APPLICATION INFORMATION

ADDITIVES FOR GEL COATS

Contents

Introduction

Gel coats are a particularly important and qualitatively demanding area of application for unsaturated polyester resins, as they represent the outer, visible layer of a finished glass fiber reinforced plastic component. Depending on the application, the requirements in terms of appearance, mechanics, and resistance to water, chemicals, or UV radiation, for example, are particularly high.

Gel coats are the first layer to be applied to the surface of a mold in a thickness of about 400-700 µm. For this reason, the demands on the liquid gel coat regarding rheology (run-off behavior), deaeration, and flow are also very high.

This brochure shows how additives help to meet these high demands.

For additional information on additives and technical topics, please contact us:
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Note

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Air release additives

Entrapped air bubbles are a common problem in manufacturing or applying unsaturated polyester gel coats. They are difficult to remove mainly because most gel coats are highly thixotropic.

In addition, they are usually applied by airless spray equipment in a single pass to a wet film thickness of 400 to 500 µm. These same air bubbles ultimately develop into pinholes, which increases porosity and dramatically reduces the gel coat's water resistance.

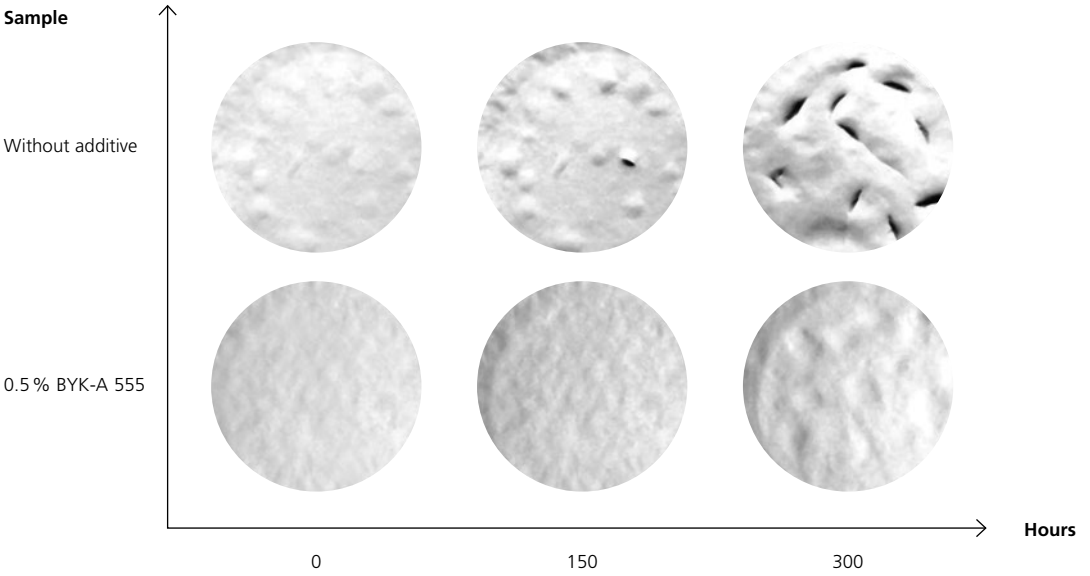
The example (G.01) shows a spray gel coat with and without BYK-A 555. Hot water resistance at 98 °C is dramatically improved in the samples with BYK-A 555. The following standard additives can be used in almost all gel coat formulations to improve air release properties during manufacturing and application.

BYK-A 555 is widely used in all types of gel coats. It is the most efficient air release additive.

BYK-A 515 can also be used in various gel coats and is especially recommended for vinyl ester based systems.

BYK-A 550 and BYK-081* are highly effective with minimal haze and are recommended for transparent gel coats.

Impact of air entrapment on hot water resistance



G.01

* For the use in food contact applications, please check the food contact sheet.

Additives to improve flow/leveling and prevent craters and fisheyes

Depending on the application method, uniform flow and leveling is required for the applied gel coat. Brushed gel coats can vary in film thickness because of insufficient flow and leveling properties.

It is critical for the mold surface to be sufficiently wet by the gel coat! Poor substrate wetting occurs when the gel coat has a higher surface tension than the mold surface (G. 02).

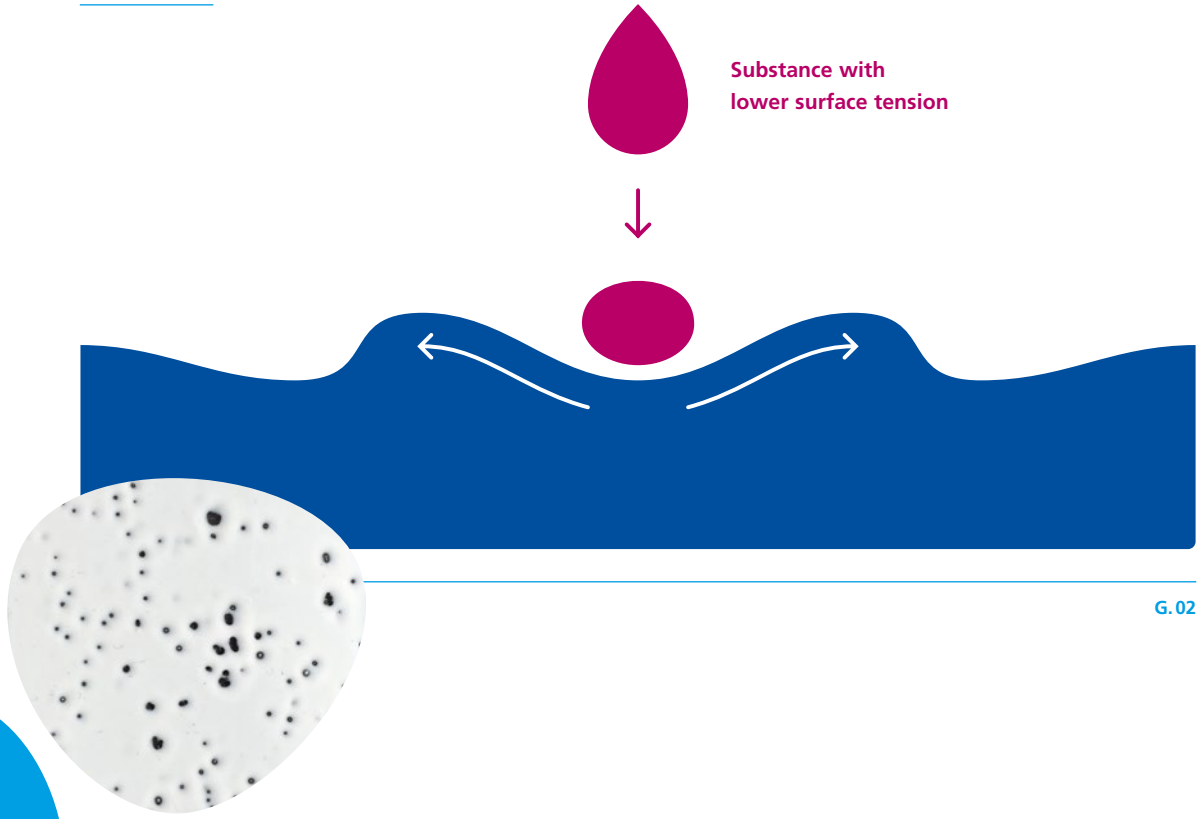
Fisheyes develop when there are surface tension differences between the mold releasing film, the gel coat film, and dust particles (G. 02). When a dust particle falls into the gel coat film, the gel coat cannot wet the particle because of its high surface tension.

The surface tension of the gel coat thus needs to be reduced in order to solve the fisheye problem.

Possible solutions to improve substrate wetting and eliminate fisheyes are:

- **Silicones** in case of large surface tension differences.
- **Acrylate leveling additives** in case of small surface tension differences.

Craters



G. 02

Substrate Wetting
Poor mold surface wetting because of gel coat's high surface tension.

Silicones

BYK-330 reduces the surface tension of the gel coat, improves flow and leveling, and eliminates fisheyes. Because of its controlled compatibility in the gel coat, it does not stabilize foam.

BYK-370 improves the flow and leveling of the gel coat. It is typically compatible with unsaturated polyester resins. BYK-370 is especially recommended in clear gel coats.

BYK-310 is a compatible silicone that reduces surface tension and improves flow and leveling.

BYK-378 significantly reduces surface tension and provides low foam stabilization. It improves substrate wetting and prevents cratering.

Acrylates

BYK-S 706 is widely used in unsaturated polyester gel coats. It improves the flow and leveling properties of the applied gel coat film and helps surface deaeration. It is often used in continuous lamination processes to improve the flow and leveling of the gel coat film and prevent fisheyes. BYK-S 706 will introduce a slight turbidity in clear gel coats.

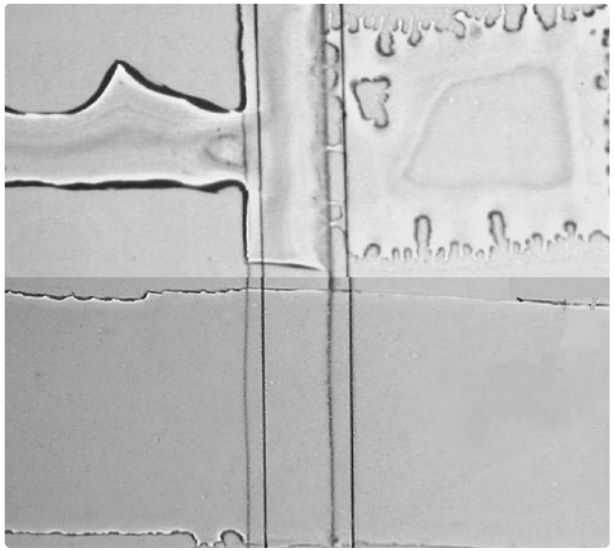
BYK-361 N improves the flow and leveling properties of the applied gel coat film and eliminates craters and fisheyes. BYK-361 N is more compatible than BYK-S 706 and can be used in clear gel coats.

Effect of BYK-330

Semi-permanent mold release **Wax**

Control

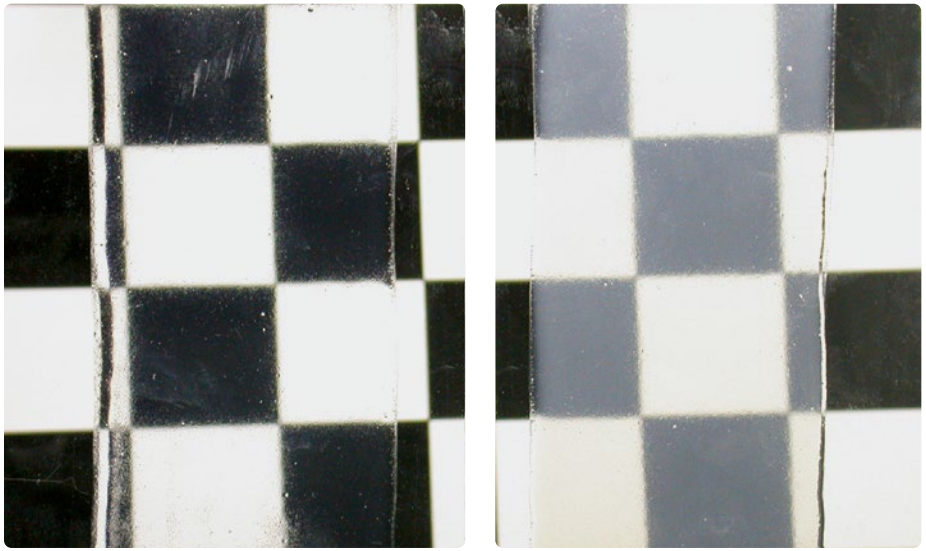
0.3% BYK-330



G.03

Comparison of BYK-370 and BYK-330 in a clear gel coat

BYK-370 **BYK-330**



BYK-370 provides good substrate wetting without causing turbidity.

G.04

Additive to improve thixotropy

Thixotropy is very important in gel coats but various problems may occur:

- no thixotropy development
- thixotropy development is too slow
- thixotropy drift over time

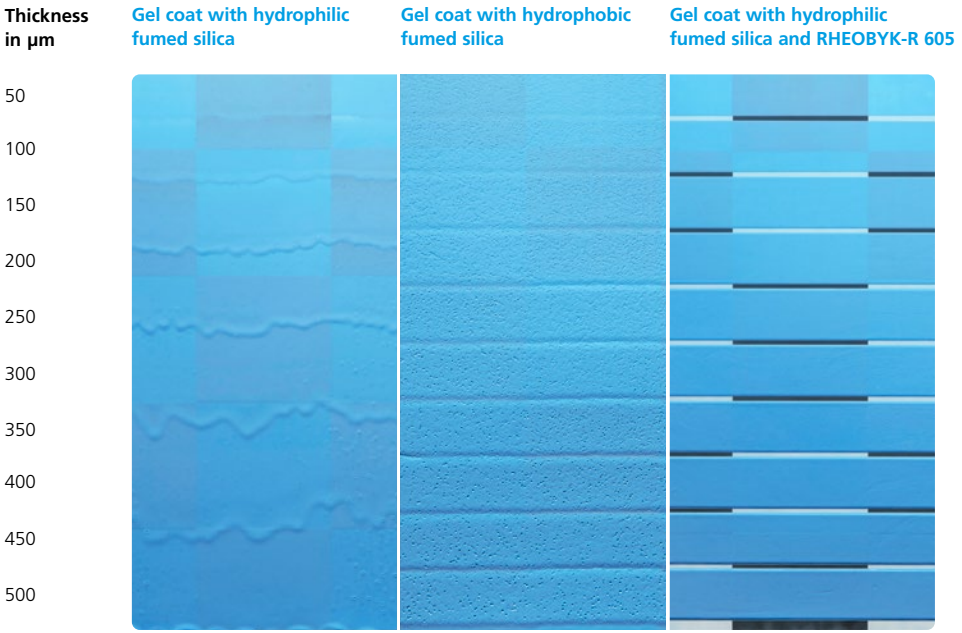
Since fumed silica is typically used to introduce thixotropy, it is very important that the fumed silica be well dispersed into the gel coat resin. Wetting the fumed silica can be challenging depending on the base resin type.

RHEOBYK-R 605 was developed to improve fumed silica wetting and dispersion and enhance thixotropic properties. In order to achieve this, RHEOBYK-R 605 should be added to the resin before the silica. This not only improves silica dispersion and enhances the thixotropic effect, but also maintains thixotropy during storage.

Vinylester gel coats

Hydrophilic fumed silica is usually not effective in vinylester resins. Hydrophobic fumed silica can be used to create thixotropy, but it is very difficult to obtain air release and good surface appearance. By using RHEOBYK-R 605 in combination with hydrophilic fumed silicas, it is possible to create the required thixotropy while retaining good air release, flow, and leveling properties.

RHEOBYK-R 605 exhibits best results in vinylester gel coats



G.05

Vinylester gel coat with RHEOBYK-R 605

Component	Type	Amount in g
Vinylester resin	Resin	100.0
BYK-A 515	Air release additive	0.5
Fumed silica	Thixotrope	1.8
RHEOBYK-R 605	Rheology additive	0.6
Pigment	Pigment	10.0
Cobalt (1 %)	Cobalt accelerator	3.0
DMA (10 %)	Amine accelerator	1.0
Peroxide	Peroxide	2.0

T.01

Additives to prevent flooding and floating

Pigment flooding and floating can be influenced by many variables. The most important variables are: the type of pigments or pigment mixtures, the grinding resin, degree of dispersion and pigment stabilization, the thixotropy of the gel coat, and the application method. It is critical that the pigments used are properly dispersed in the polyester resin, and properly stabilized after grinding so that re-agglomeration and uncontrolled flocculation do not occur.

There are basically two possible approaches for addressing flooding and floating problems:

1. **Stabilizing the pigmented system via controlled flocculation of the pigments**
   In this case, the wetting and dispersing additive is able to develop a loose bridging network between the pigment particles (G.06). Typical products are BYK-W 940, BYK-W 980, and BYK-220 SN.

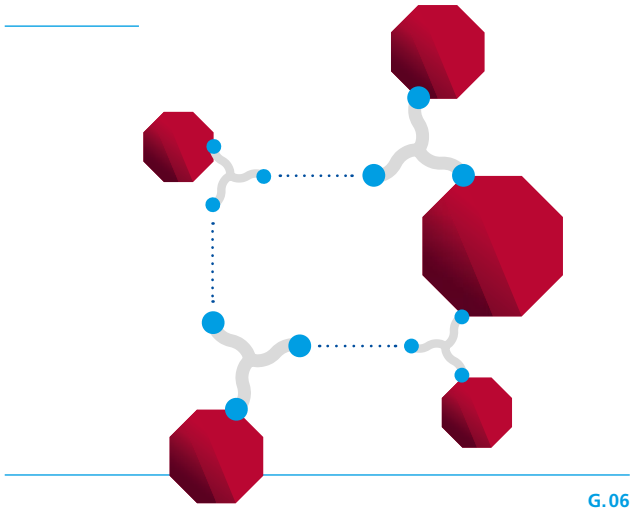
   The advantage of these products is that they do not dramatically influence the thixotropy of the gel coat. They should be added to the system before the pigment grinding stage. In some cases, it is possible to correct flooding and floating by post-adding BYK-W 940 and BYK-220 SN to the final gel coat.

2. **Stabilizing the pigmented system via deflocculation of pigments**
   Using high molecular weight block copolymers with many pigment affinic groups provides excellent steric stabilization, thereby preventing pigment flocculation. This stabilizes the color strength and hue of pigments in gel coats and pigment concentrates.

   Typical products are DISPERBYK-2163, DISPERBYK-171, and DISPERBYK-192. These additives must be introduced in the pigment grinding stage. They are highly effective, and mainly used in color pastes for gel coats.

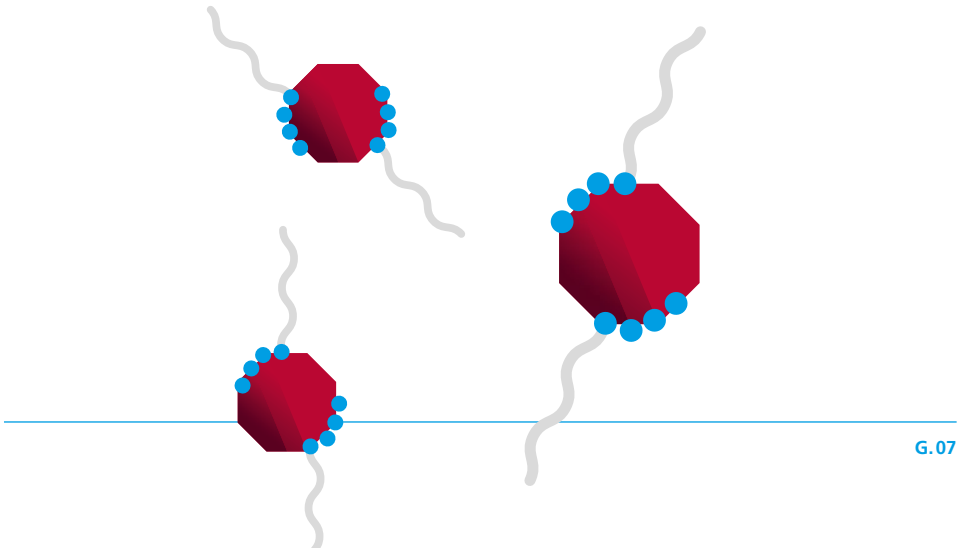
   It is important to check for possible detrimental effects on the thixotropy of the final gel coat. The additive's wetting effect on fumed silica may reduce the fumed silica's ability to develop thixotropy.

Controlled flocculation



G.06

Deflocculation with high molecular weight block copolymers



G.07

Additives to prevent porosity

Porosity is a well-known phenomenon and one of the hardest to evaluate. The effect is strongly dependent on the surface tension of the mold caused by the mold release agent, the surface tension of the gel coat, and the efficiency of the air release additive. The type of peroxide used should also be taken into consideration.

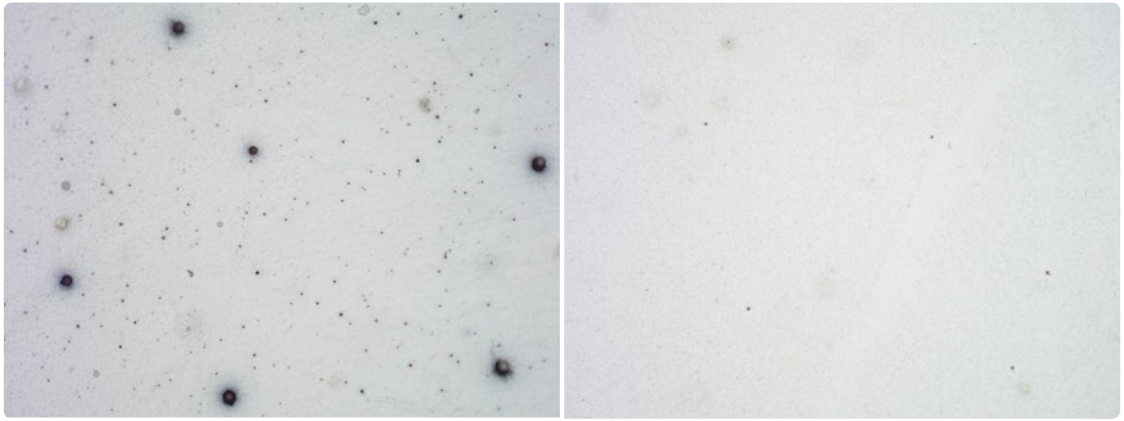
The gel coat's surface tension has to be adjusted to the surface tension of the release agent, whereas wax-based release agents are easier to wet than others. We recommend surface-active additives such as BYK-A 525 for smaller adjustments and BYK-330 for larger adjustments.

An air release additive can support the displacement of air on the mold's surface. BYK-A 515 or BYK-A 555 can be used to accomplish this.

Best results have been achieved by combining a surface-active additive with an air release additive (G. 08).

Porosity

Without additive **With 0.25 % BYK-A 515 + 0.25 % BYK-A 525**



G. 08

Anti-tack additives

Sometimes it is necessary to step on a gel coat because of the mold size (boat hulls) or to fix surface defects. If the surface of the gel coat is sticky, the worker would destroy the coating by stepping on it. BYK's range of anti-tack additives helps overcome this issue by covering the surface of the gel coat with a non-sticky film (G. 09).

A lab test can easily be performed with a cotton pad. One hour after application, the pad is placed on the gel coat's surface and a 1 kg weight is positioned on the pad. After one minute, the weight is removed and the pad is lifted from the gel coat by picking it up at the center (G. 10).

Interlaminar adhesion is normally not affected by the anti-tack additives, but should be carefully checked in each system (G. 11).

BYK-S 780, a wax dispersion, is recommended for all systems, especially for vinylester resins where interlaminar adhesion is not required.

BYK-S 782, a combination of modified waxes, is designed for applications at higher temperatures (i.e. in the summer). It can be applied in every system that requires interlaminar adhesion. The additive can be melted before use so that it is easier to handle.

Step-on test

Gel coat with BYK-S 780

Dosage of BYK-S 780 based upon gel coat

G. 09

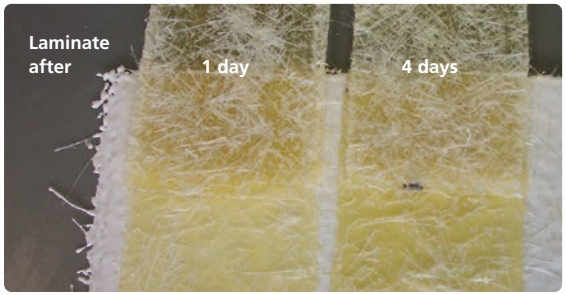
Cotton pad test

Without additive **With BYK-S 780**

G. 10

Test of interlaminar adhesion

Perfect adhesion even with 1 % BYK-S 782 on gel coat



G. 11

Additives for gel coats – summary

Application	Air release	Flow and leveling	Thixotropy	Flooding and floating	Porosity	Anti-tack
Pigmented gel coats	BYK-A 515 ● BYK-A 555 ● BYK-A 501 ○	BYK-330 ● BYK-378 ● BYK-306 ○ BYK-310 ○ BYK-361 N ○ BYK-370 ○ BYK-S 706 ○	RHEOBYK-R 605*2 ●	BYK-220 SN ● BYK-W 940 ● DISPERBYK-167 ● DISPERBYK-192 ● DISPERBYK-2152 ● DISPERBYK-2163 ● BYK-W 980 ○ DISPERBYK-171 ○	BYK-A 515 ● BYK-A 525 ● BYK-330 ○ BYK-A 555 ○	BYK-S 782 ● BYK-S 780 ○
Transparent gel coats	BYK-081*1 ● BYK-A 500 ● BYK-A 550 ●	BYK-310 ● BYK-361 N ● BYK-370 ●	RHEOBYK-R 605*2 ●		BYK-370 ●	

● First recommendation ○ Second recommendation T. 01

*1 For the use in food contact applications, please check the food contact sheet. *2 in combination with fumed silica

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