BYK
Additives & Instruments

Substance for Success.

Application Information CC-A6

Additives for Acrylate Applications

A member of ALTANA

Additives for Acrylate Applications

Content

Introduction to Acrylate Applications

In this brochure, "acrylate applications" refers to polymethyl methacrylate (PMMA) solutions in monomeric methyl methacrylate (MMA) that typically contain about 20% PMMA. This resin solution (often called "syrup") is mixed with fillers such as ATH (aluminum trihydroxide) or quartz (silica sand) and then cured at ambient or elevated temperatures using a peroxide initiator. To achieve special decorative effects, pigments (white or colored) as well as different types of flakes are also used in addition to the filler.

Different objects can be produced with acrylic syrup such as high quality bathtubs, sinks, and other sanitary equipment. Slabs and plates are other products with excellent abrasion resistance for various uses.
The right choice of additives can improve the acrylic syrup processing and quality of the final parts in many ways:

- Reduced air entrapments
- Improved mechanical and chemical resistance
- Reduced syrup viscosity, allowing higher filler loads
- Less settling and floating of filler, pigments, and flakes
- Pigment stabilization, no flocculation
- Accelerated curing reaction and more homogeneous curing
- Reduced monomeric methyl methacrylate emission

Examples of Typical Acrylate Applications

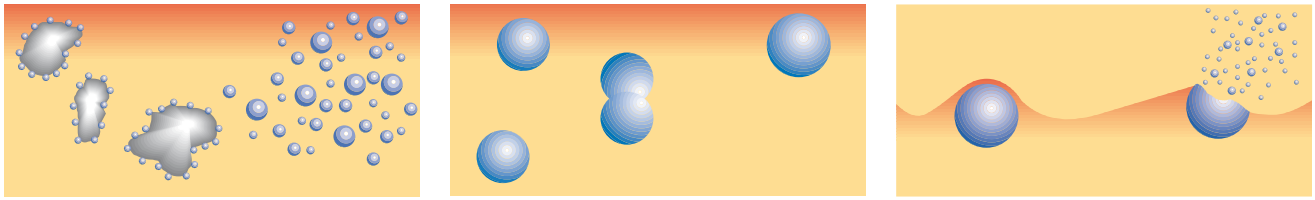
figure 1

Air Release/Defoaming

Air is easily incorporated into the acrylic syrup during mixing operations and while fillers and other solid particles (pigments, flakes) are being dispersed. If these air bubbles are not completely removed from the system before curing, such air entrapments will negatively affect the optical and mechanical properties of the final parts. A vacuum is often used for air release. Additives are very helpful in accelerating this process and minimizing the time necessary to remove the air.

Air release additives work in three steps. **Step 1**: By reducing the interfacial tension between the acrylic syrup and the solid particles (filler, pigments), the air from the particles is displaced into the resin solution. **Step 2**: Substances which stabilize the air bubbles are displaced by the air release additive. As a result, smaller bubbles coalesce to form larger bubbles and larger bubbles rise to the surface faster because of their higher buoyancy (Stoke's law). **Step 3**: Air bubbles break when they reach the surface.

Air Release Mechanism



Step 1 Step 2 Step 3

figure 2

Air Release Additives

	Type of additive	Recommended dosage
BYK-070	Silicone/polymer combination	0.3-1 % on syrup
BYK-A 515	Silicone-free polymer	0.3-1 % on syrup

figure 3

Improvement of Mechanical/Chemical Properties

Filler particles are usually only mechanically embedded in the acrylic resin matrix, and filled parts typically break at the filler/resin interface under mechanical stress. Coupling agents strengthen the interface between the filler particles and the acrylic resin by forming chemical bonds, which in turn significantly improves the mechanical and/or chemical properties.

Mechanism of Coupling Agents

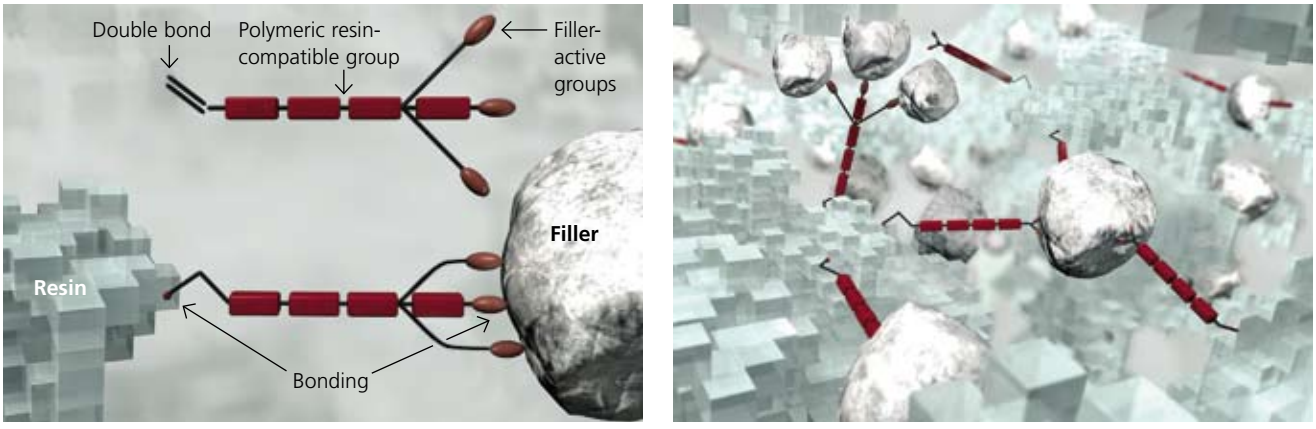
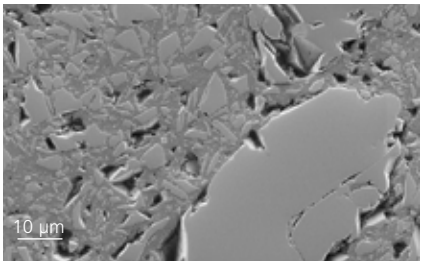
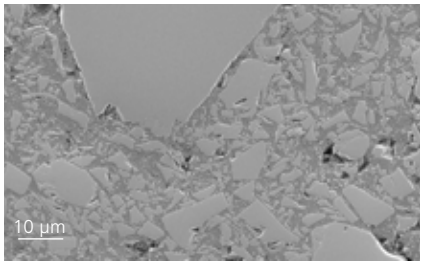


figure 4

Hot Water Immersion Test (200 h)



without BYK-C 8000



with BYK-C 8000

figure 5

Using these coupling agents, for example, can increase flexural strength by a range of 10-50 %. Chemical and water resistance is also significantly improved particularly in quartz-filled systems. Figure 5 shows the results of a hot water immersion test.

Coupling Agents

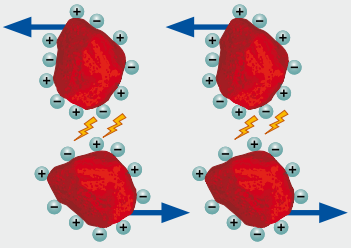
	Recommended for	Recommended dosage
BYK-C 8000	Quartz and glass flakes	0.5-1.5 % on syrup
BYK-C 8002	ATH	0.5-1.5 % on syrup

figure 6

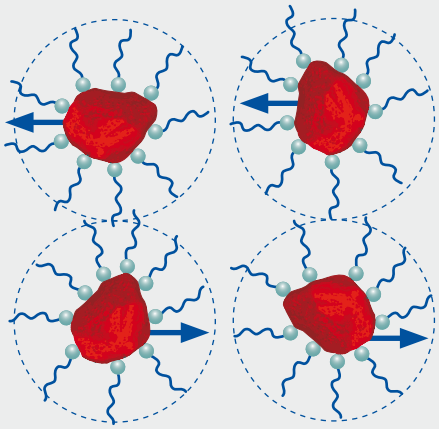
Viscosity Reduction

The quantity of filler in a highly filled acrylic system should be as high as possible, but at the same time, viscosity must be low enough to guarantee problem-free handling and processing. Wetting and dispersing additives can be very helpful to combine high filler loads with low viscosity. These additives adsorb onto the filler surface and minimize the interaction between the polar particles, which results in a much lower viscosity.

Mechanism of Viscosity Reduction



Interaction of filler particles leads to high viscosity



Wetting and dispersing additives reduce interactive forces and create lower viscosity

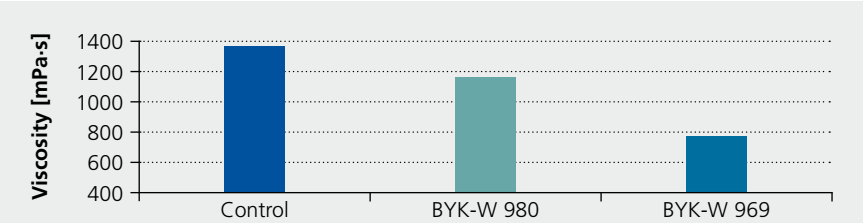
figure 7

Wetting and Dispersing Additives for Viscosity Reduction

	Recommended for	Recommended dosage
BYK-W 969	ATH, silane-treated silica sand	0.3-1.5 % on syrup
BYK-W 980	Silica sand	0.3-1.5 % on syrup

figure 8

Viscosity Reduction in an ATH-filled Acrylic System



Syrup: 20% PMMA in MMA; Filler load: 60% ATH
Additive dosage: 1% based on filler

figure 9

Anti-settling/Anti-floating

In acrylic casting systems, viscosity should be low in order to obtain good flow in the mold. Consequently, many systems face settling (sedimentation) or floating problems with the solid particles (filler, flakes). Achieving good flow properties while experiencing no settling or floating issues requires the use of specially developed wetting and dispersing additives or coupling agents that support such behavior.
These multifunctional additives adsorb onto the particle surface and form bridges between several particles. This network structure very effectively reduces settling and floating.

Mechanism of Multifunctional Wetting and Dispersing Additive

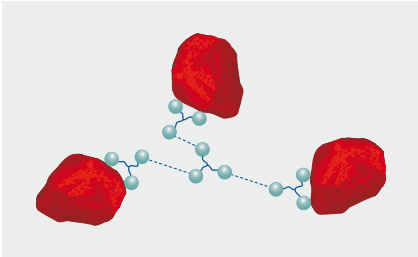


figure 10

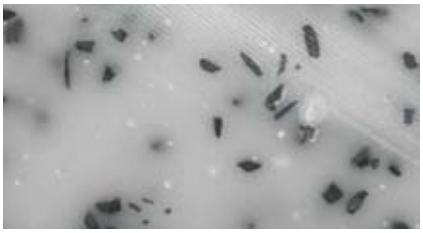
Anti-floating

Left: Floating without additive
Right: No floating with 0.3% BYK-C 8002 (on filler)

figure 11

Anti-settling

Settling without additive



No settling with 0.5% BYK-P 105 (on filler)

figure 12

Wetting and Dispersing Additives to Prevent Settling and Floating

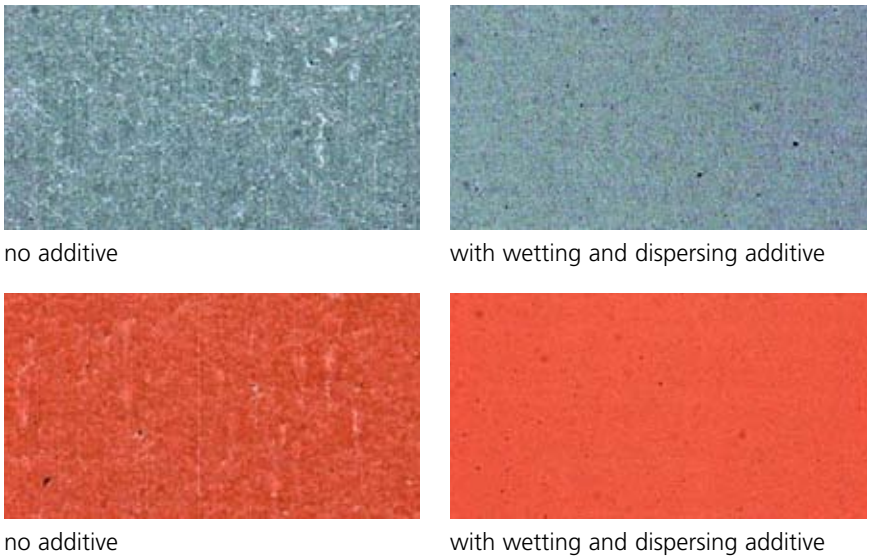
	Additive type	Recommended dosage
ANTI-TERRA-204	Multifunctional wetting and dispersing additive	0.3-1 % on syrup
BYK-C 8002	Coupling agent with multifunctional groups	0.3-1 % on syrup
BYK-P 105	Multifunctional wetting and dispersing additive	0.3-1 % on syrup

figure 13

Pigment Stabilization

Many applications require pigmentation of the acrylic syrup to achieve an optimum appearance. White pigments (titanium dioxide) are often used, but colored pigments (inorganic and organic) are also utilized for special decorative effects. Pigments tend to agglomerate with each other, with other pigments, or with the filler particles. Such flocculation negatively affects color homogeneity, color shade, and hiding power. Flocculation can be minimized by using appropriate wetting and dispersing additives. These additives stabilize the deflocculated particles and prevent reflocculation. A stable and uniform color effect is thus guaranteed. Additive dosage strongly depends on the particle size of the pigments. Small particles with a larger specific surface area require higher amounts of wetting and dispersing additives than coarser particles with a smaller specific surface area.

Pigment Stabilization with Wetting and Dispersing Additives



no additive | with wetting and dispersing additive

no additive | with wetting and dispersing additive

figure 14

Additives for Pigment Stabilization

	Additive type	Recommended dosage
BYK-W 940	Multifunctional wetting and dispersing additive	1-5 % on pigment/filler
DISPERPLAST-1142	Deflocculating wetting and dispersing additive	1-10 % on pigment

figure 15

Acceleration of Curing Reaction

Curing of the acrylic system can be accelerated with Ca^{2+} ions. Dry $Ca(OH)_2$ or a suspension of $Ca(OH)_2$ in methyl methacrylate (MMA) is usually added to the syrup/filler mixture for that purpose, but both forms have their disadvantages:

Suspension of $Ca(OH)_2$ in MMA:
- Difficult handling of dry $Ca(OH)_2$ to produce the suspension
- Agglomeration and sedimentation of $Ca(OH)_2$

Dry $Ca(OH)_2$:
- Difficult to handle (corrosive)
- Difficult to dose materials in powder form
- No homogeneous distribution in the mixture
- Moisture and CO_2 absorption leads to reactivity change over time

Using $Ca(OH)_2$, either in powder form or in suspension, presents handling difficulties and can also lead to an inconsistent curing situation. This may negatively impact the quality of the final parts.

BYK-2616 is a CaO paste with 74% CaO and is the better way to accelerate acrylic syrup curing:
- Pumpable paste
- Dust-free handling
- Fine particles in a very homogeneous distribution
- Fast acting due to large specific surface area
- Excellent storage stability

Overall, BYK-2616 facilitates accelerated curing that is consistent and homogeneous and enables the production of high-quality final parts.

Curing Accelerator

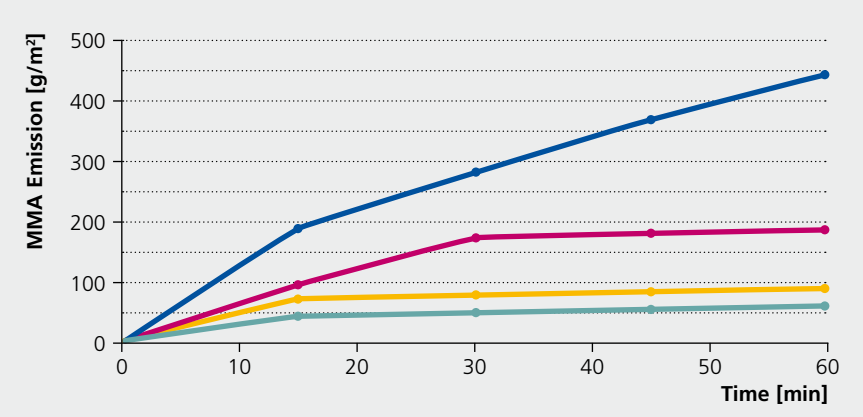
	Additive type	Recommended dosage
BYK-2616	Suspension of CaO	0.5-2 % on syrup

figure 16

Suppression of MMA Emission

A typical acrylic syrup contains about 80% monomeric methyl methacrylate (MMA), which has a high vapor pressure of 40 hPa and evaporates quite easily. Therefore, a considerable amount of MMA can be detected in the workplace when an acrylic syrup is exposed to air. To avoid the unpleasant smell of MMA and protect the workers, the MMA emission should be as low as possible. Emission suppressants BYK-S 780 and BYK-S 782 can reduce the MMA emission substantially; a reduction of more than 80% is possible.

MMA Emission of a Filled Acrylic System



BYK-S 782 based on resin: 0% 0.5% 1% 1.5%

figure 17

Syrup: 20% PMMA in MMA; Filler load: 60% ATH

Emission Suppressants

		Recommended dosage
BYK-S 782	First recommendation	0.5-1.5 % on syrup
BYK-S 780	Alternative to BYK-S 782	0.5-1.5 % on syrup

figure 18

Summary of Additive Recommendations

Additive Recommendations for Acrylate Applications

	First recommendation	Second recommendation
Air release/defoaming	BYK-A 515	BYK-070
Improvement of mechanical and chemical properties	BYK-C 8000 BYK-C 8002	
Viscosity reduction	BYK-W 969	BYK-W 980
Anti-settling/Anti-floating	BYK-P 105	BYK-C 8002
Pigment stabilization	BYK-W 940 DISPERPLAST-1142	
Acceleration of curing reaction	BYK-2616	
Suppression of MMA emission	BYK-S 782	BYK-S 780

figure 19

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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