BYK
Additives & Instruments

Application Information CC-A 4

# Additives for Epoxy Applications

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# Additives for Epoxy Applications

## Content



# Introduction to Epoxy Applications

Epoxy resins are used today in a wide variety of different products. This is attributed to good commercial availability of raw materials and also because of specific properties such as:

- excellent electrical insulating values
- outstanding adhesion
- excellent chemical resistance
- good mechanical properties

These properties can be modified depending on the type of resin and hardener system that is chosen, and even further influenced by the choice of other raw materials used, such as fillers, reinforcement and additives.
The selections made lead to reinforced products such as wind blades, pipes, automotive parts, and sporting goods (ski, surfboards etc.), or to non-reinforced applications such as flooring, mineral cast, putties, paints, adhesives, and resins for electrical casting and insulation.

Along with this broad range of final applications comes a variety of different application techniques:
Reinforced parts could be made by simple manual lay-up but also by RTM or infusion technology, and several casting or spraying technologies are available for non-reinforced systems.

# Defoaming/Air Release

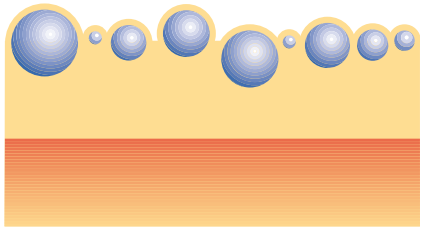
Epoxy systems require defoamers as well as air release additives. The significant difference between these two types of additives is how they function (figure 1).

Defoamers are primarily active at the surface of the system; they prevent surface bubbles and pinholes. Air release additives (or deaerators) are active within the bulk of the liquid, causing smaller bubbles to coalesce and form larger bubbles that are more easily transported to the surface. In practice, however, a clear differentiation between defoamers and air release additives is not always possible, especially when both functions are combined in one product.

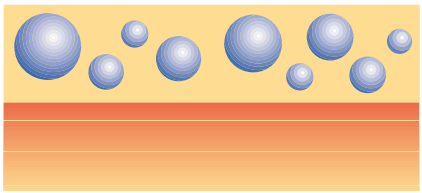
Defoamers and air release additives can be based on (modified) polysiloxanes, silicone-free polymers, or a combination of both. Whether or not a particular polymer can destroy foam bubbles depends on the product's compatibility and solubility in the liquid medium. All defoamers and air release additives must have some degree of incompatibility – managing that delicate balance between compatibility and incompatibility. This is achieved by adjusting the molecular weight and/or polarity of the polymeric structures.

At the time of publication, **BYK-A 535** fully meets all requirements of the European Union for "articles and materials intended to come in contact with foodstuffs" (incl. drinking water). For details, please refer to the relevant documents on our website or contact our product safety department.

## Defoaming and Air Release



Foam on the surface. **Defoamers** destabilize the foam bubbles.



Air incorporation within the system. **Air release agents** accelerate the migration of the bubbles to the surface.

figure 1

## Air Release in a Solvent-free, 2-pack Epoxy Casting System

**Without additive**

**With 1% BYK-A 530**

figure 2

## Additives to Prevent Air Entrapment, Foam and Pinholes

| | | |
|---|---|---|
| **Silicone-based** | BYK-066 N | very effective, universal |
| | BYK-067 A | solvent-free |
| | BYK-A 525 | universal |
| | BYK-S 732 | solvent-free, universal |
| **Silicone-free polymer*** | BYK-A 501 | universal |
| | BYK-A 535 | VOC-free, for food contact applications |
| **Silicone/polymer combination** | BYK-A 530 | best air release effect in epoxies |

*Silicone-free products are preferred for the amine component.

figure 3

# Wetting and Dispersing

One of the most important steps in producing filled or pigmented epoxy systems is the homogeneous distribution of the solid pigments and fillers within the liquid binder solution. If this step (grinding) is not optimized, a wide range of defects such as flocculation, flooding and floating (pigment separation), and settling can occur as well as poor flow behavior during application.

Wetting and dispersing additives accelerate solid particle wetting and stabilization, and provide the following benefits:

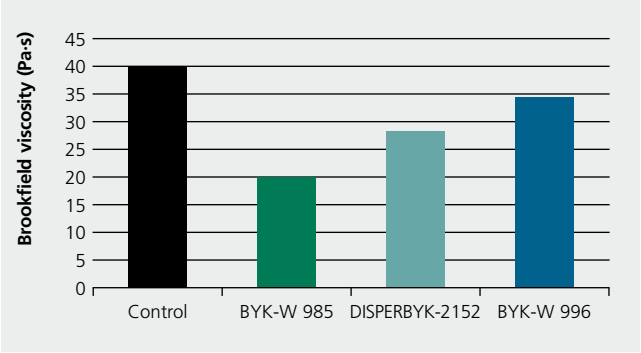
- color consistency
- higher filler load at low viscosity
- better flow due to low viscosity
- no filler sedimentation

## Wetting and Dispersing Additives

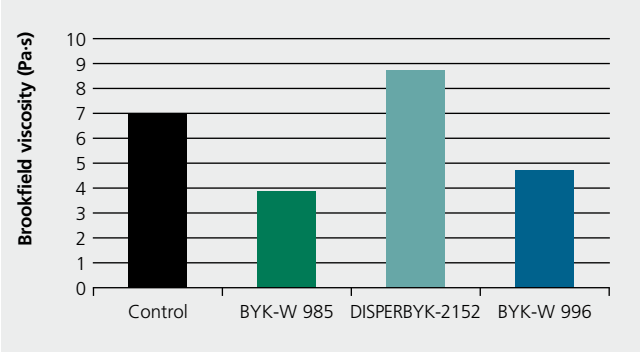
| | | |
|---|---|---|
| **Strong viscosity reduction** | BYK-W 903 | very effective with APP, suitable for anhydride systems |
| | BYK-W 985 | very effective, universal |
| | BYK-W 996 | very effective with $CaCO_3$ |
| **Viscosity reduction, anti-settling** | BYK-W 980 | very stable in the epoxy resin even at higher dosage |
| **Strong viscosity reduction, pigment stabilization** | BYK-9076 | very stable in the epoxy resin even at higher dosage |
| | BYK-9077 | also suitable for the amine hardener |
| | DISPERBYK-2152 | very stable in the epoxy resin even at higher dosage |
| **Anti-settling** | ANTI-TERRA-204 | also suitable for the amine hardener |
| | BYK-W 940 | universal |

figure 4

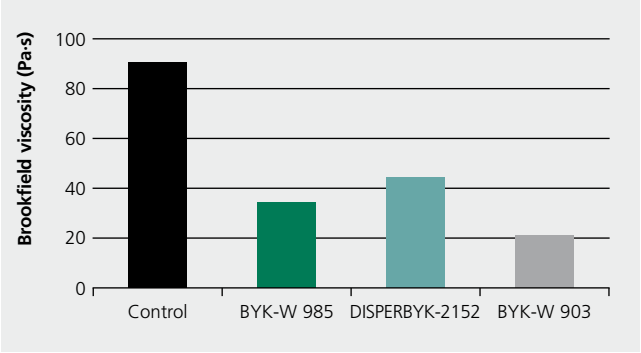
## Viscosity Reduction in Epoxy Systems



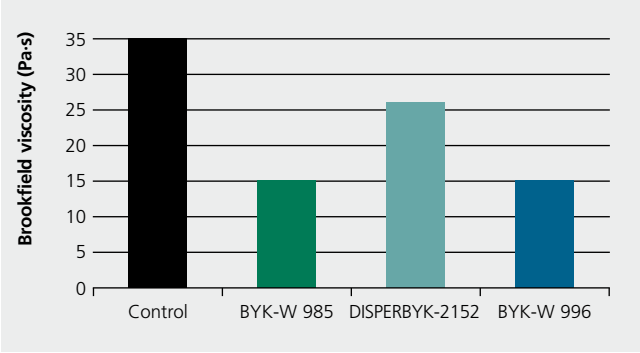

**60% Quartz powder in diluted Bisphenol A resin**




**50% Barium sulfate in diluted Bisphenol A resin**




**60% Ammonium polyphosphate (APP) in diluted Bisphenol A resin**




**50% Calcium carbonate in diluted Bisphenol A resin**

Additive level: 1% on filler

figure 5

# Rheology Control/Thixotropy

### Liquid Rheology Additives

**BYK-410** is a modified urea that forms strong, three-dimensional network structures, thereby creating thixotropy.

**BYK-430** is based on polyamides modified with compatibility enhancing groups (alkyl and polyether segments) to optimize the incorporation as well as the rheological activity. BYK-430 is recommended for medium polar systems and is used mostly in anhydride hardeners to give anti-settling properties.

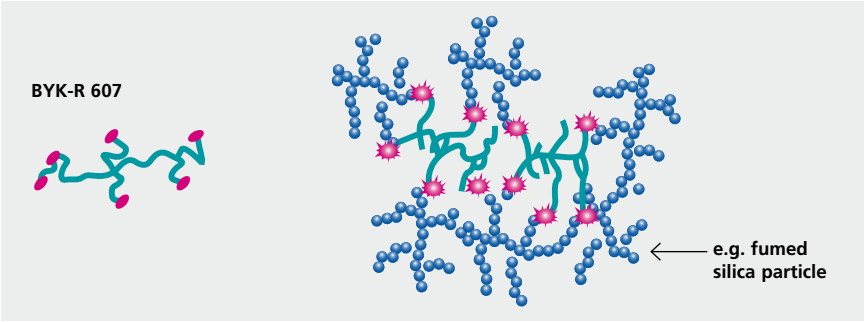
### Thixotropy Booster

**BYK-R 605** and **BYK-R 607** are thixotropy boosters; they strongly enhance the rheology effect of hydrophilic (fumed) silica by intensifying the network structure of the silica particles through hydrogen bonding (figure 6). They are not effective in combination with hydrophobic fumed silica.

Optimum processability coupled with high sag resistance requires a perfectly adjusted rheology profile and often fumed silica is used for this. However, the problem is that when the amine hardener is added to the epoxy resin with fumed silica, the viscosity spontaneously drops.
The situation is improved when more expensive hydrophobic fumed silica is employed and the resulting viscosity may be sufficient for medium film thickness. When high film thickness is required the common technique is to additionally use hydrophilic silica in the amine hardener. The disadvantage of this approach, besides the cost aspect, is that the user must accept poorer deaeration and extended production times due to the mixing of two liquids with high viscosity.

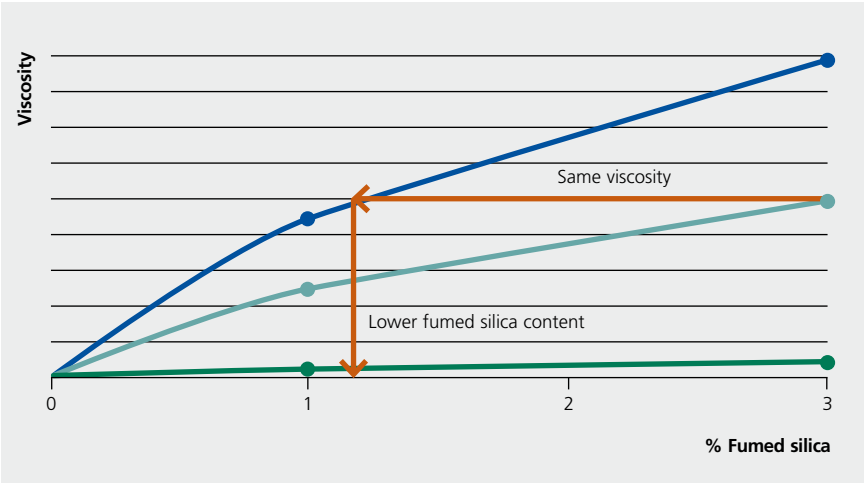
A much better solution is now available with the thixotropy booster **BYK-R 607**: the less expensive hydrophilic fumed silica can be used in the epoxy resin and BYK-R 607 is added to the amine hardener. Both components, the resin and the hardener are less viscous and develop the required rheology profile only when being mixed. This ensures good processability, deaeration and outstanding anti-sagging properties at reduced formulation cost (figure 7).

### BYK-R 607 – Mode of Action




Multiple functional groups effectively enhance the solid thixotropic network. figure 6

### Cost Saving with BYK-R 607: Same Viscosity with 60% Less Fumed Silica



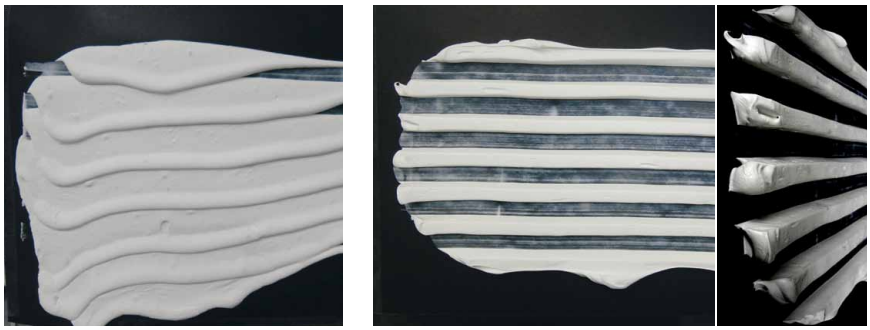

Hydrophilic fumed silica
Hydrophobic fumed silica
Hydrophilic fumed silica + 30 % BYK-R 607

figure 7

### Solid Thixotropes

Furthermore it can be very beneficial to replace the fumed silica with **GARAMITE-7305**. It is a solid thixotrope based on the patented Mixed Mineral Thixotrope (MMT) technology. The additive is organically modified in order to meet medium to high polarities from different epoxy systems. Compared to fumed silica it has a much higher bulk density and due to multiple particle morphologies the powder disperses very easily into the resin or hardener with only moderate shear force. Similar to the fumed silica particles it forms a three-dimensional network via hydrogen bonds.
In combination with BYK-R 607 outstanding sag resistance at low dosages of solids can be achieved at lower costs (figure 8).
Low dosages of GARAMITE-7305 without BYK-R 607 give already good anti-settling performance.

### Excellent Sag Resistance in High Thickness Applications



**GARAMITE-7305** **GARAMITE-7305 + BYK-R 607**

figure 8

### Rheology Additives

| | | |
|---|---|---|
| **Liquid rheology additives** | BYK-410 | anti-settling, sag resistance |
| | BYK-430 | anti-settling; for anhydride systems |
| **Solid thixotrope** | GARAMITE-7305 | sag resistance, anti-settling; combination with BYK-R 607 recommended |
| | GARAMITE-1958 | for the amine hardener |
| **Thixotropy booster for fumed silica and GARAMITE** | BYK-R 605 | anti-settling; for the epoxy resin |
| | BYK-R 607 | anti-settling, anti-sag; for the amine hardener or the epoxy resin |

figure 9

## Flow/Leveling, Anti-cratering

Whenever an epoxy system is applied in a certain layer on a substrate, defects such as craters, Bénard cells, pinholes, orange peel and others can appear on the surface.
One very significant parameter that impacts all these defects is the surface tension, or more specifically, tension differences. The following additives could be used to prevent or minimize these differences in surface tension.

### Cratering and Poor Leveling

figure 10

### Surface Additives

| | | |
|---|---|---|
| **Modified polysiloxane** | BYK-306 | strong surface tension reduction; anti-cratering |
| | BYK-307 | |
| | BYK-310 | |
| | BYK-320 | |
| **Acrylate copolymer** | BYK-361 N | improved leveling |
| | BYK-392 | |

Note: Silicone-free products are preferred for the amine component.

figure 11

# Summary of Additive Recommendations

## Additive Recommendations for Epoxy Applications

| | | First recommendations | Second recommendations |
|---|---|---|---|
| **Gel coats** | Air release | **BYK-A 530** | BYK-A 501 |
| | Viscosity reduction | **BYK-W 980** | |
| | Flow/leveling, anti-cratering | **BYK-306** | BYK-310<br>BYK-320 |
| | Anti-settling | **BYK-R 605*** | BYK-410 |
| | Thixotropy | **GARAMITE-7305**<br>**BYK-R 607**** | |
| | Pigment stabilization | **DISPERBYK-2152** | BYK-W 940 |
| **Casting systems, polymer concrete, mineral cast** | Air release | **BYK-A 501**<br>**BYK-A 530** | BYK-066 N<br>BYK-A 535 |
| | Viscosity reduction | **BYK-W 985**<br>**BYK-W 996** | BYK-W 980 |
| | Anti-settling | **BYK-410**<br>**GARAMITE-7305** | GARAMITE-1958 |
| | Flow/leveling, anti-cratering | **BYK-310** | BYK-392 |
| **Lay-up, spray-up** | Air release | **BYK-A 501**<br>**BYK-A 530** | |
| | Viscosity reduction | **BYK-W 980** | |
| | Thixotropy | **BYK-R 607**** | |
| **Infusion techniques, RTM** | Air release | **BYK-A 530** | BYK-067 A<br>BYK-A 525 |
| | Flow/leveling, anti-cratering | **BYK-310** | |
| | Filler incorporation | **BYK-9076** | BYK-9077 |
| **Flooring, lining** | Air release | **BYK-066 N** | BYK-A 530 |
| | Viscosity reduction | **BYK-W 980** | BYK-W 985 |
| | Flow/leveling, anti-cratering | **BYK-306** | |
| | Anti-settling | **BYK-410** | |
| | Thixotropy | **BYK-R 607**** | |
| **Electrical cast** | Air release | **BYK-A 530** | BYK-A 535 |
| | Viscosity reduction | **BYK-W 985** | BYK-W 980 |
| | Substrate wetting | **BYK-307** | BYK-392 |
| **Anhydride systems** | Air release | **BYK-S 732** | |
| | Viscosity reduction | **BYK-W 903** | |
| | Flow/leveling, anti-cratering | **BYK-307** | BYK-361 N |
| | Anti-settling | **BYK-430** | |
| **Amine hardener** | Thixotropy | **BYK-R 607**** | |
| | Anti-settling | **ANTI-TERRA-204** | GARAMITE-1958 |
| | Viscosity reduction | **BYK-9077** | |

* in combination with fumed silica or GARAMITE in component A (epoxy resin)

** in combination with fumed silica or GARAMITE; suitable for the amine component

figure 12

# Products and Applications

## BYK Additives

**Product Range Additives:**

- Additives to improve surface slip, leveling, and substrate wetting
- Adhesion promoters
- Defoamers and air release agents
- Processing additives
- Rheological additives
- UV absorbers
- Viscosity depressants
- Wax additives
- Wetting and dispersing additives for pigments and extenders

**Application Areas:**

**Coatings Industry**
- Architectural Coatings
- Automotive Coatings
- Industrial Coatings
- Can Coatings
- Coil Coatings
- Wood & Furniture Coatings
- Powder Coatings
- Leather Finishes
- Protective & Marine Coatings

**Plastics Industry**
- Ambient Curing Systems
- PVC Plastisols
- SMC/BMC
- Thermoplastics

**Printing Ink Industry**
- Flexo Inks
- Gravure Inks
- Inkjet Inks
- Silk Screen Inks
- Offset Inks
- Overprint Varnishes

**Paper Coatings**
- Impregnation
- Coatings

**Adhesives & Sealants**

**Construction Chemicals**

**Pigment Concentrates**

**Raw Materials for Manufacturing Release Agents**

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