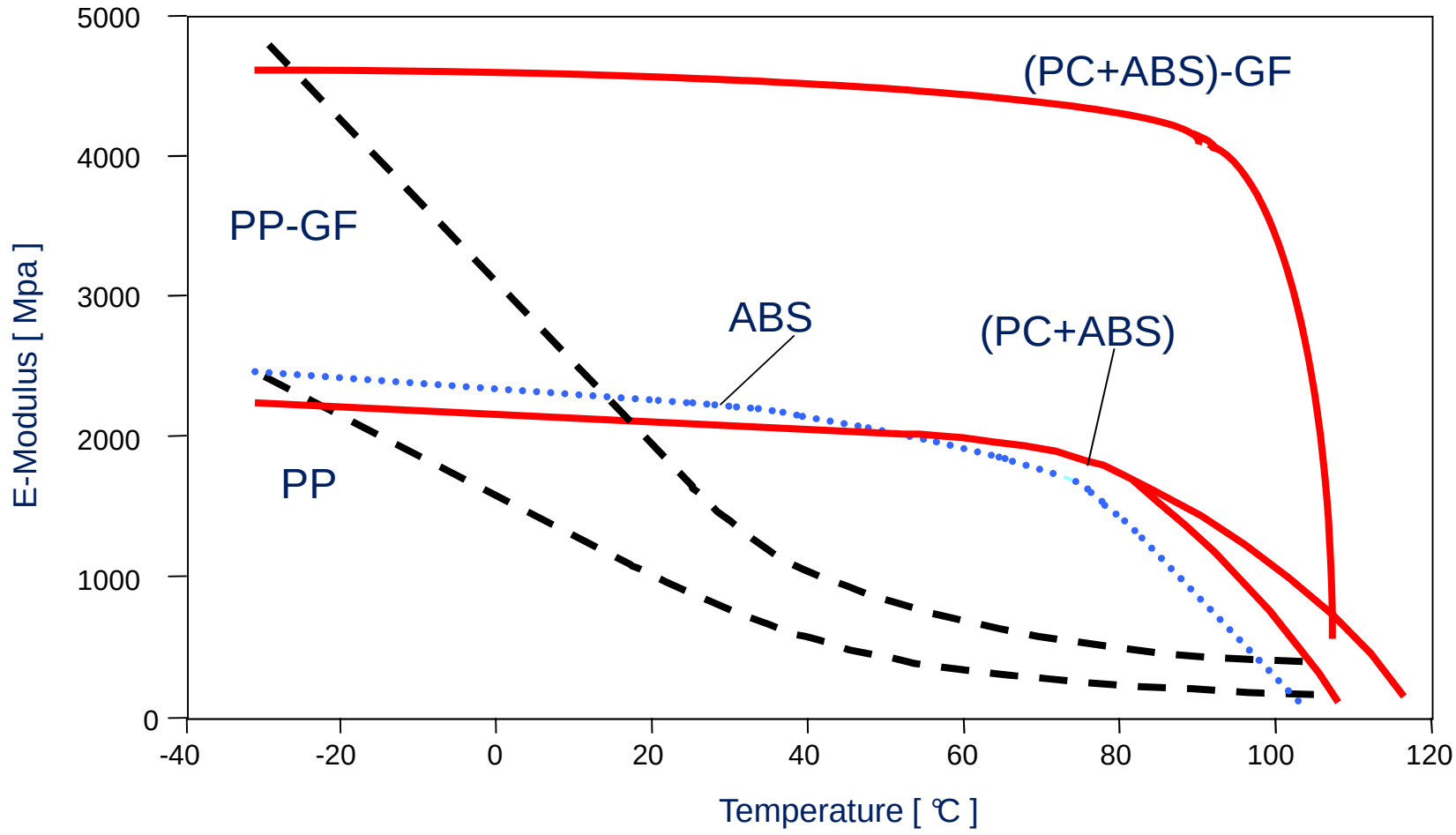
Bayblend® GF Grades

- Melt viscosities reduced by 30-40 % vs. conventional Bayblend® GF grades; ***T88 GF-10 is successor of T88-2N; T88 GF-20 is successor of T88-4N***
- Inreased long term heat aging reasistance
- Tensile modulus increased by 25 %; ~ 50 % increase in tensile strength
- Excellent color stability when exposed to (UV) light
- Improved surface cosmetics – benchmark in PC/ABS GF
- Very good adhesion to PU foams / TPU´s – even after aging
- Excellent performance in backmolding of interior wooden trim parts
- Part production with reduced wall thickness - utilizing full potential of new grades

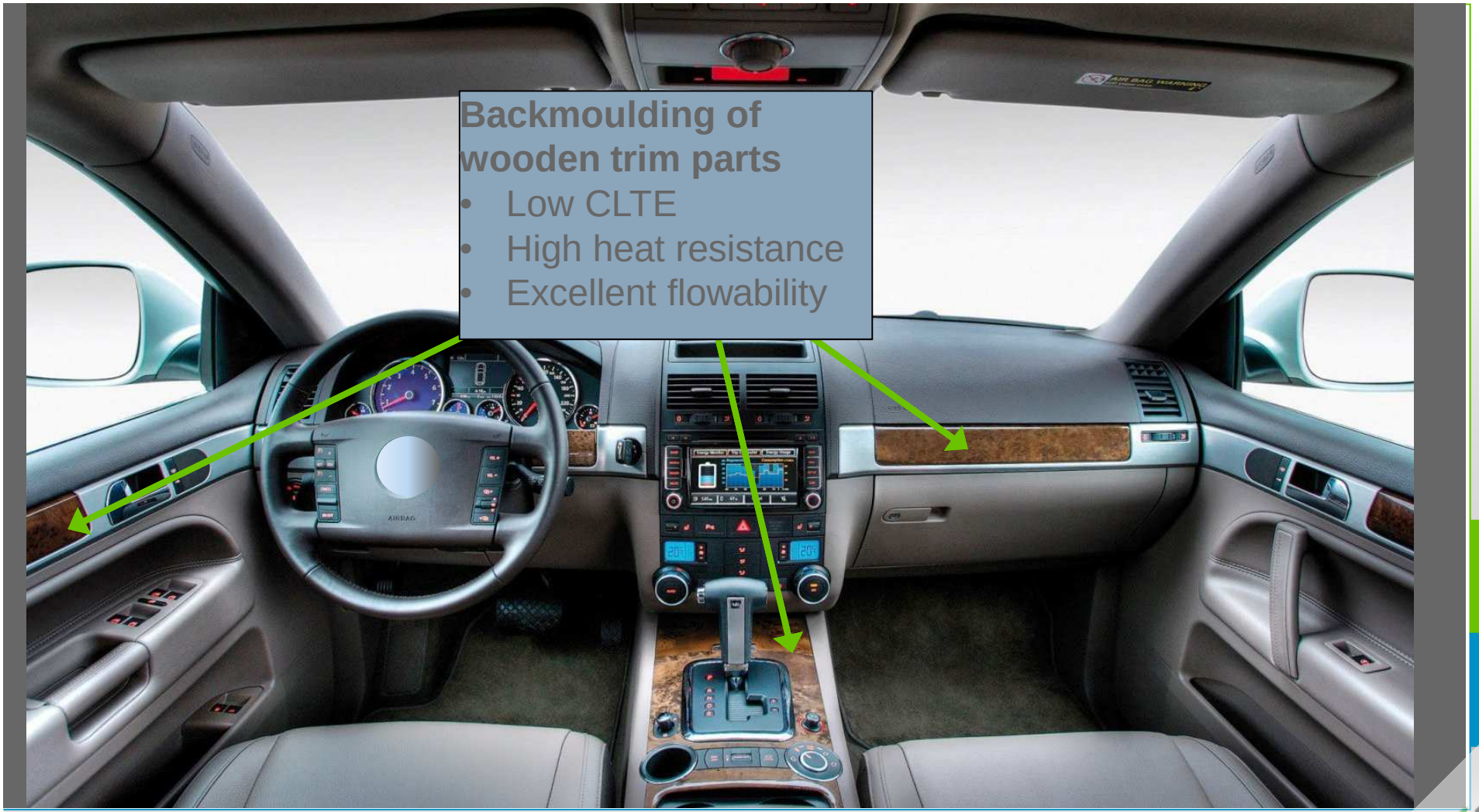
Bayblend® GF

	T88 GF-10	T88 GF-20	T88 GF-30
an Izod ISO 180/U RT [kJ/m²]	35	38	35
Vicat B/120 [℃]	134	130	134
Shear viscosity 260 ℃/1000 s^{-1} [Pa*s	205	210	250
Tensile modulus [MPa]	5100	7500	10000
Glass fibre content [%]	10	20	31

E-modulus over Temperature



Bayblend T88 GF-10 / 20 / 30



T88 GF-10 for IP-Carrier

Advantage:

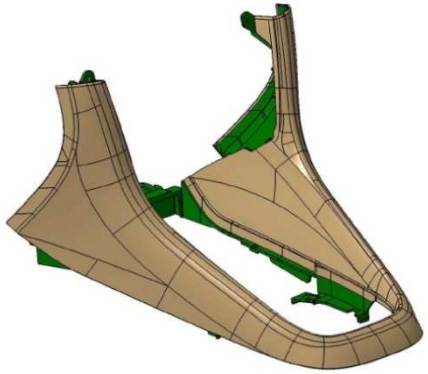
- High flowability results in faster cycle times/ better profitability
- Thermoageing stable
- Applications: Ford Focus C-Max

Bayblend® T88 GF-10
Centre console (VW Golf)

Advantages:

- Good flowability
- high stiffness
- good warpage behavior
- excellent retention of ductility upon long-term exposure to (humid) heat
- Low wall thicknesses possible
- Minimized warpage
- Good adhesion of both components
- High dimensions stability, comfortable haptics, good scratch resistant, good light fastness, matt finish

2K centre console
Bayblend® T88 GF-10 + TPU



Bayblend® LGX300

- **Inherent low gloss**
- High stiffness, high impact High heat resistance
- Good weatherability
- Low emission
- Good flowability

		A1 polish		texture	
		20°	60°	60°	85°
LGX300	ASTM D523 (GU)	32	83	1.8	2.6
T85XF		98	100	3.1	5.8

Agenda

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Automotive Glazing

Roofs, side and rear windows

1st transparent component:

- Makrolon AG 2677,
- IR absorbing colors available

2nd black component:

- Bayblend T95 MF
- Makroblend UT 235 M

Horizontal Parts Applications
Roof Bezels

OEM: VW/Audi/Skoda/Seat/Lancia…
Application: 1-Piece U-Trim
Material: MK 2605 MAS083 black (=>AX2675)
coated with AS 4700 &SHP470FT 2050

Bayblend® W85 XF

PC + ASA blend tailored for non-painted exterior and interior automotive applications requiring superior light aging stability or weatherability

- heat distortion temperature superior to competition
- melt flow comparable to Bayblend® T65
- multiaxial ductility down to -20 ℃
- enhanced tensile modulus
- compliant with European automotive OEMs' low-emission standards
- good surface cosmetics
- customer specific color developments on request

Bayblend® Mineral filled Grades

Mineral-reinforced PC/ABS injection molding grade with outstanding heat distortion temperature

- improved balance of ductility and stiffness vs. GF grades
- heat distortion temperature similar to pure PC
- reduced CLTE and molding shrinkage vs. non-reinforced PC/ABS blends
- isotropic molding shrinkage behavior
- nearly isotropic CLTE
- high dimensional stability
- superior melt flow vs. comparable Makroblend® grades
- high energy uptake capacity under multi-axial impact load down to temperatures as low as -30 ℃
- class A, low gloss surface appearance

Bayblend® Mineral Grades

	T95 MF	T90 MF-20
an Izod ISO 180/U RT [kJ/m²]	≥ 150	33
Vicat B/120 [℃]	142	130
MVR 260 ℃/5 kg [cm ^{3}/10 min]	18	12
Shear viscosity 260 ℃/1000 s $^{-1}$ [Pa*s]	410	230
Tensile modulus [MPa]	3350	5200

Bayblend® T90 MF-20

Roof Spoiler

- 20 % mineral filled grade, low CLTE, isotropic behavior
- Class-A-surface
- Excellent paint adhesion
- Fully amorphous material, high modulus up to > 100℃

- Excellent Flowability
- Target: Metal- and SMC-replacement

Bayblend® T85 XF

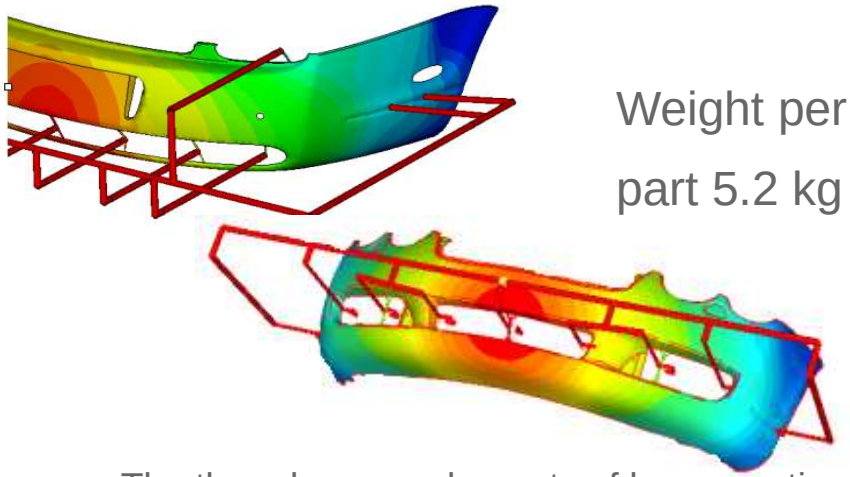
Rear Spoiler

- Class-A-surface
- Excellent paint adhesion
- High heat resistance and for large horizontal parts
- Excellent Flowability, 15-20 % improved to Bayblend T85
- Metal- and SMC-replacement in large horizontal body panel applications

SGM 258 MPV spoiler T85XF

Front and Rear Bumper
Makroblend PC+PBT KU2-7912

OEM: Bentley
Type: Continental Flying Spur



Weight per part 5.2 kg

OEM: VW
Type: Phaeton

The three bumper elements of lower section, protective strip and cover are injection molded by system suppliers, and then **painted without plasma pretreatment or flame treatment.**

Makroblend® UT 6007 (PC/PBT)

- Improved weatherability
- High impact strength
- Excellent chemical resistance

- Target: truck exterior inluding non-painted mudguards

- Non-painted front grille

Makroblend® AR 205 (PC+PET)

New easy flowing PC+PET - Blend for Automotive Radiator grills

Outstanding properties:

- Easy flowing
- Excellent processing stability
- Good surface quality
- High heat resistance
- Easy release
- Excellent paintable (single layer coating systems or high gloss piano black systems working well)

Comparison AR 205 vs DP7645

	AR 205	DP7645
MVR 270℃ / 5 kg	40	24
Melt viscosity 270 ℃ / 1000 s^{-1}	220	240
Tensile modulus [MPa]	2200	2100
an IZOD ISO 180U -30 ℃ [kJ/m^2]	n.b.	n.b.
ak IZOD ISO 180A 23 ℃ [kJ/m^2]	39	50
ak IZOD ISO 180A -20 ℃ [kJ/m^2]	18	23
Vicat B/120 [℃]	137	133
HDT-B [℃]	125	120
Shrinkage [%]	0.6 – 0.8	0.6 – 0.8

PC+PBT / PC+PET mineral filled

	KU 2-7609	UT235M	GR235M
MVR 260℃/5 kg [cm^3/10 min]	11	16*	18*
Shear viscosity [Pa*s] 260 ℃ /1000 s^{-1}	370	230*	280*
Tensile modulus [MPa]	3400	4200	4600
an IZOD ISO 180U 23 ℃ [kJ/m²]	160	110	100
ak IZOD ISO 180A 23 ℃ [kJ/m²]	20	8	8
Vicat B/120 [℃]	120	140	142
HDT-B [℃]	106	130	-
Shrinkage [%]	0.4 - 0.6	0.5 - 0.6	0.5 - 0.6
CLTE [10^{-4}/K]	0.7	0.45	0.46

* at 270 ℃

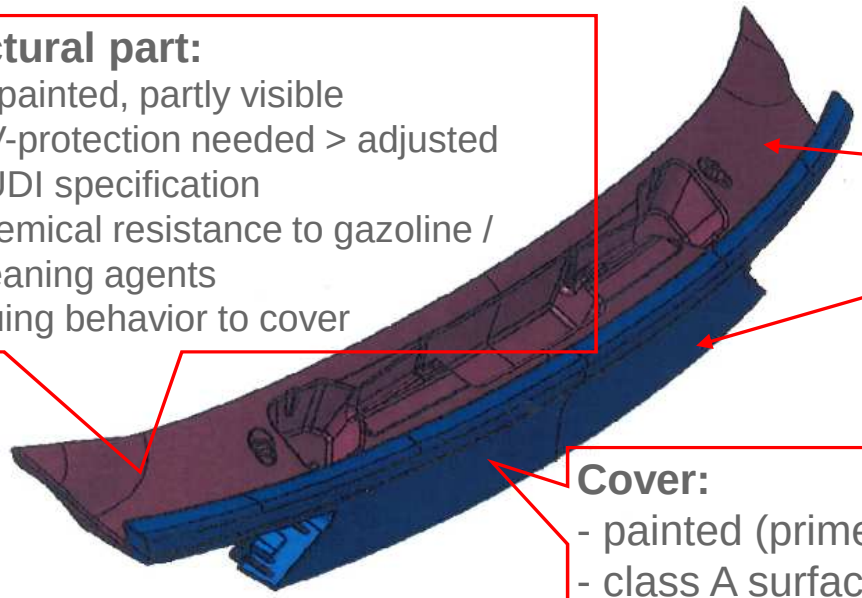
Makroblend® UT235M
(15% mineral filled PC/PET)

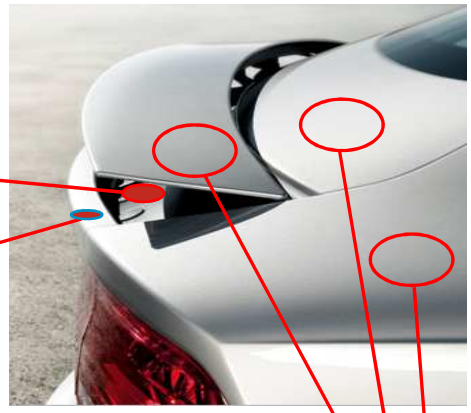
- Prefered grade for horizontal exterior parts with low CLTE
- Much better flowability than DP7665
- Less mineral streaks
- Coefficient of linear thermal expansion < 0.5 [10-4/K]
- Low isotropic shrinkage (nearly same than DP7665)
- Good paint adhesion

Makroblend® UT235M
(15% mineral filled PC/PET)

OEM: Audi A7
Part: Cover and structural part for tailgate

Structural part:
- unpainted, partly visible
- UV-protection needed > adjusted AUDI specification
- chemical resistance to gazoline / cleaning agents
- gluing behavior to cover





Cover:
- painted (primer, base coat, clear coat)
- class A surface
- gluing behavior to structural part

sheet metal

Makroblend® UT235M
(15% mineral filled PC/PET)

- Opel Insignia Sports Tourer
- Rear spoiler

- Audi A5 cabriolet
- Cover for the convertible top box

Makroblend® UT235M
(15% mineral filled PC/PET)

Mercedes SLK (R172): Pillar and roof trim

Makroblend® GR235M (PC/PET)

(15% mineral filled PC/PET)

Agenda

- Product Portfolio
- Color Competence
- Interior Application
- Exterior Application
- Lighting Application

PCS automotive lighting applications

- Head lamp lens and fog lamp lens covers
- Bezels and reflectors
- Indicator and break lights：signal colors
- Rear Lamps
- LED
- Collimator lenses

Head Lamp Lens and Fog Lamp Lens

Material grades:

Makrolon: M. AL2447; M. AL2647 (550396)

Apec: A.1603; A.1703; A.1803; A.1897

- UV stabilized
- High impact strength
- Optical quality / High transparence
- Easy-moldability
- SAE/ECE approvals

Resistance to UV light, chemical attack and scratches by special hard coat

Head Lamp Lens and Fog Lamp Lens

Apec 1603 551022 for fog lamps

Bezels/Reflectors

Material	Bayblend® T80XG	Bayblend® T90XG	Makrolon® 1260, 2205, 2405	Apec® 1695	Apec® 1795	Apec® 1895	Apec® 2095
Vicat Temperature* 50 N, 120K/h	127℃	130℃	143℃	158℃	173℃	183℃	203℃
Typical Application	Bezel for rear lamps	Bezel for rear lamps	Bezel for forward lighting and rear lamps	Bezel for forward lighting	Bezel for forward lighting	Bezel for forward lighting	Bezel for forward lighting

BAYBLEND® quality material

MAKROLON® the high-tech material

APEC® *

100℃ 120℃ 140℃ 160℃ 180℃ 200℃ Vicat (VST B120)

* Please take the UL RTI temperature into account ➔ *Tailor-made materials for a broad range*

Bayblend® T80 XG

Automotive light reflector applications requiring class-A, high-gloss appearance after metallization

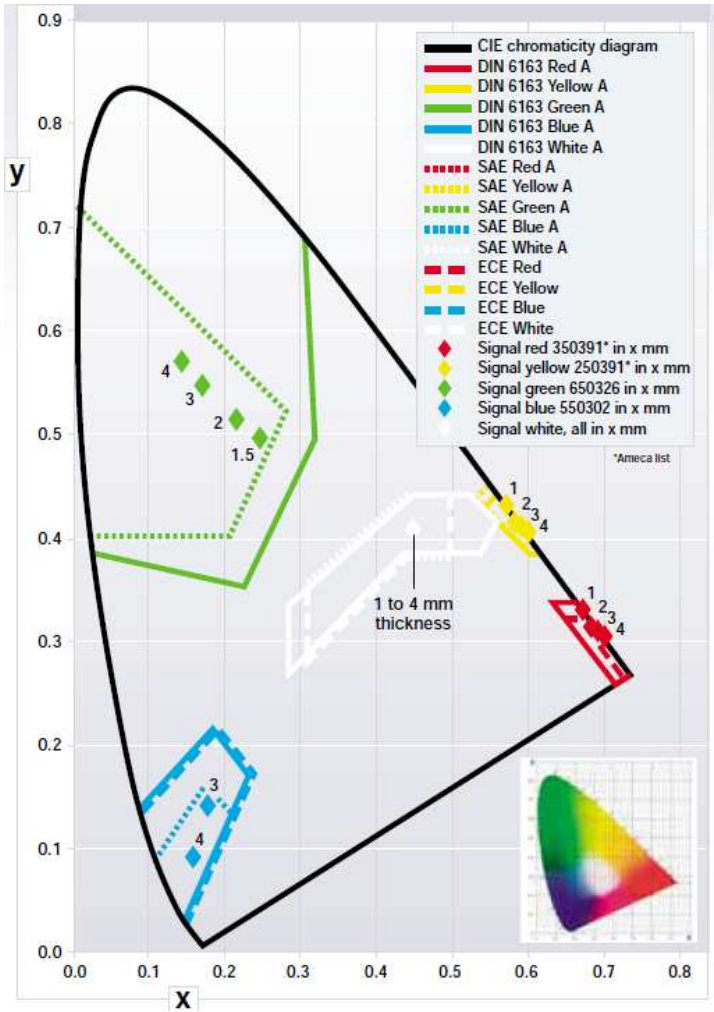
- excellent processing behavior
- homogenous high-gloss surface appearance
- good metallization behavior
- high heat distortion temperature
- welding ability with PC and PMMA
- high ductility at application temperatures

Indicator and break lights: Signal Colors

Material grades:

- ❑ Makrolon: M.2207; M.2407; M.2607; M.2807
- ❑ Apec: A.1697; A.1797; A.1897

- ➢ Special colors within the defined signal color range
- ➢ AMECA approval for signal colors
- ➢ High purity and tight color specifications
- ➢ High variety of signal colors to fulfill individual needs



Rear Lamps

Light guide

Light guide *Structured surface*

Translucent Cover

Sophisticated effects

Many rear lamp components are made of Makrolon!

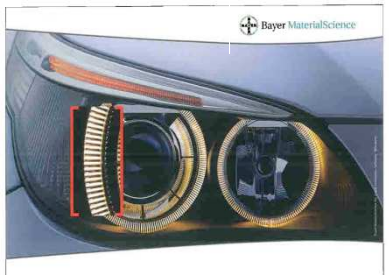
LED Auto lighting

Motivation for OEMs and Tier1:

- Energy saving
- Weight saving
- Design freedom
- Longer lifetime

BMS perspective:

- Makrolon for light guides, collimator optics, reflectors and other parts
- Development activities BMS:
  - Makrolon LED2245/LED2445
  - Molding technology



Lamp cover made in glass

Lamp covers made in PC Lenses made in glass

Lamp covers made in PC Lenses made in PC

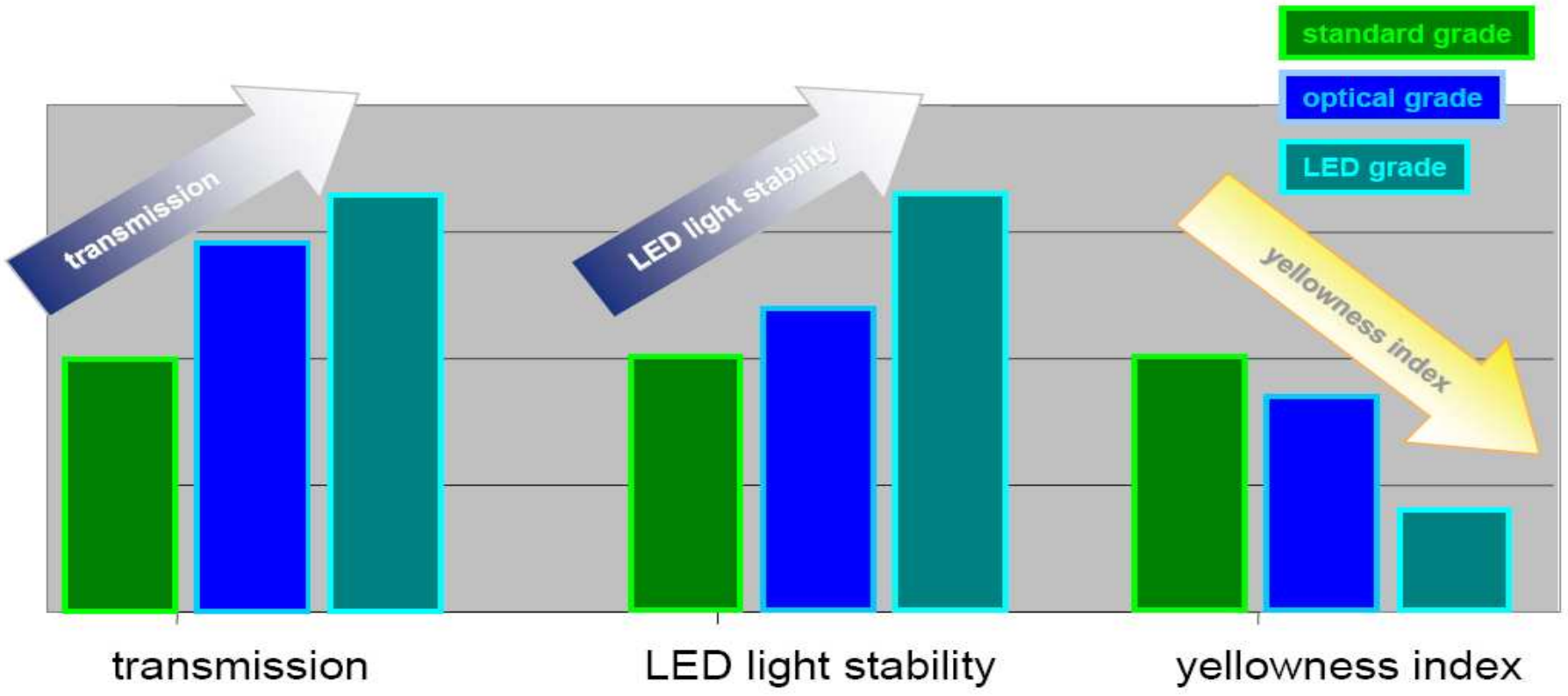
Makrolon® Grades for Optical Lens Applications

new

Makrolon grade	Makrolon OD2015	Makrolon LED2045/ LED2245**	Makrolon LED2245	Makrolon AL2447/AL2647	Makrolon LQ2647	Makrolon LQ3187
Color code	000000	000000	550207	550396	550115	550131
Color	Non tinted	Non tinted	Ice color	Crystal clear	Crystal clear	Crystal clear
MVR (cm³/10 min @ 300℃)*	61	61/36	36	19 / 12	12	6
Transmission (4 mm)*	90 %	90 %	89~90%	88 %	88 %	86 %
Transmission (20 mm)*	88-89 %	88-89 %	85-87 %	83 %	83 %	tbd
Application	CD/DVD	Light guide	Lenses Light guide	Head lamp lenses	Opthalmics, visors	Opthalmics, visors
UV-protected	no	no	no	yes	UVcut 380	UVcut 400

** Typical values, no specification*
*** Availability depends on region*

Optical properties of standard, optical and LED Makrolon® grades



→ LED grades: enhanced transmission, decreased yellowness index and improved LED light stability

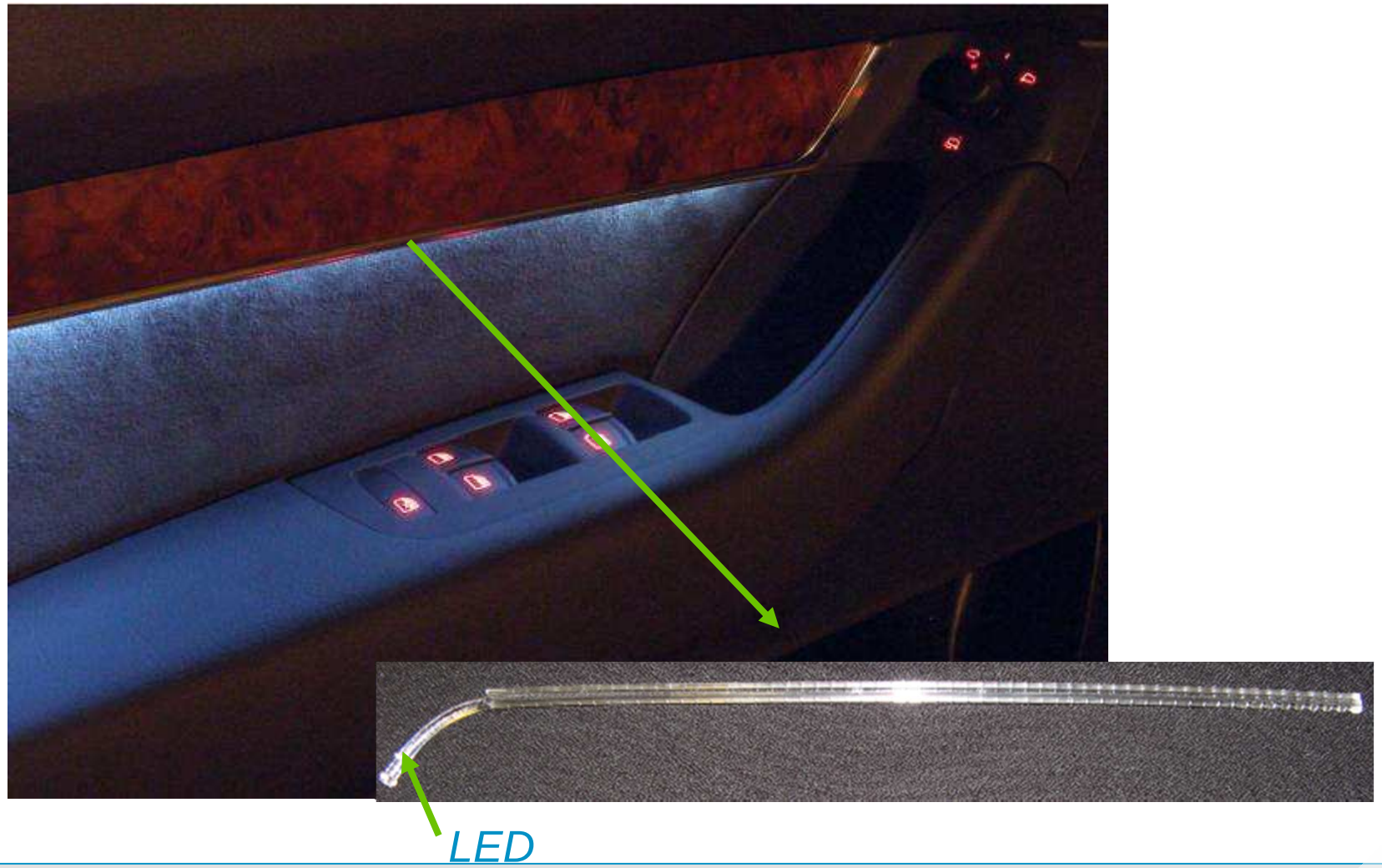
LED Auto lighting

Makrolon® 2405 MAS048 901510

Makrolon® AL2447 550396

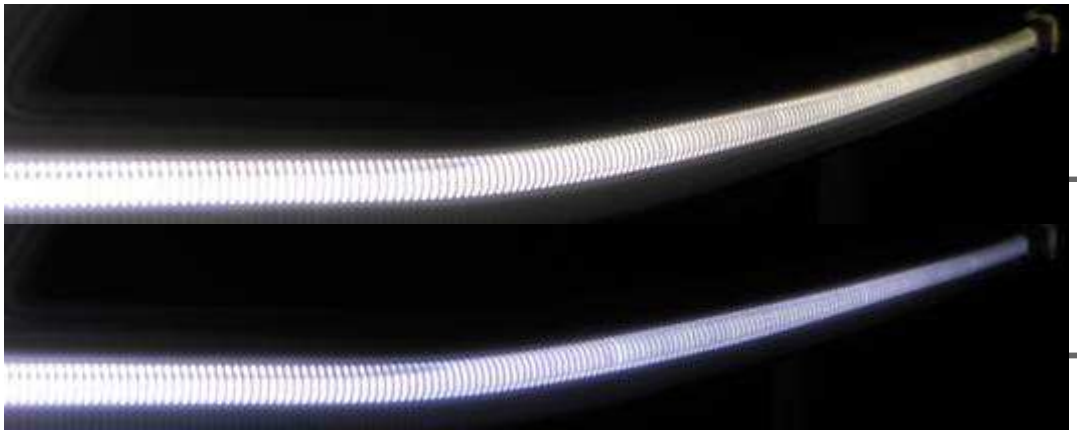
Makrolon® LED2245 000000

Makrolon light guides in door panels (Audi A6)



LED internal lighting(Audi A8)

LED Grade Ice Color



→ Counter grade material

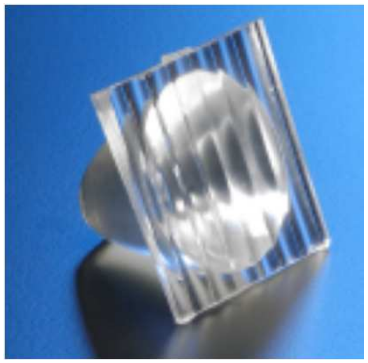
→ Makrolon ®
LED2245 ice color

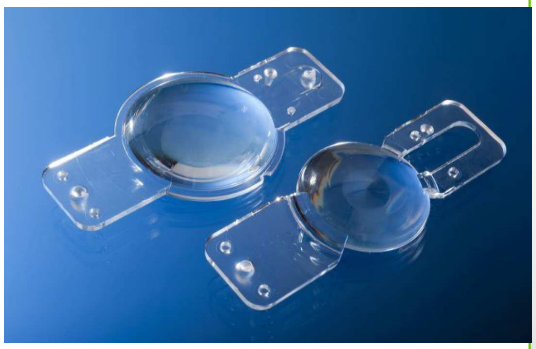
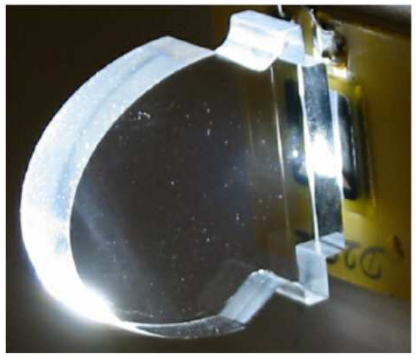
Makrolon ®
LED 2245 550207
Ice color

- High transmission (>89%, 4mm)
- Low YI (<M.LED2245 000000)
- Low haze (<M.LED2245 000000)

Audi A7

Collimator lenses



Makrolon/Apec are the right material for all these complex lenses

Science For A Better Life

Thank you!

Forward-Looking Statements

This presentation may contain forward-looking statements based on current assumptions and forecasts made by Bayer Group or subgroup management.

Various known and unknown risks, uncertainties and other factors could lead to material differences between the actual future results, financial situation, development or performance of the company and the estimates given here. These factors include those discussed in Bayer's public reports which are available on the Bayer website at www.bayer.com.

The company assumes no liability whatsoever to update these forward-looking statements or to conform them to future events or developments.