

Evonik Additives for PU Shoe Sole

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Polyurethane Shoe Sole Market Trends

- **Increasing demand on comfort level - low density shoe sole**

- Catalysts recommendation: DABCO® KTM 60, TEGOAMIN® AS MEG, DABCO® BL 11 and DABCO® XD 102
- Surfactant recommendation: TEGOSTAB® B 8960 (polyester) and TEGOSTAB® B 8946 PF (polyether)
- Cell opener can help further reduce density: TEGOSTAB® B 8948 and GORAPUR® IMR 852

- **Increasing demand for better performance on adhesion and abrasion**

- DABCO® LK 221 and ORTEGOL® AB

- **Increasing awareness on safety – antistatic agent as a post formulation additive**

- Antistatic Agent: ORTEGOL® AST 5 and ORTEGOL® AST 8

- **Increasing demand for customization - 3D printing**

- Various small startup companies in the US partner with Nike, Adidas, New Balance to make 3D printing shoe for optimal customization in shoe making. Everyone has a different formulation. So far it's still in very early stage but has interesting potential.

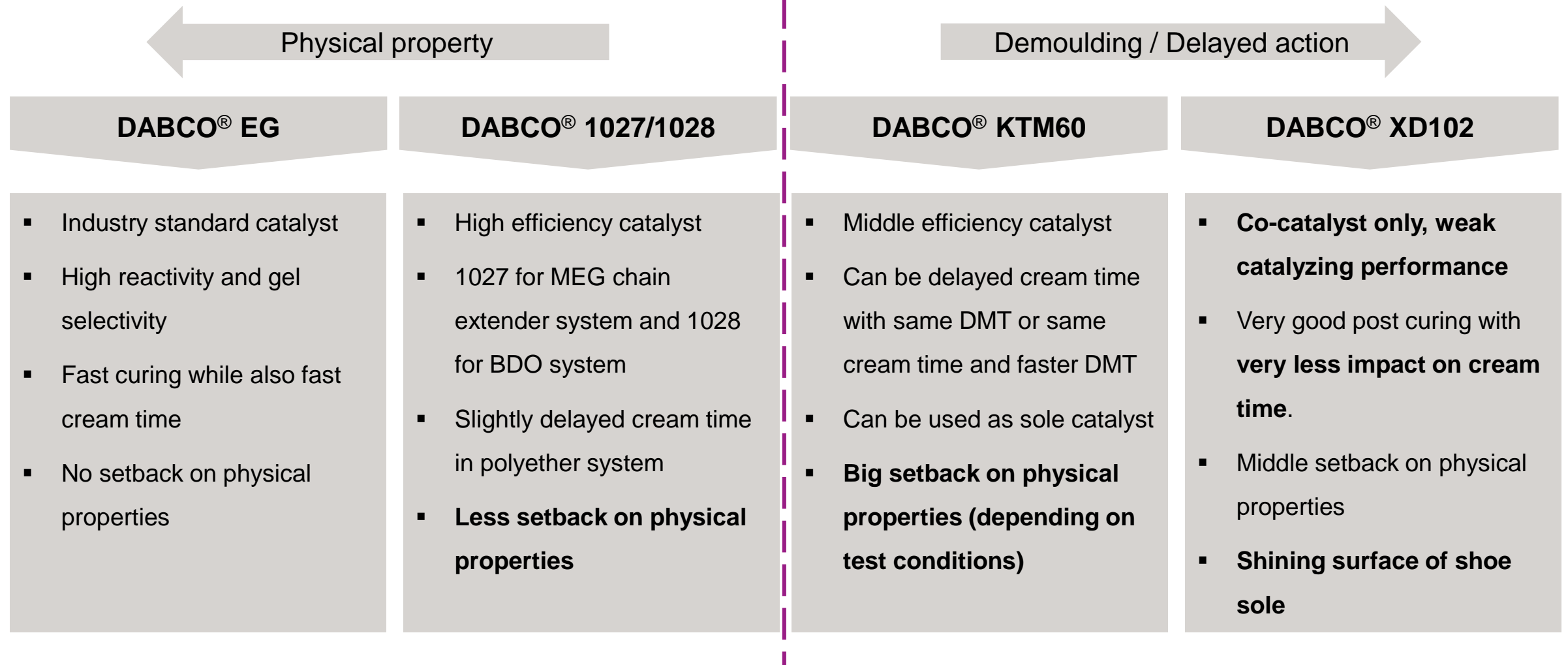
Catalyst recommendation for Low density shoe sole

Catalysts	
PRODUCT	PERFORMANCE
DABCO® Crystal	Industry standard gel catalyst (triethylenediamine solid)
DABCO® EG	Industry standard gel catalyst for MEG extended systems
DABCO® 255	Industry standard gel catalyst for BDO extended systems
DABCO® 1027	Delayed action co-catalyst for MEG extended systems giving Improved flowability and/or faster demold
DABCO® 1028	Delayed action co-catalyst for BDO extended systems for Improved flowability and/or faster demold
DABCO® 1029	Delayed action co-catalyst for MEG extended systems giving Improved flowability
DABCO® BL11	Industry standard blowing catalyst to improve foam flowability especially in low density applications
DABCO® MP609	Delayed action blowing catalyst to improve foam flowability especially in low density applications
DABCO® XD102	Balanced catalyst to improve foam flowability especially in low density applications

- DABCO® KTM 60 has a Tri-functional crosslinking for very hard sole in lady shoe (wedges) reduce the flexible resistance. Not good for high quality union shoe. Low density high heel shoe – light but hard product without flexible application.
- DABCO® 1029 (Europe version) or TEGOAMIN® AS MEG (Americas version) is a pure delayed action catalyst without any crosslinking effect.
- DABCO® BL11 is a blowing catalyst that can reduce bubbles in cold mold to reduce ice flower (snow flake) defect.
- DABCO® XD102 low density midsole alternative to EVA. It gives good flowability and skin. 0.4pphp, similar to TEDA.



Fast demoulding solutions



Surfactant recommendation for Low density shoe sole

- To maintain cell structure in reduced density system, use TEGOSTAB® B 8960 for polyester system and TEGOSTAB® B 8946 PF for polyether system

Surfactants					
PRODUCT	PERFORMANCE	SYSTEM	DENSITY		
			low	medium	high
TEGOSTAB® B 8993	Very potent cell regulator providing fine, uniform cell structure; Improves the compatibility of the raw materials and enhances the tensile strength, elongation at break and Ross-Flex properties.	universal	*	**	***
DABCO® DC 193	Industry standard, potent cell regulator providing uniform cell structure and good surface quality.	universal		***	***
TEGOSTAB® B 8960	Medium potency cell regulator providing excellent skin, less peeling and reduced pinholes.	polyester	**	***	
TEGOSTAB® B 8905	Potent cell regulator providing fine and uniform cell structure; Improves tensile strength and Ross-Flex properties.	polyether	*	***	***
TEGOSTAB® B 8930	Medium potency cell regulator reducing pinholes and generally improving optical appearance of the surface.	polyether	**	***	*
TEGOSTAB® B 8946 PF	Co-surfactant providing a slightly coarser, open cell-structure improving dimensional stability.	universal	***	***	
DABCO® LK 221 E	Silicone free surfactant for dual density applications, e.g. in safety shoes, or athletic shoes with Inserts.	polyester	**	**	**

Cell opener can help further reduce density

Performance Additives

CELL OPENERS

PERFORMANCE

TEGOSTAB® B 8948

Mild organic cell opener reducing shrinkage in medium to low density foams.

GORAPUR® IMR 852

Potent silicone based cell opener reducing shrinkage in low density foams.

ABRASION REDUCER

PERFORMANCE

ORTEGOL® AB

Silicone based abrasion reducer for medium to high density application; easy to blend into the system.

ANTI-STATIC AGENTS

PERFORMANCE

ORTEGOL® AST 5

Anti-static agent with activity comparable to industry standard products but without impact on physical properties. Can be pre-blended into the system or dosed via a separate stream in the mixing head.

ORTEGOL® AST 8

Very efficient, non-reactive anti-static agent to meet standard and ESD anti-static demands of safety shoe soles and sock liners without impacting physical properties.

ADHESION PROMOTER

PERFORMANCE

DABCO® LK 221 E

Organic adhesion promoter to be added to promote adhesion towards inserts.

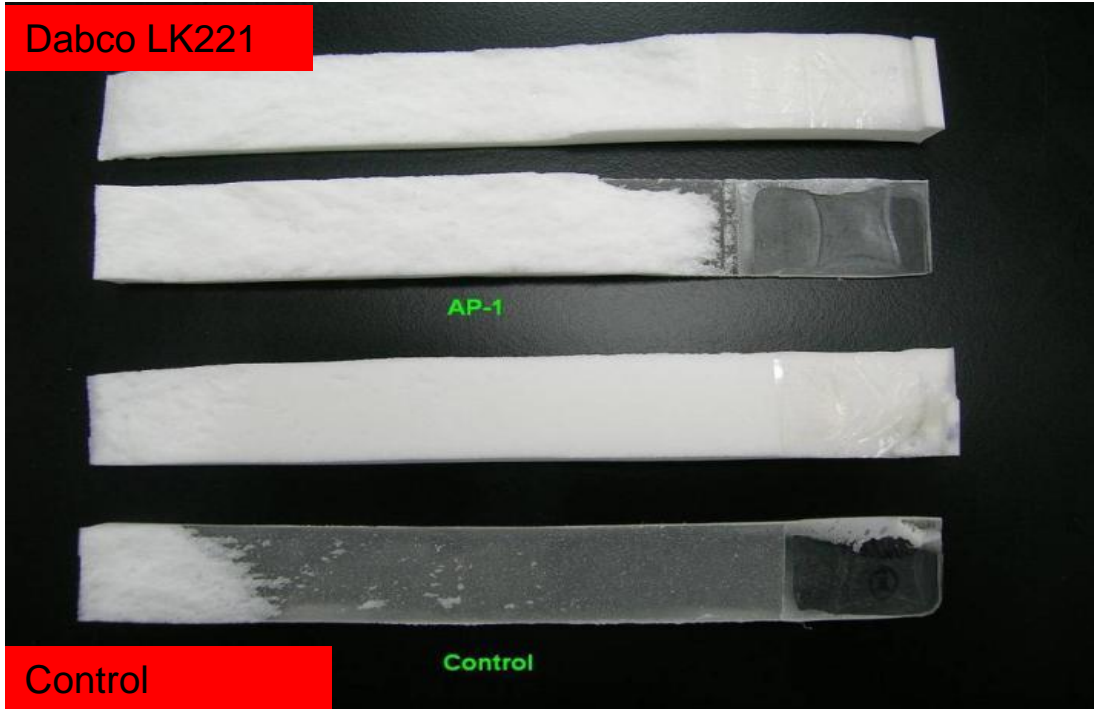
- Dual density sole or bonding with other material than PU (wood, plastic and others) DABCO® LK 221 really improves bonding
- Cell opener can help further reduce density. More water, results in CO₂ which, when temperature lowers, shrinkage happens. By using cell opener, create more space for the air to come out.



DABCO® LK 221 Surfactant

- DABCO® LK 221 can improve adhesion of PU and substrate, especially suitable for dual density applications like safety shoes and athletic shoes. Also useful to fix the adhesion problem caused by silicone surfactant.

	Control	DABCO LK221
Polyester blend	100	100
DABCO LK221	0	0.5
Peel strength (kg/cm)	1.7	2.5
Remark	Break on interface	Break on PU layer



Adhesion test between PU and TPU

Better Abrasion Resistance with ORTEGOL® AB



	Standard formulation			+ 0,5% ORTEGOL AB		
	Hardness ShA DIN 53505	Abrasion (mg) DIN 53516	Rossiflex 50000 cycles slit length(mm)	Hardness ShA DIN 53507	Abrasion (mg) DIN 53516	Rossiflex 50000 cycles - slit length
Sample 1	53	121	2,6	55	59	2,5
Sample 2	53	132	2,3	55	60	2,5
Sample 3	53	111	2,3	54	69	2,4
Sample 4	53	111	2,3	55	72	2,3
Average	53	119	2,4	55	65	2,4

Study done on polyester system - similar results in polyether; material is silicone based; silicone-free options could be discussed

→ Abrasion can be reduced up to 50%

Antistatic Agents in Safety Shoes



Anti Static Agents are added to the polyol system or blended directly in the mixing head to increase the electric conductivity / lower the electric resistance to meet the standards for safety shoes:

- ▶ ISO 20345 – STANDARD SAFETY SHOES (0.1 – 1000 MΩ)
- ▶ ESD (electrostatic discharge) – SAFETY SHOES (0.1 – 35 MΩ (worn shoes))



Antistatic Agents for Polyether and Polyester Applications		Density (kg/m ³)	Use Amount %
ORTEGOLAST 5	Innovative antistatic for <u>PU polyester</u> . Is very compatible with other components, doesn't migrate and doesn't affect the hydrolysis resistance. Active even in low humidity environments.	>150	1.0-5.0
ORTEGOLAST 8	Ultra-high efficiency antistatic for very special application: Parts for Electrostatic Discharge Sensitive Devices (ESDS), very low density application (Insoles and others)	<150	1.0-4.0

Antistatic Agent

	Conventional Antistatic agent	ORTEGOL® AST 5	ORTEGOL® AST 8
MEG content	<ul style="list-style-type: none"> ▶ 20% 	<ul style="list-style-type: none"> ▶ 20% 	<ul style="list-style-type: none"> ▶ zero
Post forming effects	<ul style="list-style-type: none"> ▶ Severe migration ▶ Worse paint-ability ▶ Worse glue-ability 	<ul style="list-style-type: none"> ▶ No migration ▶ No effect on paint-ability ▶ No effect on glue-ability 	<ul style="list-style-type: none"> ▶ No migration ▶ No effect on paint-ability ▶ No effect on glue-ability
Transport-classification	<ul style="list-style-type: none"> ▶ Dangerous Good 	<ul style="list-style-type: none"> ▶ Not regulated 	<ul style="list-style-type: none"> ▶ Not regulated
Further information	<p>Quaternary ammonium salt:</p> <ul style="list-style-type: none"> ▶ Affects hydrolysis resistance ▶ Reduces mechanical properties ▶ Reacts with polyol component ▶ Reducing machine-tank shelf life 	<p>Diluted ionic liquid where sensitive dosing is difficult:</p> <ul style="list-style-type: none"> ▶ No effect on hydrolysis resistance ▶ No effect on mechanical properties ▶ No reaction with polyol component ▶ No influence on machine-tank 	<p>Pure ionic liquid where sensitive dosing is possible</p> <ul style="list-style-type: none"> ▶ No effect on hydrolysis resistance ▶ No effect on mechanical properties ▶ No reaction with polyol component ▶ No influence on machine-tank



**Stop prototyping.
Start producing.**



EVONIK

POWER TO CREATE