Substance for Success.

Additives for Molding Compounds

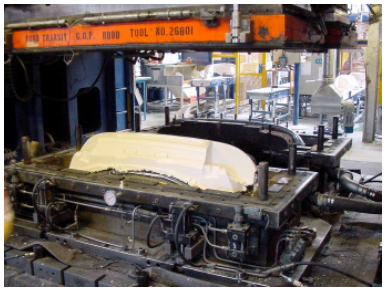
Closed Mold, Gerard Reestman
Faiplar, November 2010

A member of ALTANA

BYK Additives & Instruments

Enduse Closed Mold
Definition

Compounds and Pastes that are made for curing temperatures > 100 °C and / or under high pressure, like:



- **SMC**
- **BMC**
- **Pultrusion**
- **Phenolic, EP (and PU) compounds**

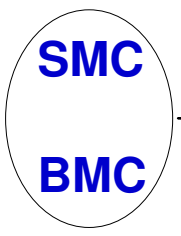
BYK Additives & Instruments

Enduse Closed Mold
The market for Closed Mold additives

	Market size		
	High	Medium	Low
Market segments	SMC	BMC	RTM
		Pultrusion	Other compounds
Resin technology	UP/VE	UP/VE	UP/VE
	Phenol	EP	EP
		PU	PU
		Phenol	Phenol

BYK Additives & Instruments

Types of molding compounds



		shrinkage
Standard		> 0.15 %
Low Shrink	LS	0.05 – 0.15 %
Low Profile	LP	< 0.05 – (- 0.20) %

BYK Additives & Instruments

Molded product appearance

Type of compound:		surface smoothness
Standard	pigmentable	
Low Shrink (LS)	pigmentable	
Low Profile (LP)	not pigmentable	

BYK Additives & Instruments

Equipment and production

Important steps in the process:

- Storage / dosing / mixing of raw materials
- Glass (quantity, distribution)
- Process parameters during compounding
- Storage of the SMC/BMC (temperature / thickening)

BYK Additives & Instruments

Storage, dosing, mixing: possible mistakes

Raw materials storage:

- Temperature, moisture, FIFO

Dosing:

- Constant and reproducible quantity of raw materials as liquid and powder

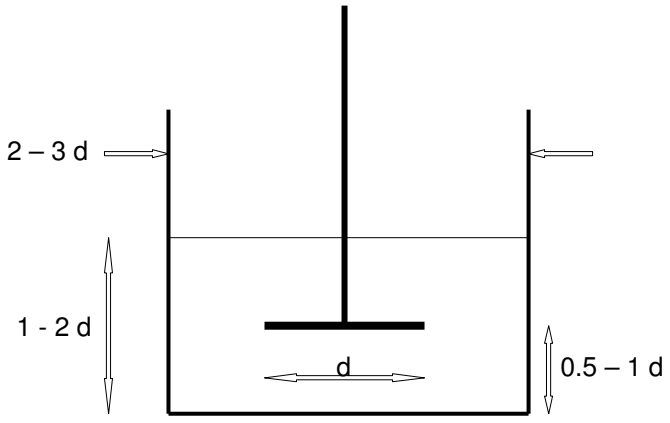
(resins, cure system, additives, fillers, mold release, pigment paste, MgO paste)

Mixing the components:

- Constant parameters (homogeneity, temperature)

BYK Additives & Instruments

Optimal dispersion with dissolver Dimensions:



BYK Additives & Instruments

Dispersion parameters

For a good dispersion following dimensions should be respected:

diameter of the dissolver blade:	d
diameter of the mixing vessel:	2 – 3 d
height of the compound mix:	1 – 2 d
distance bottom – blade:	0.5 – 1 d
Circumferential speed	18 – 25 m/s

calculation of speed: $v = (d \cdot \pi \cdot n)/60$ [m/s]
d = diameter of the blade [m]
n = r.p.m.

BYK Additives & Instruments

Dispersion

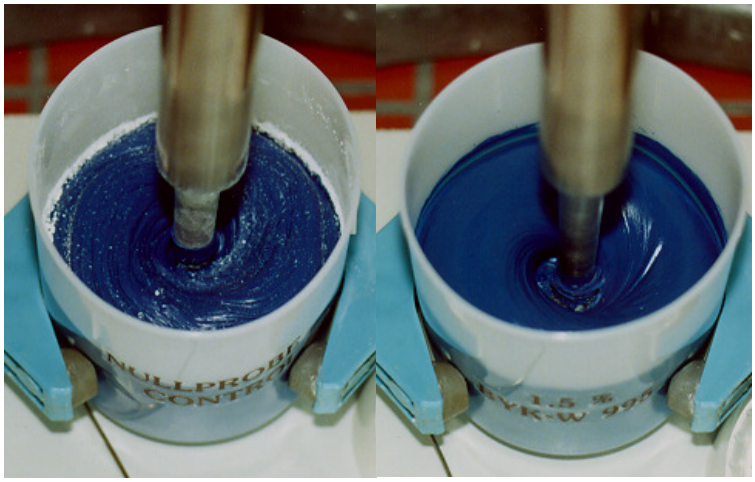
Dispersion process

BYK Additives & Instruments

SMC process

BYK Additives & Instruments

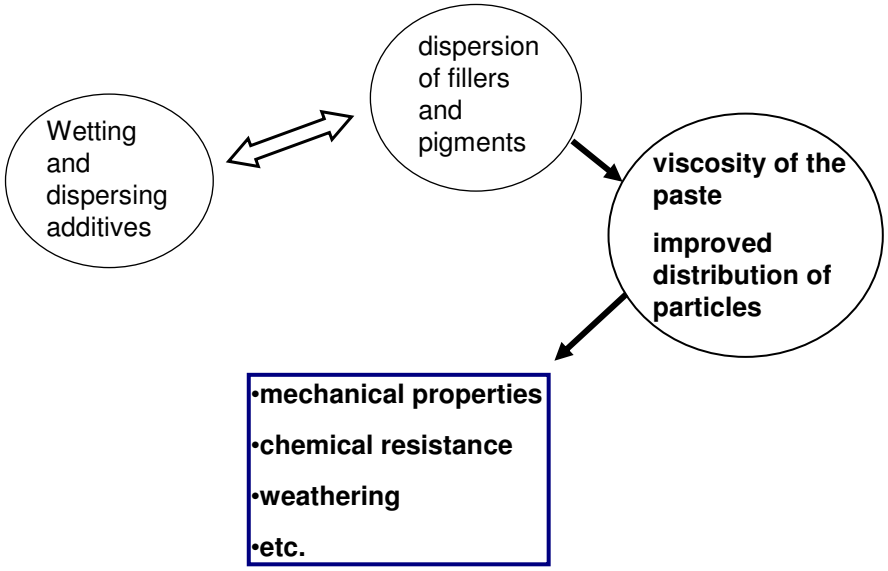
Filler dispersion



Control | With W/D additive

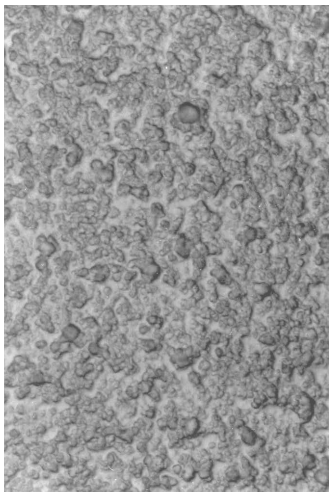
BYK Additives & Instruments

Wetting and dispersing

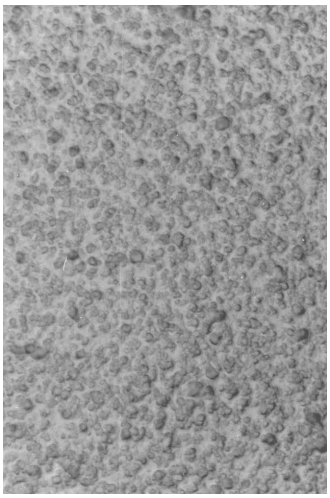


BYK Additives & Instruments

Wetting and dispersing: filler dispersion



without W/D additive



with BYK W/D additive

Microscope 400 x

BYK Additives & Instruments

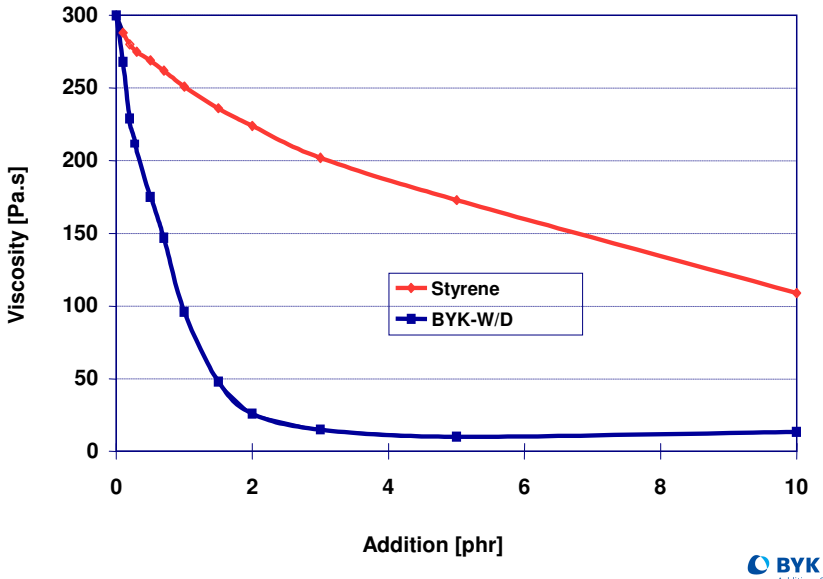
Influence of BYK-W/D additive and styrene on the viscosity

UP resin	50	50	phr
LP additive	50	50	phr
BYK-W/D additive	0 - 10		phr
Styrene		0 -10	phr
Zn stearate	5	5	phr
ATH (21 µm)	300	300	phr

Sample-preparation: dispersion of the paste for two minutes at 1865 rpm and stored for 30 minutes at 30°C.
Viscosities measured with a Brookfield HBT (Spindle T-B @ 5 rpm).

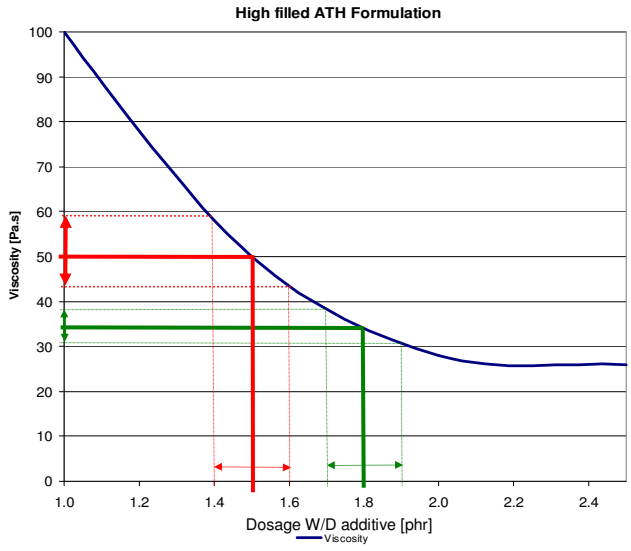
BYK Additives & Instruments

Influence of BYK-W/D additive and styrene on the viscosity



BYK Additives & Instruments

Influence of dosage W/D additives on the viscosity



BYK Additives & Instruments

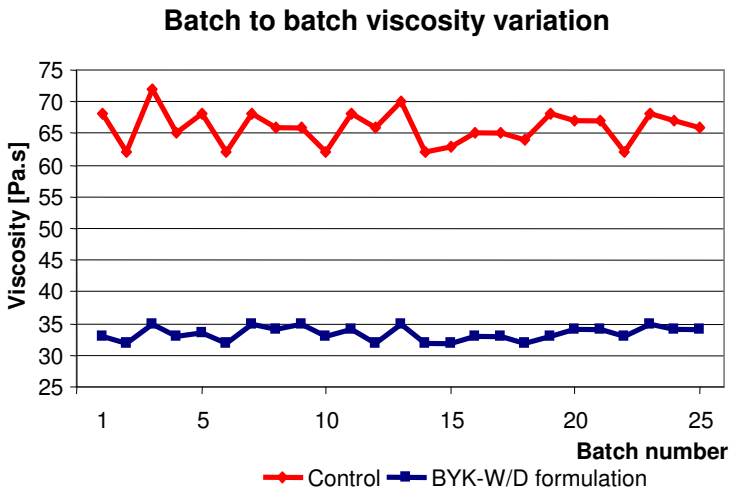
Stabilization of SMC production process

Pure maleic resin	60	phr
LS additive	40	phr
BYK-W/D additive	0 /1.5	phr
TBPB	1.5	phr
ZnSt	2	phr
CaSt	2	phr
$CaCO_3$	150	phr

Viscosities measurement with Brookfield RVT, sp 6, 10 rpm, 23°C

BYK Additives & Instruments

Stabilization of SMC production process



BYK Additives & Instruments

Stabilization of BMC compound

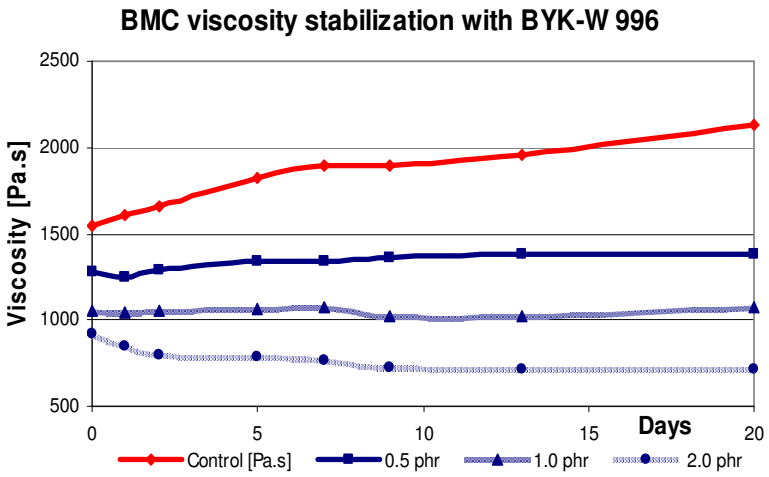
Formulation:

Pure maleic resin	60	phr
LP additive	40	phr
BYK-W/D additive	0 - 2.0	phr
TBPB	1.0	phr
Inhibitor solution	0.1	phr
ZnSt	2	phr
CaSt	2	phr
$CaCO_3$	275	phr

Viscosities measurement with Brookfield HBT, TD, 5 rpm, 23°C

BYK Additives & Instruments

Stabilization of BMC compound



BYK Additives & Instruments

Anti-separation

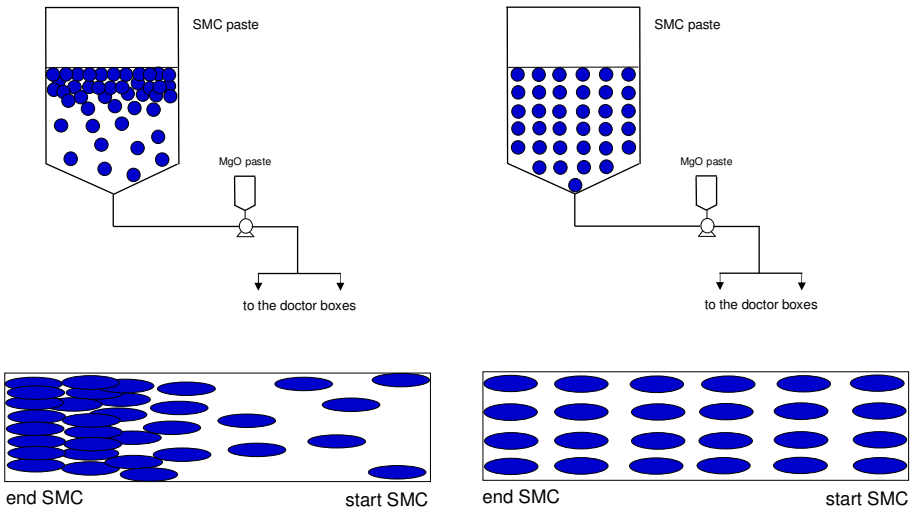
without with BYK additive

without

with BYK additive

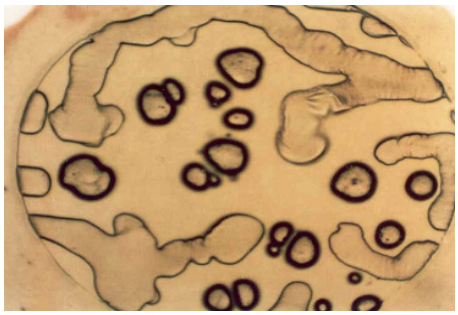
BYK Additives & Instruments

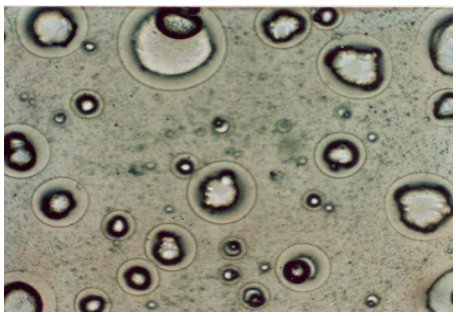
Anti-separation: influence on SMC quality



BYK Additives & Instruments

Stabilization of LS systems





after curing

without additional stabilization

- No regular micro separation
- Surface defects
- Non uniform color

after curing

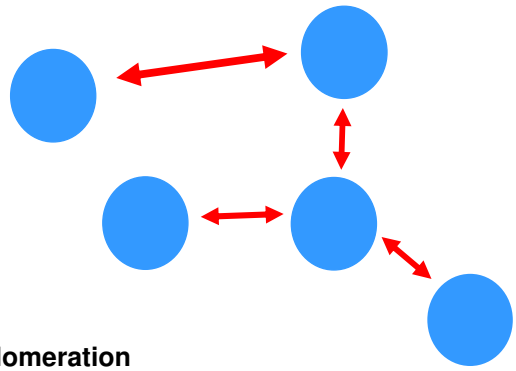
with additional stabilization

- Regular micro separation
- Improved color and surface

Microscope pictures of UP/PS-system
Magnification: 100x

BYK Additives & Instruments

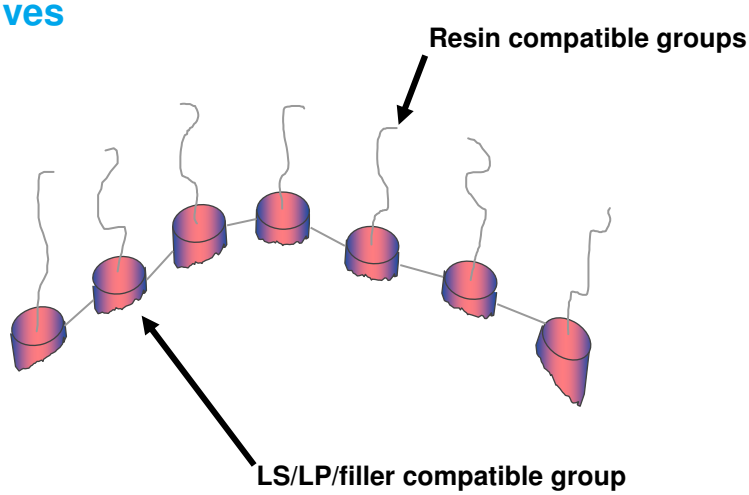
Higher molecular weight Anti-separation Additives



Re-agglomeration
forces of the thermoplastic particles

BYK Additives & Instruments

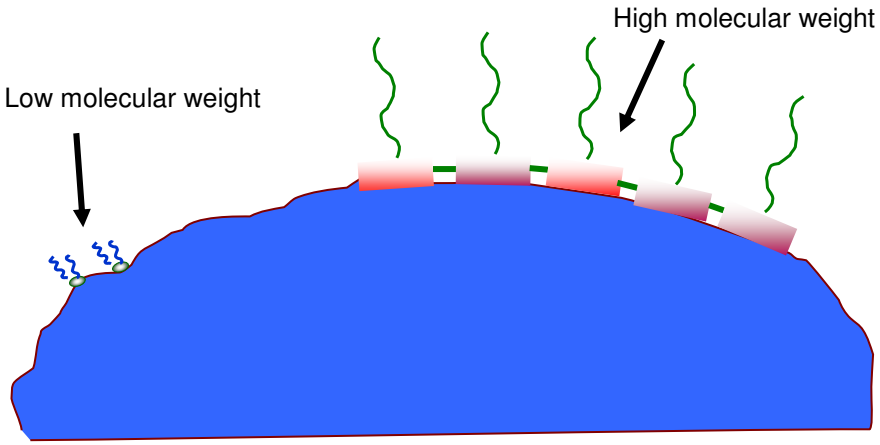
Higher molecular weight Anti-separation additives



BYK Additives & Instruments

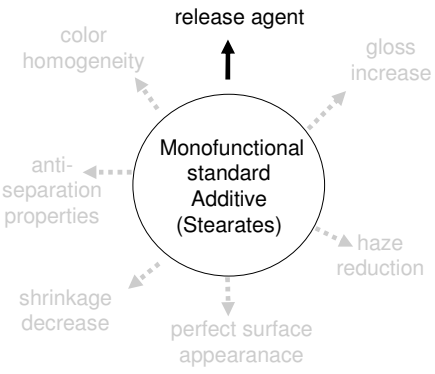
Higher molecular weight

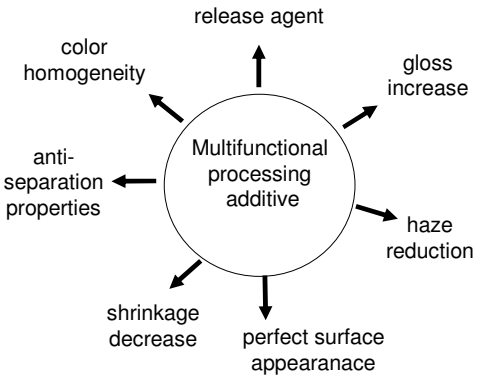
Anti-separation Additives



BYK Additives & Instruments

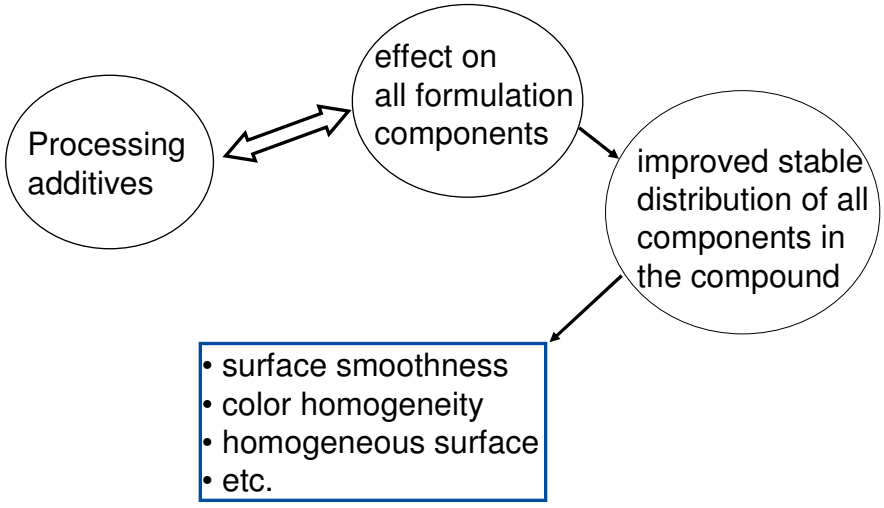
The Concept of a Multifunctional Additive





BYK Additives & Instruments

Processing Additives



BYK Additives & Instruments

Processing additives for headlamps
Fogging in headlamps

BYK Additives & Instruments

Processing Additives for headlamps

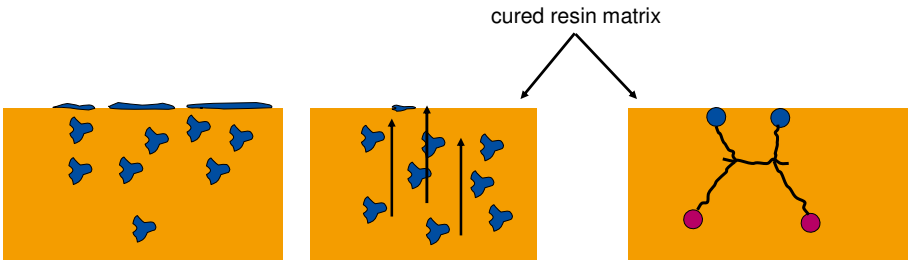
The usage of materials at high temperature cause migration and sublimation of a.o. convential internal mold release agent. Even after metalization and coating.

This becomes visible as a haze on the cold part (polycarbonate pane) inside a headlamp.

Called: F O G G I N G

BYK Additives & Instruments

Processing additives: effect in molded parts



convential mold release agents

directly after molding

convential mold release agents

migration over time

BYK processing additives

BYK Additives & Instruments

Processing additives for headlamps
Fogging test equipment

Test procedure:

Molded samples are heated on a hot plate at a temperature of 220°C for 2h. The sublimated components condense at the watch glass on top of the glass cylinder.

BYK Additives & Instruments

Fogging Test

BMC-test panels with a size of app. 60 * 60 mm are placed on a precision hot plate at a temperature of 220 °C.

Place on the panels a glass cylinder with the following dimensions:

$Ø_{extern}$	=	50	mm
$Ø_{intern}$	=	45	mm
h	=	100	mm

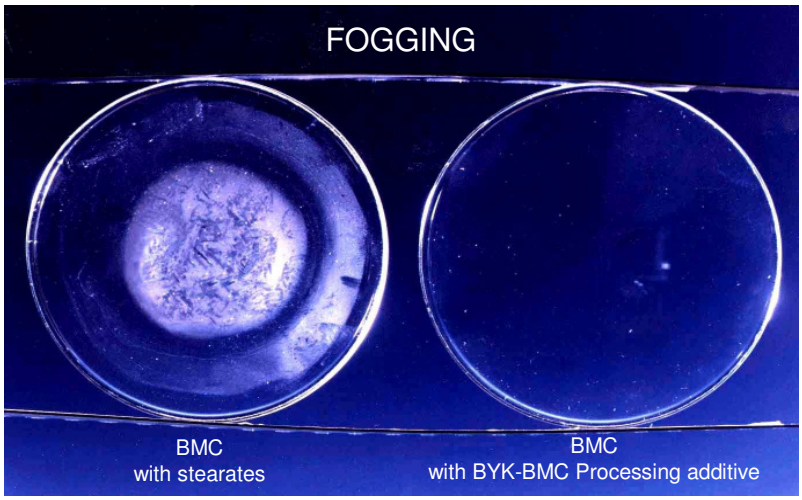
The glass cylinder is covered with a watch glass, which is cooled with water.
The watch glass has to be very clean and before exposure measured with the BYK-Gardner Haze-gard plus on haze (no dimension).

The testing time is 2 hours.

After these 2 hours, dry the watch glass and measure the haze.
The difference in haze is an indication for the fogging, the higher the number, the more haze ➔ more fogging.

BYK Additives & Instruments

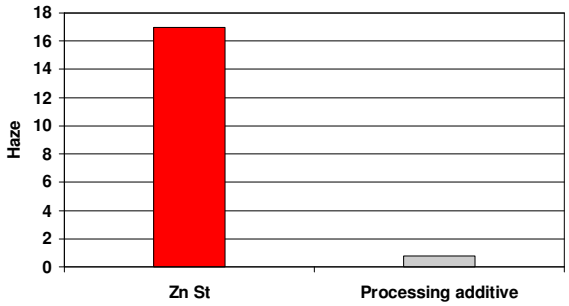
Processing Additives for headlamps



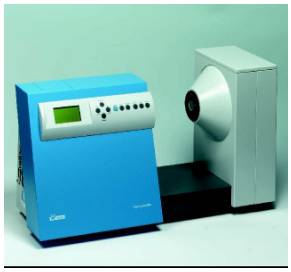
BYK Additives & Instruments

Processing Additives for headlamps

Fogging of different BMC - panels



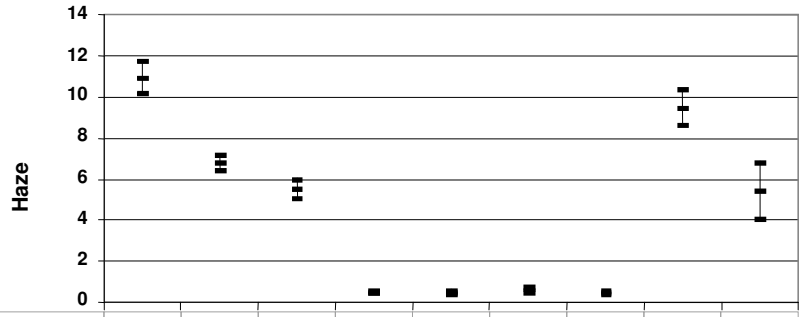
Haze-value of the watch glass measured with Haze-Gard *plus* (BYK-Gardner) according to ASTM D 1003.



BYK Additives & Instruments

Processing Additives for headlamps

Fogging of BMC plates

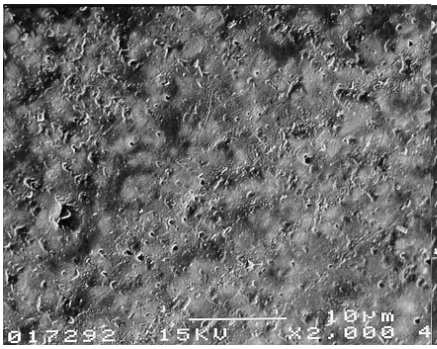


Formulation with:									
BYK-BMC Processing				2.0	2.5	3.0	3.5	2.0	2.0
Zinc stearate	4.0		2.0					2.0	
Calcium stearate		4.0	2.0						2.0

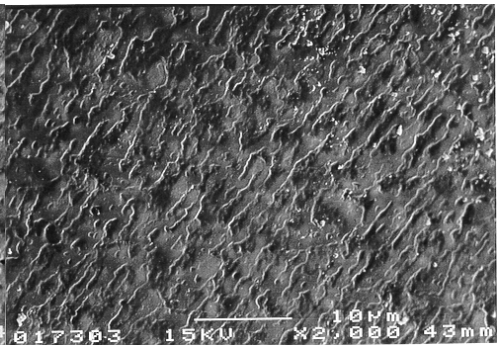
BYK Additives & Instruments

Processing Additives for headlamps

REM pictures of headlamps



Control formulation 40º angle



Formulation with processing additive 40º angle

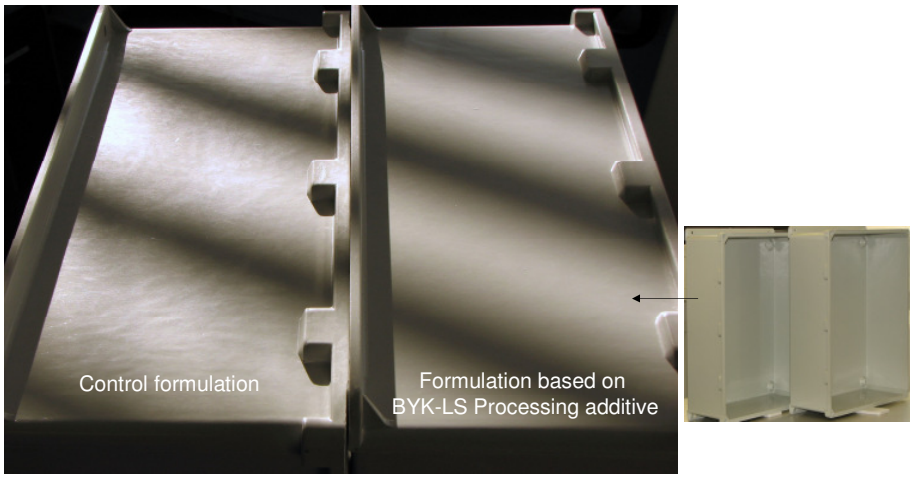
BYK Additives & Instruments

Processing Additives for LS SMC / BMC

Processing additive to stabilize LS SMC and BMC

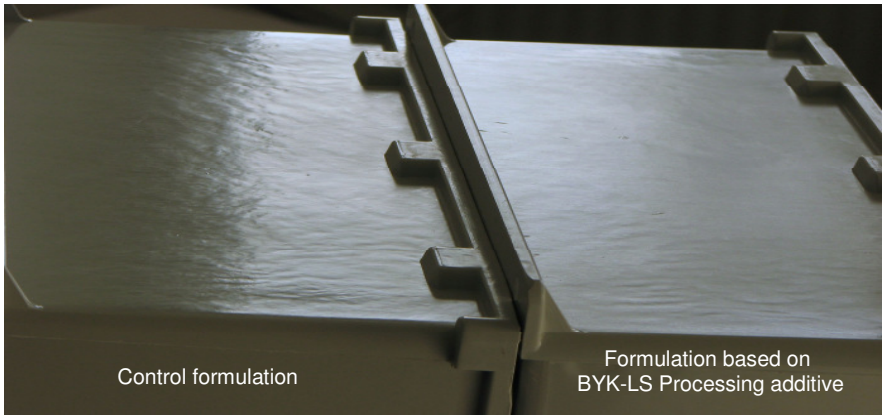
BYK Additives & Instruments

BYK-LS Processing additive: Better Vertical Sides of Molded Parts



BYK Additives & Instruments

BYK-LS Processing additive: Better Vertical Sides of Molded Parts



The fotos show the significant reduction of waviness and improvement of appearance achieved by the usage of BYK-LS Processing additive.

BYK Additives & Instruments

Processing Additives for LS SMC / BMC
Benefits

- Easier raw material handling compared to use of zinc stearate – BYK-LS Processing additive replaces completely the traditionally used zinc stearate working as internal mold release agent
- No separation of LS SMC/BMC compounds - reduced cob webbing
- Lower scrap rate by
  - decreased shrinkage - less warpage
  - increased gloss and reduced haze
  - improved color homogeneity and surface appearance of molded parts
- No sanding after molding for parts to be painted or bonded. The additive is fixed in the cured resin matrix and does not migrate to the surface of finished parts
- Low influence on total cost due to low dosages

BYK Additives & Instruments

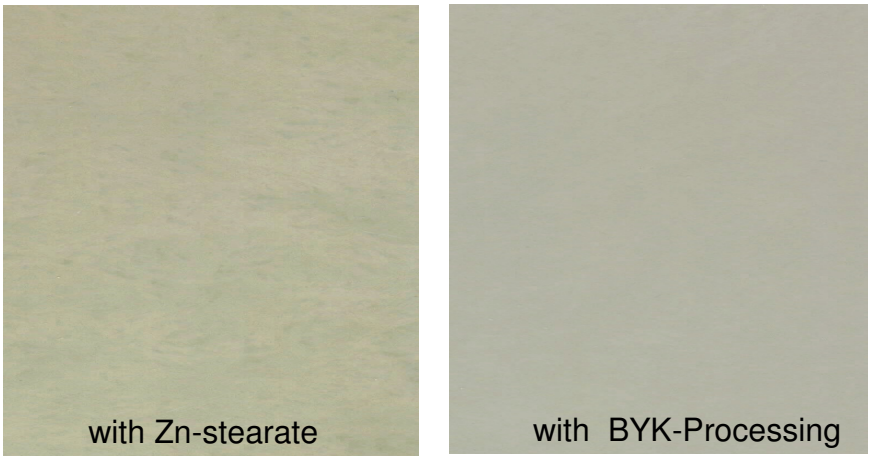
Processing Additives for LS SMC
Anti-separation effect

Control | 1 phr BYK- LS Processing | 2 phr BYK-LS Processing

Formulation based on UP (ortho) resin + PS

BYK Additives & Instruments

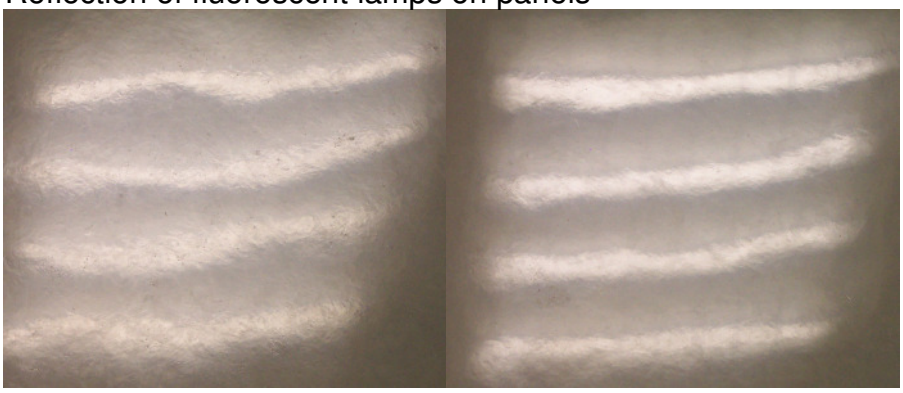
Processing Additives for LS SMC
Color homogeneity



BYK Additives & Instruments

Processing additives for LS SMC
Improved surface smoothness

Reflection of fluorescent lamps on panels



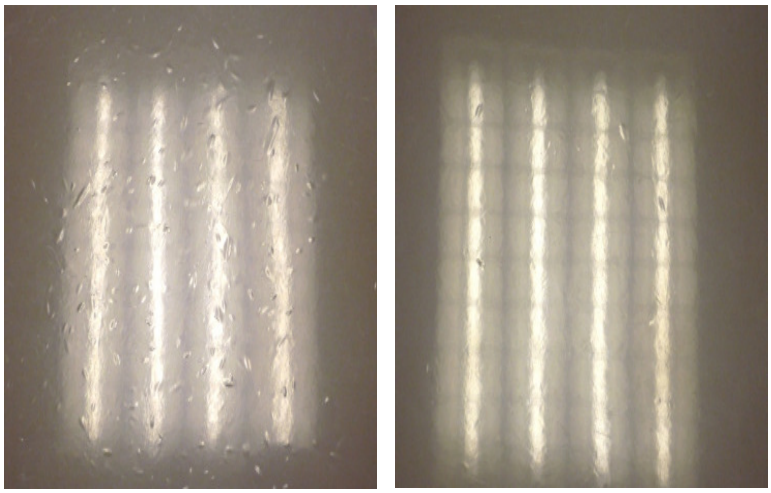
Control formulation

Optimized formulation with BYK-LS Processing

BYK Additives & Instruments

Processing Additives for LS SMC

Result after 500 hours in 60°C tapwater:

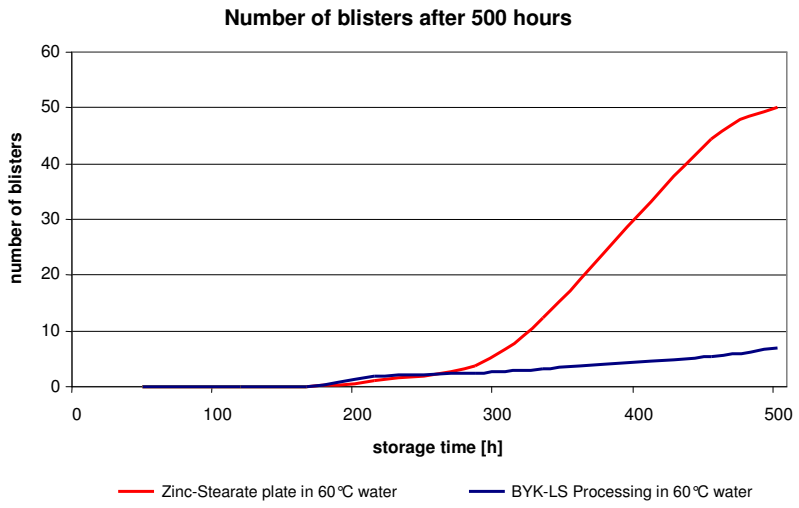


Control formulation

Formulation based on BYK-LS Processing

BYK Additives & Instruments

Processing Additives for LS SMC
Result after 500 hours in 60 °C tap water:



BYK Additives & Instruments

Processing Additives for LS SMC tested in Japanese sanitary system

Result of 93 °C tap water test:

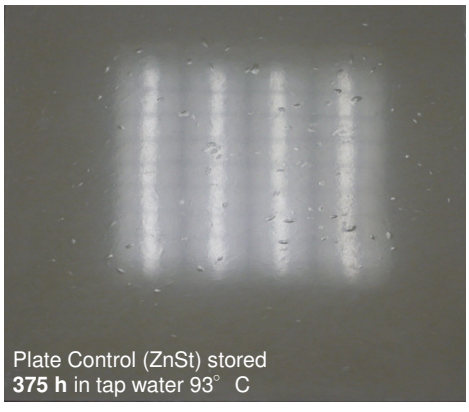


Plate Control (ZnSt) stored **375 h** in tap water 93° C

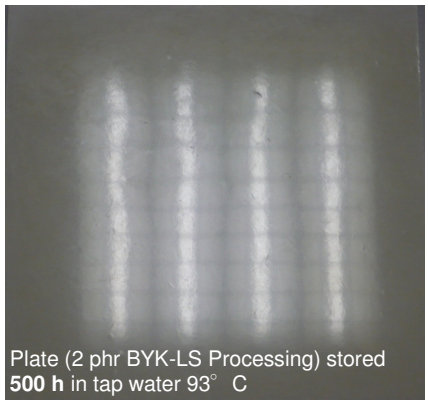


Plate (2 phr BYK-LS Processing) stored **500 h** in tap water 93° C

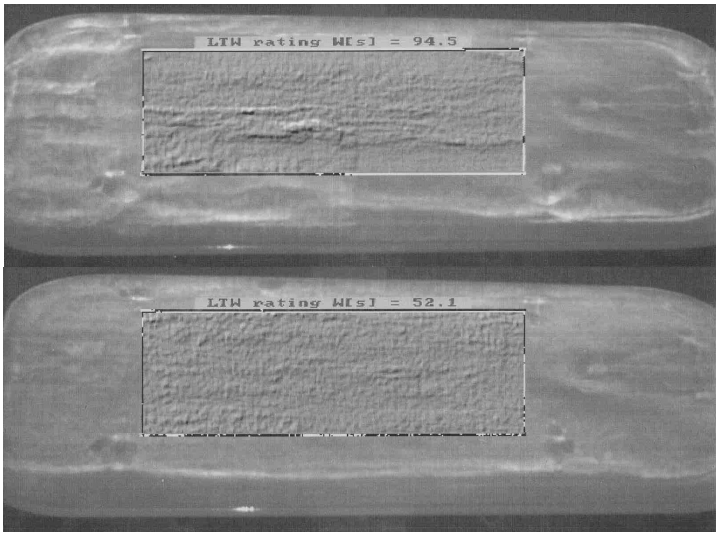
BYK Additives & Instruments

Processing Additives for LP Formulations

Scania Toolbox lid

BYK Additives & Instruments

Processing Additives for LP Formulations



Control with CaSt

with BYK-LP Processing additive

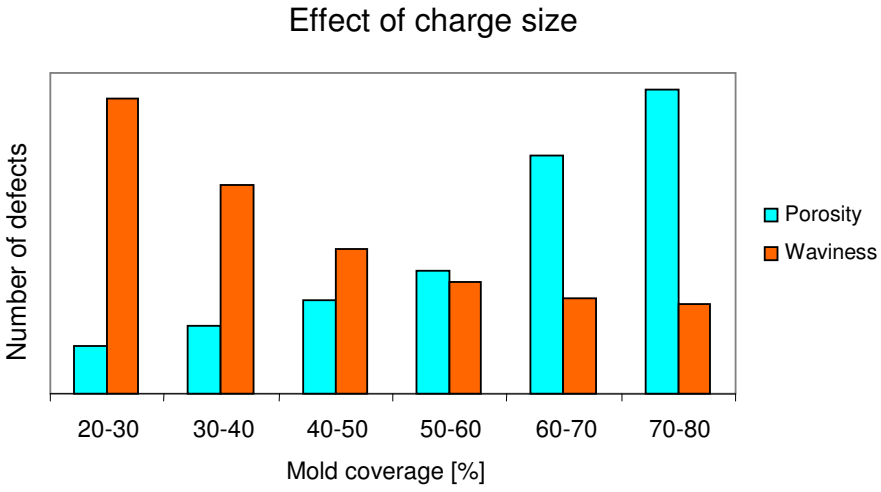
BYK Additives & Instruments

Processing Additives for LP Formulations

Processing additive for Class A and LP SMC and BMC

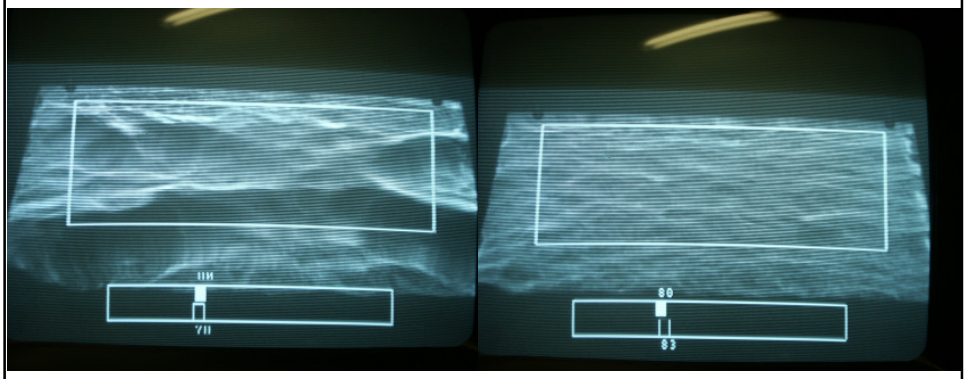
BYK Additives & Instruments

Processing Additives for LP Formulations SMC Molding



BYK Additives & Instruments

Processing Additives for LP Formulations
SMC Molding tests: Diffracto LTW

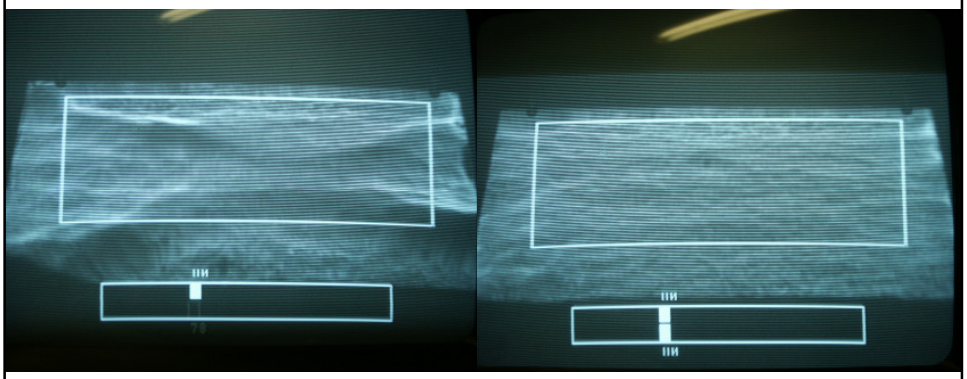


Control formulation
40% mold coverage

BYK-LP Processing formulation
40% mold coverage

BYK Additives & Instruments

Processing Additives for LP Formulations
SMC Molding tests: Diffracto LTW



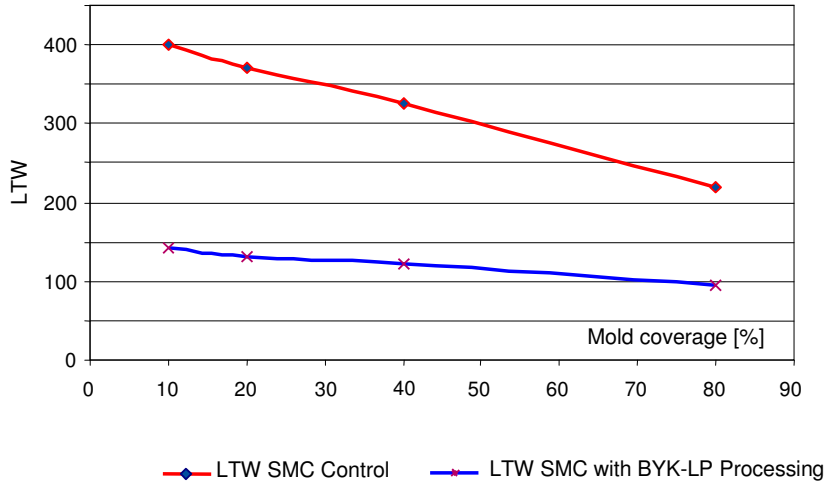
Control formulation
80% mold coverage

BYK-LP Processing formulation
80% mold coverage

BYK Additives & Instruments

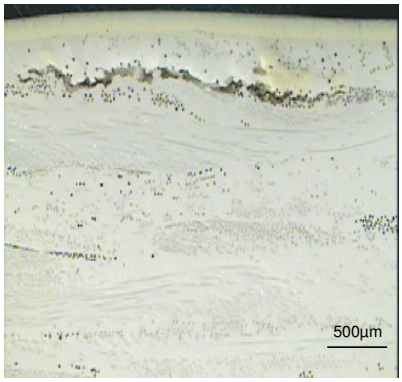
Processing Additives for LP Formulations

SMC Molding tests: Diffracto Long Term Waviness



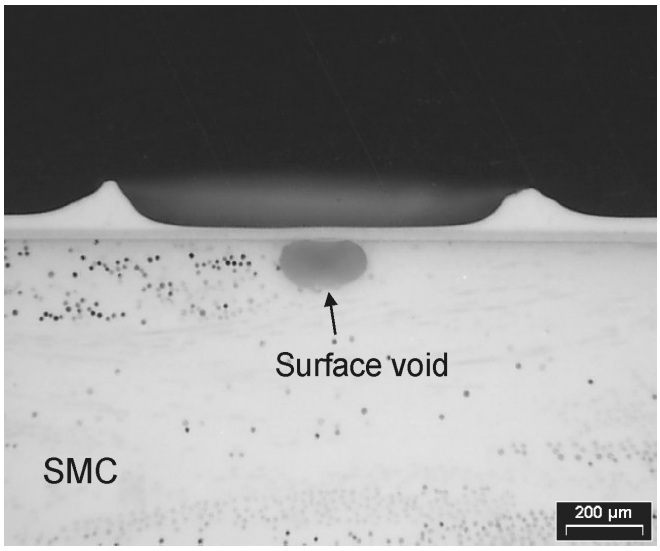
BYK Additives & Instruments

Processing additives for LP Formulations
Cracks under the surface create problems!



BYK Additives & Instruments

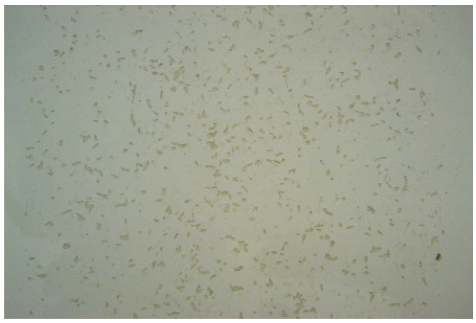
Surface void in the molded part



BYK Additives & Instruments

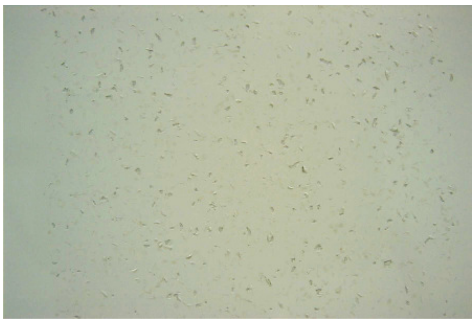
Processing Additives for LP Formulations
Paint Adhesion: Gravelometer test

Panels were coated with a 2 component auto body paint



LP SMC with CaSt

Rating: 2

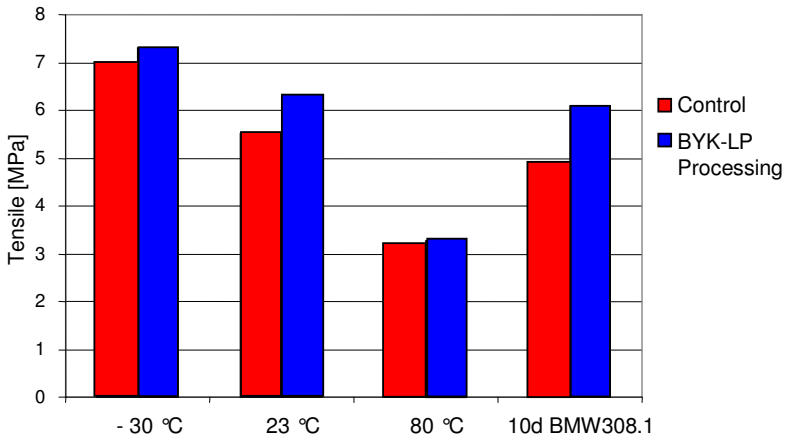


LP SMC with BYK-LP Processing

Rating: 1 - 2

BYK Additives & Instruments

Processing Additives for LP Formulations
Adhesive test



BYK Additives & Instruments

Processing Additives for LP Formulations
Adhesive test on Scania Side Skirt

Cleaning: only with solvent (Heptane),
Bonding system: 2K PUR
Heating IR-heaters during 260s. Time in unit: 15 minutes (parts faced > 85°C during 180s).
Destructive test after 3 days.

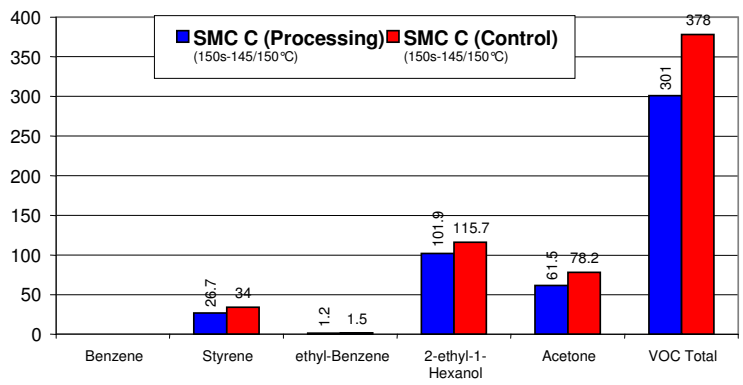
Standard Class A SMC

BYK SMC-1 BYK-LP Processing

BYK Additives & Instruments

Emission

BYK-LP Processing has no negative influence on the emission



BYK Additives & Instruments

Processing Additives - the different products

BMC / headlamps	LS-SMC / BMC	LP / Class A
		
BYK-BMC Processing	BYK-LS Processing	BYK-LP Processing

BYK Additives & Instruments

Processing Additives
Conclusions

- Many types of processing problems and or difficulties can be solved through the use of processing additives.
- Changing the processing characteristics can open up windows of opportunity in many applications.
- Improved processing always leads to cost reduction.

BYK Additives & Instruments

Pigmentation

BYK Additives & Instruments

Influences of components on pigmentation

Resins: the type of resins and LS/LP components

Fillers: Influences may be caused by: surface area, structure, coating, pH-value, particle size distribution, transparancy, hardness, impurities, color

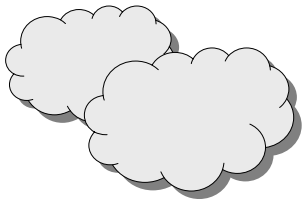
Fibers: type of fiber and type of sizing

Others: all other ingredients of the formulation may also affect the pigmentation.

BYK Additives & Instruments

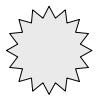
Particle size differences

Calcium carbonate



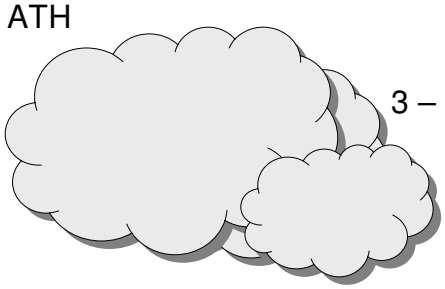
3 – 5 µm

Organic pigments



0,1 – 5 µm

ATH



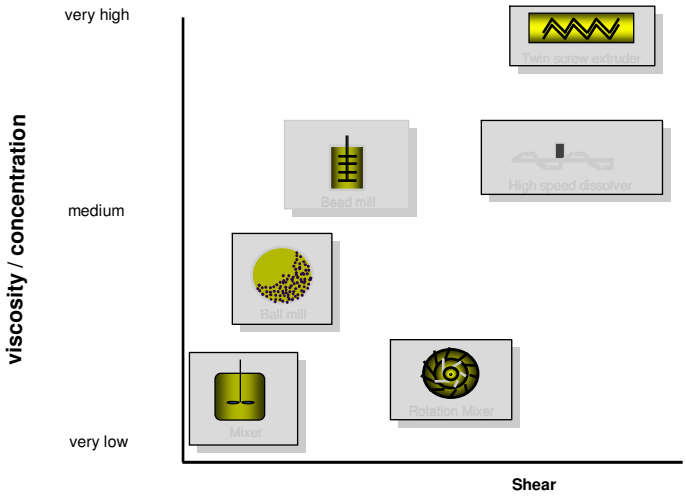
3 – 60 µm

Inorganic pigments

1 – 10 µm

BYK Additives & Instruments

Grinding and dispersing of pigments in relation of viscosity and concentration



BYK Additives & Instruments

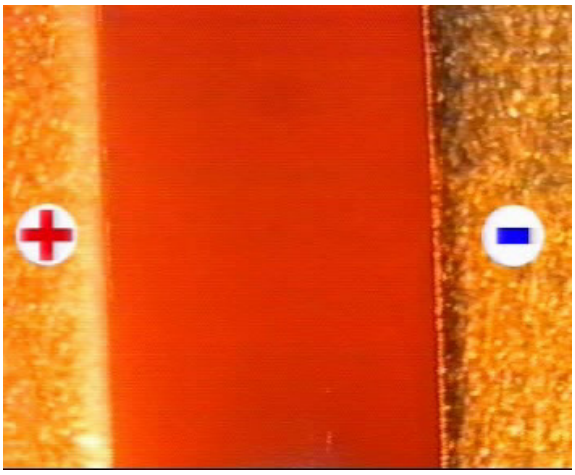
Today's monomer free color pastes

•**Main types and characteristics**

Type	Pigment concentration	Viscosity Range [mPa.s]	Addition wt % on paste
White (Titanium dioxide)	~ 70 - 75 %	4 000 – 12 000	2,5 – 3,5 %
White (Zinc sulfide)	~ 75 %	4 000 – 12 000	3 – 4 %
White (Lithopone-ZnS/BaSO4)	~ 80 %	4 000 – 12 000	3,5 – 4,5 %
Black (carbon black)	~ 20 – 50 %	3 000 – 15 000	1 – 4 %
Grey (various comb.)	~ 60 – 79 %	3 000 – 12 000	3 – 4,5 %
Other colors (org./inorganic or mixtures)	30 – 75 %	2 000 – 12 000	3 – 6 %

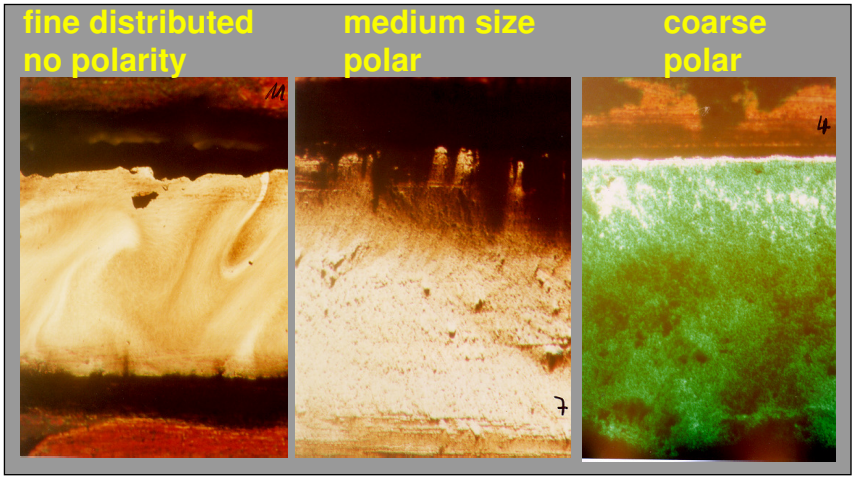
BYK Additives & Instruments

Pigment charge



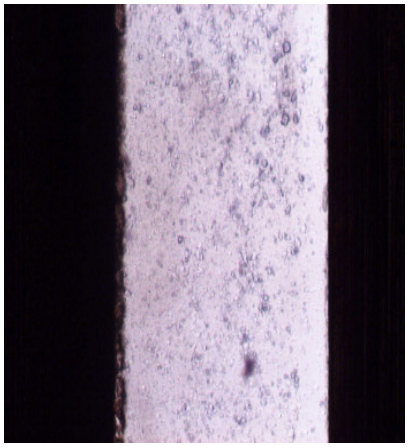
BYK Additives & Instruments

Polarity and particle size of pigments



BYK Additives & Instruments

Effects of fillers / pigments



UP+PS+ATH
RAL 7035

UP+PS+ATH+PE
RAL 7035

BYK Additives & Instruments

Pultrusion

- pastes with low viscosities
- high content of reinforcement
- open or closed impregnation of reinforcement
- in general same challenges as for SMC pastes

BYK Additives & Instruments

Pultrusion
High filled flame retardant profiles

- pastes with low viscosities are needed
- use of halogens and Antimony trioxide are under pressure
- high content of reinforcement
- open or closed impregnation of reinforcement

ATH + APP combinations up to 300 phr to obtain high flame retardancy are possible !!

BYK Additives & Instruments

BYK Additives & Instruments