EVONIK INDUSTRIES

Smart Formulating Journal

Additives | Coloring | Crosslinkers | Matting | Resin Components | Resins

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Shrink Wrapped is Well Packed
A new product from Evonik
Page 3

High Solids Coatings
New high solids binders and additives
Page 4

High Performance Combined with Eco-compatibility
Three new TEGO® Dispers products for pigment concentrates
Page 11

Additives

Nature Likes Water – Waterbased Coatings Like Structured AEROSIL®: AERODISP® WR 8520

AERODISP® WR 8520 is a new, structured aqueous dispersion based on hydrophobic AEROSIL® fumed silica technology. AERODISP® WR 8520 makes it possible to easily and effectively improve the following performance attributes in aqueous pigmented coatings and waterbased clear coats: thickening and thixotropy, anti-settling, pigment stabilization and improvement of the mechanical properties in applications like: automotive coatings, plastic coatings, wood coatings or industrial coatings.

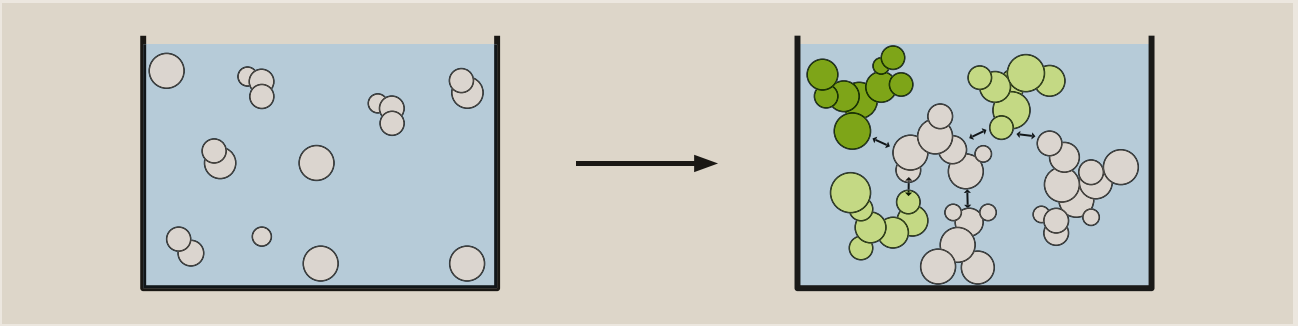


Figure 1
Why is AERODISP® WR 8520 a structured product?

Development of AERODISP® WR 8520

In contrast to solvent-containing coatings, a waterbased system with all of its additives offers outstanding dispersion conditions for AEROSIL® fumed silica. Aggregates become over-dispersed; where they become too small, that they no longer come into contact with one another and can no longer build up an interactive network (see figure 1, left). The aggregates are so homogeneously distributed that the resulting thickening effect is drastically reduced. Such a system no longer stabilizes large, heavy pigments and fillers. Such a system also demonstrates poor sag properties when applied to vertical surfaces.

▸▸▸

Editorial

Dear Mesdames and Sirs,

In our Smart Formulating Journal we regularly inform our customers in the paints and coatings industry about new items in our product portfolio and new developments in our Group. We would also like to use this issue – now our eighth – to intensify our communication with you, our customers.

"Evonik = specialty chemicals" is the most important message from our Group. Evonik is becoming a pure specialty chemicals group and will focus its investments on this area. We have approved an ambitious growth program that specifically considers the global megatrends of resource efficiency, health and nutrition, and globalization of technologies.

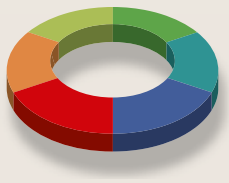
We are well aware, however, that we will be able to achieve this growth only in cooperation with you, our customers. Coating is a particularly important market for us because we generate around 14% of our revenue with customers at the different stages of the value chain in the coatings market. In order not just to maintain but build on this position, we are investing around 4% of our revenues in researching and developing new products and technologies.

Our network of experts in the Area of Competence "Coating & Bonding Technologies" will be instrumental to making our plans work. By staying in close contact with customers, these experts will not only be able to provide all-round service, but also identify the needs and problems of the market so that the new developments can deliver real solutions.

With these activities, our aim is to be a professional contact for all things coating-related, with whom you – our customers – are happy to work.

Best regards,

Dr. Thomas Haeberle
Member of the Board of Management
of Evonik Degussa GmbH



If the silica is present in structured and hydrophobic form and stabilized with special additives, the aggregates remain more stable and intact in an aqueous environment. In addition, the surface chemistry must be such that an optimum reciprocal exchange of forces is possible. In figure 1, this is symbolized by the arrows. This balanced interaction is the basis for an efficient network and is established only if both parameters, structure and surface chemistry, are present at the same time.

Intensive studies have shown that the surface chemistry of the hydrophobic AEROSIL® fumed silica has to be properly selected and optimized in order to allow this intensive exchange of interactive forces in waterbased coatings.

Structure of aggregates are carefully preserved by dispersing the hydrophobic AEROSIL® fumed silica so that it forms a 20% solution in water in the presence of suitable additives with customized shearing forces. The optimized shear forces give the aggregates sufficient stability so that they withstand the storage and transport, as well as, formulating conditions to avoid settling and flocculation once added to coating formulations.

Further characteristic application-specific properties of AERODISP® WR 8520 are:

- Environmentally-friendly waterbased dispersion using hydrophobic AEROSIL® fumed silica (20%)
- Customized structuring
- Dispersion exhibits high stability
- Good compatibility with many coating systems
- Efficient thickening and thixotropic agent
- Efficient anti-settling agent
- Minimal effect on the optical properties of waterbased clear coats

Processing recommendations

For binder-containing waterbased coatings, the recommended additive amount is a dispersion addition rate of 5 – 10% (corresponding to 1 – 2% AEROSIL® fumed silica by weight solids), calculated on the basis of the entire coating formulation. The dispersion should be added to the coating under agitation at low to average shearing forces (e. g., dissolver), typically at the end of the batch. High shearing forces, like those generated in a media or bead mill, should be avoided; as these high shear forces would irreversibly destroy the customized structure of the aggregates!

Binder molecules can actively participate in the network build-up by means of interacting forces. In waterbased, binder-free or low-binder solutions like glazes it may consequently be necessary to increase the AEROSIL® fumed silica concentration to approx. 5% (solids) since the binder will not play a significant role in network support.

AERODISP® WR 8520 is compatible with many coating systems tested so far; as a rule, flocculations or other incompatibilities do not appear.

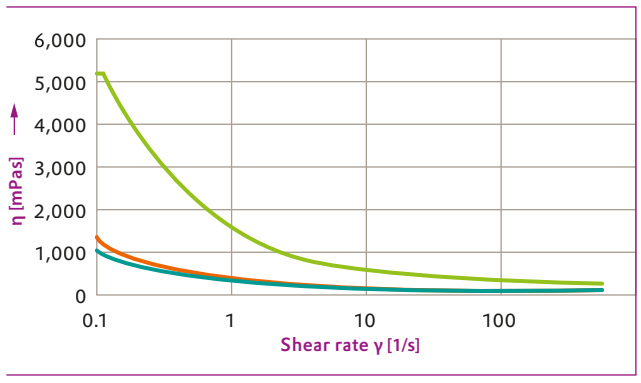
Applications

In waterbased coatings, AERODISP® WR 8520 is often characterized by its efficient rheological effectiveness (high thickening and thixotropic influence).

This is demonstrated on the basis of a random practical example. Figure 2 plots the viscosity of a waterbased filler used in the automotive industry versus the shearing rate. At low shear, the viscosity without AEROSIL® fumed silica is quite weak, i. e., heavy pigments would easily precipitate in such a coating.

According to the current state of the art, AEROSIL® fumed silica can be used to effectively raise the viscosity in solvent-containing systems at low shear rate and provide shear thinning qualities to mostly Newtonian systems. The quick rheological rebounding behavior, in such systems applied on vertical surfaces, once the shear is removed, is the basis of the wellknown anti-sag behavior. In many waterbased coatings such rheological response typically does not occur by adding approx. 1% AEROSIL® fumed silica in powder form and dispersing using a bead mill. (see figure 2)

Figure 2
Rheological effectiveness of SERODISP® WR 8520 in a waterbased filler for automotive coatings; 1% silica



After many investigations testing various powdered grades of AEROSIL® fumed silica combined with additives and shear combinations, AERODISP® WR 8520 is developed to give the classic rheological benefits to waterbased coatings, as AEROSIL® fumed silica is known for in solvent-containing systems. With an addition rate of 5% relative to dispersion (1% relative to AEROSIL® fumed silica) the wellknown and expected advantages by formulators trained in the art become evident. AERODISP® WR 8520 is a waterbased dispersion based on hydrophobic fumed silica. It should be added to the final coating, with low shear agitation (e. g. stirrer or dissolver) and is easy to mix into the letdown phase to get the desired viscosity build-up. Media, bead, or high intensity mills are not recommended to incorporate it.

During the actual application process it is desirable that the viscosity of the coating should be low. This keeps the required application energy needed low and the coating should flow evenly and with ease. At high shear rate, the coating containing the AEROSIL® fumed silica additive should behave as the control without AEROSIL® fumed silica. Once the coating reaches the substrate, and the applied shear force is removed, extra low shear force takes over. Without proper viscosity recovery behavior, on vertical surfaces, the coating runs due to this low gravitation shear forces. Only the coating containing AERODISP® WR 8520 shows stability on vertical surface and sagging is prevented (right part of figure 3).

Figure 3
Rheological effectiveness of AERODISP® WR 8520 in a waterbased filler in the application step (0 – 120 seconds: high shear rate (500 s^{-1}, simulation of the spraying process); 120 – 450 seconds: low shear rate (0.5 s^{-1}, simulation of the situation shortly after application))

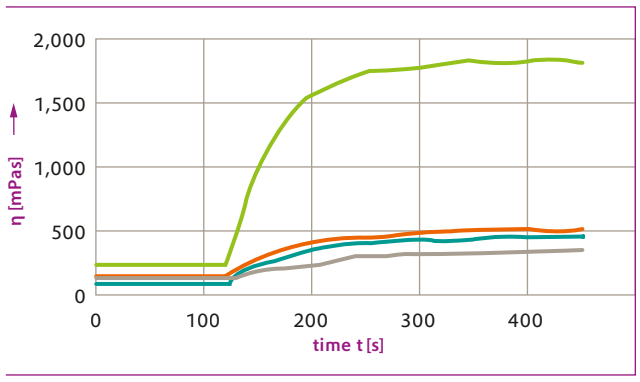


Figure 4 shows the performance of AERODISP® WR 8520 vs control without. In comparison to the control, suspension is improved of the pigments in the waterbased coating containing AERODISP® WR 8520. The dry film thickness is also even and homogeneous which is a critical parameter to maintain on vertical surfaces.

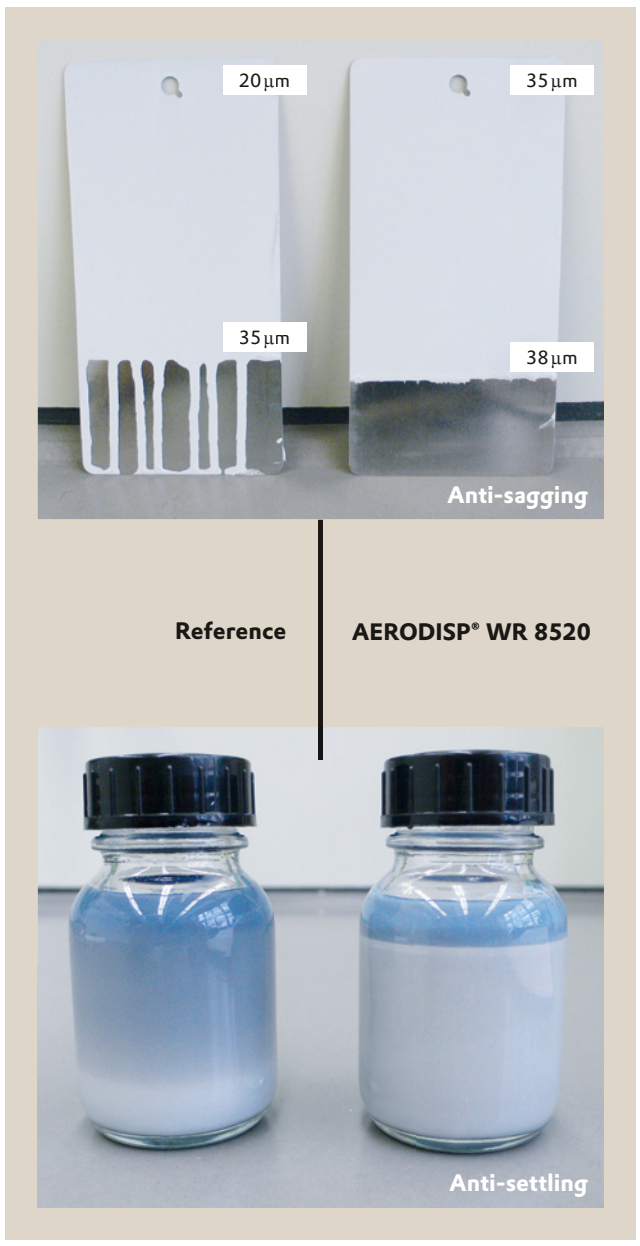


Figure 4
Improvement of the anti-settling behavior and thixotropic behavior in a pigmented waterbased coating with AERODISP® WR 8520

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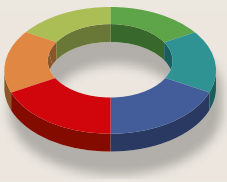

Shrink Wrapped is Well Packed

A new product from Evonik meets high design requirements for flexible packaging materials. DEGALAN® 1040 L, a new binder from the Coatings & Adhesive Resins Business Line, ensures optimal adhesion properties on PET substrates for flexible packaging materials.

Current marketing studies indicate that, in addition to the quality of the contents, the appearance of a packaged product is a decisive factor in its market success. Because the packaging of a consumer product is the first thing the customer sees and handles, it must be of high quality and aesthetically appealing. In the industrial sphere the most important consideration is protection of the product against mechanical stress during transportation and storage.

Consumer goods, from books sent by mail to supermarket groceries, are protected by shrink sleeves. For the printed variety, a number of design options are available to give the packaged product the attractive appearance that induces customers to buy. Typical applications of shrink sleeves films here are for beverage bottles, bottle cap seals, and outer packaging of foods like yoghurt and energy drinks as well as of detergents and cosmetics.

For shrink sleeves packaging, the printed image is first applied in the reverse printing process. This has the advantage that after shrinking the film the inked surface lies on the inside, between the packaging film and the product to be decorated. The film used as packaging material thus protects the printed image. Before the film can be shrunk, the edges must first be joined together to form a flexible tube. This is then drawn over the bottle and the shrinking is performed over a few seconds at a temperature between 60 and 200 °C, depending on the plastic material employed. PVC, OPS, and PET (polyethylene terephthalate) films are most commonly used for decorative packaging, but also materials like PE, PA and PP are applied. A packaging designer`s decision in favor of one or other packaging film depends on technical requirements as well as price. In particular, environmental aspects such as simplified recycling of the roll, or the wrapping of highly complex shapes favor the choice of PET films, which have high shrinkage and therefore enclose the product optimally.

Comparison of adhesion and elasticity of printing inks based on DEGALAN® 1040 L

Formulation	Thermoplastic acrylic resin/CAP* (2:1)	DEGALAN® 1040 L/CAP (2:1)
Tape test (stripping of printing inks from substrate /%)		
PET substrate [%]	90	5
OPS substrate [%]	5	0
PVC substrate [%]	5	0
Wrinkle test (cracking of the coating)		
PET substrate	--	+
OPS substrate	-	++
PVC substrate	-	++

* CAP = cellulose acetate propionate

Particularly in the case of beverage bottles with narrow necks, the shrinkage expected of the film is 70% or more. Finely adjusted adhesion properties are therefore a must for the printing ink. Inks based on the new binder can produce excellent adhesion as well as good pigment wetting, despite high shrinkage on the substrate. In addition to good adhesion to PET, DEGALAN® 1040 L also shows good results with OPS, PVC, PBT (polybutylene terephthalate) and PA substrates. Samples are provided after signing a secrecy agreement.

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One Year of Successful Methacrylate Production in Shanghai

The large integrated production site for methacrylates in Shanghai took up operations in late 2009.

The core of the site is the production of methyl methacrylate (MMA) with an annual capacity of 100,000 metric tons while six closely interlinked individual plants produce additional methacrylate monomers and polymethyl methacrylate (PMMA).

It took just two years to build the facility complex with an investment volume of approximately €250 million. Given this investment scope, there were high expectations for the development of production and sales in the region in spite of the economic crisis.

After one year of operations, the results are very positive. The production in all sub-plants started up without major difficulties and most “German specialists” who accompanied the construction and start-up phase have left. The economic crisis affected the Asian market, and particularly China, to a lesser extent than the Western world, which resulted in strong local demand for the products of the new facility.

Methacrylate monomers are primarily used in plastics and the coatings and paint industry, but also in adhesives. The heavy demand for most of these applications and a boom in consumer electronics such as LED flat screen monitors led to full capacity utilization in production.

After the global economic recovery, the new facility complex will be a fixed part of the global logistics concept to supply customers in other regions with high-quality monomers.

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High Solids Coatings

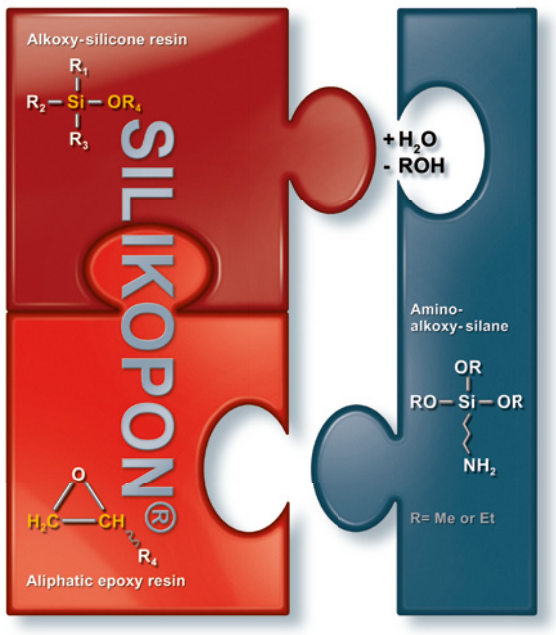
New high solids binders and additives make a sustained contribution to modern eco-friendly coatings

Evonik Tego Chemie GmbH is firmly established as a reliable supplier of environmentally friendly additives, co-binders and specialty resins for high quality coatings and printing inks. The company has long occupied a leading position in waterborne additives. Binders and additives for radiation curable systems are also part of the portfolio. In response to the increasingly stringent environmental regulations, e. g. in the European Directive 2004/42/CE of 21 April 2004 limiting volatile organic compounds in coatings, Evonik Tego has recently developed additional specialty resins, co-binders and additives for high solids solvent-borne coatings.

High solids specialty binder

Epoxy-Polysiloxane-Hybrid – SILIKOPON® EF

The Ultra High Solids binder SILIKOPON® EF is intended for use in environmentally-compatible paint formulations. Its particular advantage is that isocyanate-free 2-pack formulations can be formulated with a VOC content < 250 g/L.



It can be used in anti-corrosion coatings for steel, coatings for wood and concrete and easy to clean marine biocide-free coatings. The use of amino-silanes as hardeners and the resulting high crosslink density lead to finishes with good dirt repellency and excellent resistance to graffiti.

SILIKOPON® EF also offers advantages on various types of wood. In such applications, VOC content can be reduced to below 100 g/L.

Other advantages, particularly for wood applications, are low flammability, good abrasion resistance and brilliant burnishing of the surface.

Furthermore, SILIKOPON® EF can be used in the formulation of highly chemical-resistant coatings utilized, for example, in flooring and industrial plants.

High solids co-binders

The fundamental properties of a coating are decisively influenced by the choice of the main binder. The new high solids alkyds or polyurethanes developed for the formulation of ecologically-compliant solvent-borne coatings, do not, however, possess the required performance profile. Co-binders such as TEGO® VariPlus SK positively influence coatings properties such as hardness, touch-drying speed and viscosity.

High solids co-binder TEGO® AddBond HS

The new product, TEGO® AddBond HS, is a 75% nonvolatile matter solution of a specialty polyester resin dissolved in butyl acetate. Its performance in improving adhesion on metals and plastics in high solids systems is comparable to that of TEGO® AddBond LTW.

High solids co-binder TEGO® AddBond 1270

TEGO® AddBond 1270 is a carboxylic acid functional polyester resin supplied as a 70% nonvolatile matter solution in sec.-butanol. Used in high solids solvent-borne paints, it improves adhesion on metallic and plastic substrates. After neutralization with amines, it can be mixed with water. The VOC content of these waterborne paints is even lower than that of solvent-borne high solids coatings. TEGO® Addbond 1270 is very efficient at improving adhesion on metals including aluminium and galvanized steel. ▸▸▸

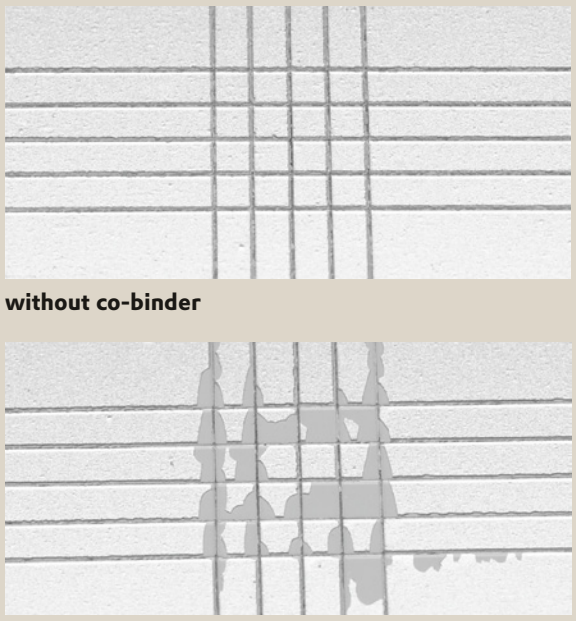


Figure 1
Improved adhesion using TEGO® AddBond 1270

Pigment concentrates with TEGO® VariPlus EP-UC

Pigment concentrates must have certain viscosity characteristics in order to achieve low VOC levels in pigmented coatings and inks. TEGO® VariPlus EP-UC makes a considerable contribution to that. As a liquid resin, it is VOC-free. It exhibits excellent pigment wetting properties. High solids pigmented industrial coatings can be easily formulated with TEGO® VariPlus EP-UC because only a few percent of an organic solvent is needed to obtain a low viscosity solution. Furthermore, TEGO® VariPlus EP-UC can be used as a grinding resin in waterborne universal pigment concentrates, i. e. the resin even tolerates aliphatic hydrocarbons used as organic solvents for dissolving the alkyd resins in the let-down.

TEGO® VariPlus EP-UC can also be used to obtain 100% liquid pigment preparations or solid pigment preparations dilutable in both organic solvents and water.

Additives for high solids coatings

After choosing the binder, the application parameters of the high solids coatings are optimized. The application window of high solids coatings is typically somewhat smaller than that of conventional medium solids coatings. At the same time, requirements are even more demanding.

Avoiding entrapped air in high solids coatings

Increasing the solids content at working consistency and the limited choice of solvent substantially affect the deaerating characteristics of high solids coatings. Consequently, high solids coatings have a tendency to form pinholes and air inclusions. Because of the changed polarity, the deaerating additives used in high solids paints differ from those used in medium solids formulations. The following table shows initial recommendations for suitable binder systems based on comprehensive laboratory tests. In the case of clear coats in particular, the deaerating additive must be both highly effective and compatible.

Table 1
Recommendations for additives for preventing entrapped air in high solids paints

Coatings system	Clear	Pigmented
Alkyd	TEGO® Airex 931 TEGO® Flow 370[1] TEGO® Flow ZFS 460[1]	TEGO® Airex 940 TEGO® Airex 944 TEGO® Glide 420
2-pack PU	TEGO® Airex 950 TEGO® Airex 945 TEGO® Flow 370	TEGO® Airex 944 TEGO® Airex 986 TEGO® Foamex N
2-pack PU polysapartics	TEGO® Airex 916 TEGO® Foamex K 7[1,2] TEGO® Airex 962	TEGO® Airex 944 TEGO® Airex 962 TEGO® Glide 420
Polyester / melamine	TEGO® Airex 931 TEGO® Airex 962 TEGO® Flow 370[1]	TEGO® Airex 986 TEGO® Airex 931 TEGO® Airex 935[2]

[1] silicone-free [2] not available in the US

Optimizing the flow of high solids coatings

A frequently observed weakness of high solids coatings is developing optimal flow. There is a tendency to use low molecular weight binders to achieve a low coating viscosity. At the same time, however, the rheology is adjusted to prevent sagging on vertical surfaces. Furthermore, the type and amount of solvent, which also greatly influences flow, is highly restricted. These changes significantly impair flow. TEGO® Wet, Flow and Glide counteract these effects and help to achieve the required flow and gloss.

Table 2
Recommended additives for optimizing flow in high solids coatings

Coatings system	Clear	Pigmented
Alkyd	TEGO® Glide 450 TEGO® Glide B 1484 TEGO® Flow 370[1]	TEGO® Glide 420 TEGO® Glide A 115 TEGO® Flow ZFS 460
2-pack PU	TEGO® Flow 425 TEGO® Glide 415[2] TEGO® Flow 370[1]	TEGO® Glide 415[2] TEGO® Glide 420 TEGO® Flow ZFS 460
2-pack PU polysapartics	TEGO® Glide 411[2] TEGO® Glide 415[2] TEGO® Wet 505[1]	TEGO® Glide B 1484 TEGO® Glide 420 TEGO® Wet 505[1]
Polyester / melamine	TEGO® Flow 425 TEGO® Glide 100 TEGO® Flow 300[1]	TEGO® Glide 100 TEGO® Flow ZFS 460 TEGO® Glide 415[2]

[1] silicone-free [2] not available in the US

Summary

Evonik Tego Chemie GmbH offers solutions to meet the demanding challenges of high solids coatings. The recommendations are based on the results of work carried out in our application laboratories and are designed to be as customer-relevant as possible.

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VISIOMER® Methacrylate Monomers – Sustainable Resources for Coatings and Paints

Evonik is working to develop a climate strategy. The objective of the Chemicals Business Area is to improve the carbon footprint of the Evonik Group in the long run. In this regard, comparing CO_2 emissions with indirect CO_2 savings represents a special focus. This process balances emissions from production with customer savings during the utilization phase of our products.

According to a study by the International Council of Chemical Associations (ICCA), every metric ton of CO_2 released into the environment during product manufacturing by the chemical industry saves double the amount of CO_2 during the customer utilization phase.

The Performance Polymers Business Unit conducted a life-cycle assessment (LCA) for its major monomer product, methyl methacrylate (VISIOMER® MMA) and the polymer made from it, polymethyl methacrylate (PMMA, brand name PLEXIGLAS®), in 2010. The analysis was performed in accordance with ISO 14040 / 14044 and was certified by the accredited institute PE International. It included source materials, energies, and internal production ("cradle to gate") as well as the utilization phase and final disposal or recycling („cradle to grave").

The Cradle-to-Grave study showed that, thanks to the long service life of PLEXIGLAS®, the global warming potential is by a factor of more than two below this of alternative materials in most of the applications. We expect the results for our methacrylate-based coating materials to resemble those of PLEXIGLAS® and, in collaboration with our customers, also plan to do cradle-to-grave analyses for sample applications in the coatings sector. The results of our LCA analysis for VISIOMER® MMA, VISIOMER® GMAA, VISIOMER® BMA, and VISIOMER® HEMA are available in the form of compact cradle-to-gate studies, so-called Environmental Protection Declarations (EPD).

In a parallel effort, the business unit is consistently working to lower its own carbon footprint.

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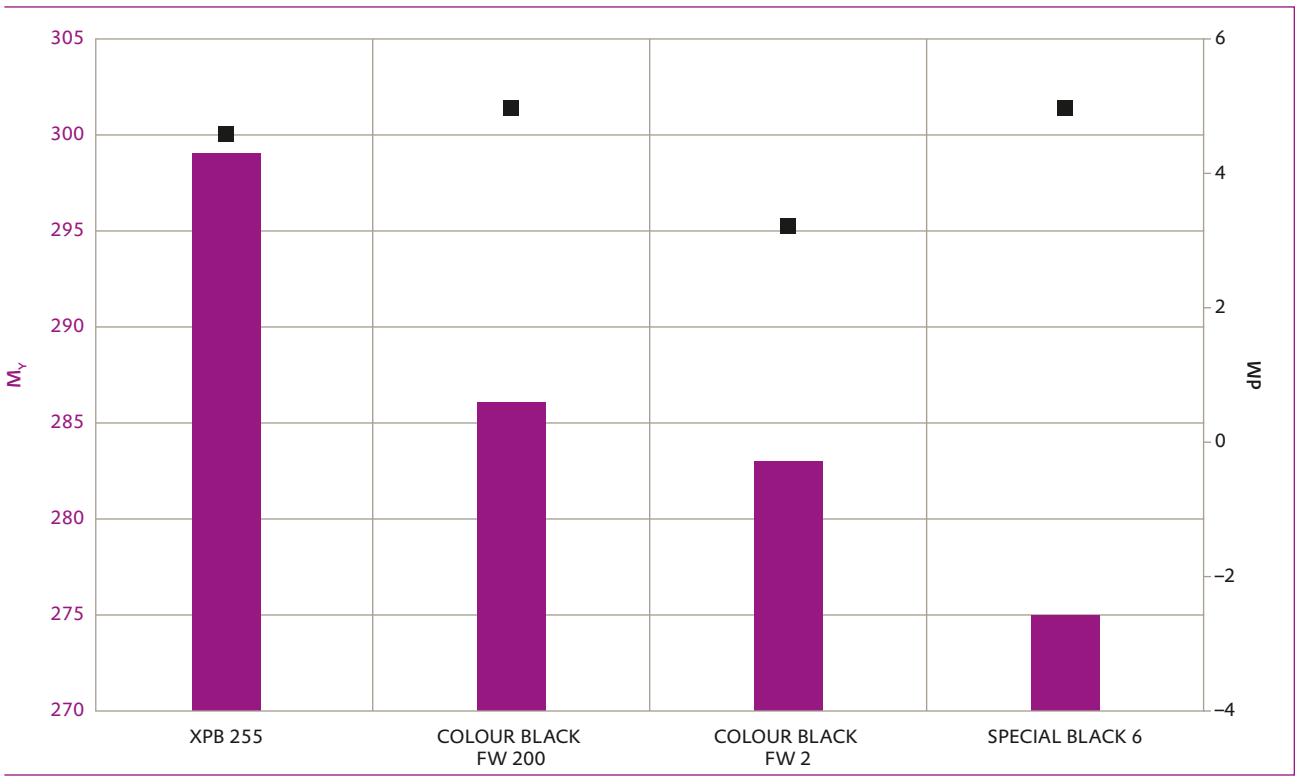
New High Jet Carbon Black Pigments for Water- and Solvent-borne Coatings

The performance requirements of Carbon Black Pigments used for automotive coatings are becoming increasingly stringent with regards to high jetness and bluish undertone. The mean primary particle size as well as particle size distribution of Carbon Black aggregates have the greatest influence on coloristic properties of the coating.

Generally, in case of masstone, the jetness increases with decreasing mean primary particle size of the Carbon Black Pigment. For years, Evonik Carbon Black GmbH has been offering pigments for high-jetness applications that are manufactured by either the Degussa gas black process or the furnace black process. Several years ago, we announced with COLOUR BLACK FW 171a new high-jetness Carbon Black Pigment for waterborne coatings.

To retain the special particle design of COLOUR BLACK FW 171 (e.g. small primary particle size and a narrow particle size distribution) and to achieve a Carbon Black Pigment compatible with solvent-borne coatings, the EXPERIMENTAL GRADE XPB 255 was developed. XPB 255 is manufactured by after-treatment of COLOUR BLACK FW 171. This after-treatment process generates a polar Carbon Black surface that improves the stabilization of the Carbon Black Pigment in solvent-borne coatings resulting in a high dM value, i.e. a high bluish undertone. The graph demonstrates that in an alkyd/melamine stoving enamel XPB 255 achieves comparable dM values to the wellknown grades COLOUR BLACK FW 200 or SPECIAL BLACK 6, but a significantly increased jetness value – resulting in a much deeper visible blackness. XPB 255 furthermore combines a constant high jetness (high M_Y value) in different solvent-borne coating systems with a surprisingly high jetness in waterborne coating systems for an after-treated Carbon Black Pigment. Based on this, it can be used on a broad variety of different coating systems.

Alkyd/melamine stoving enamel. (Pigment concentration 5% related to binder (solid)



$M_Y = 100 \log[1/Y]$, $dM = M_C - M_Y$, $M_C = 100 \{\log[X_n/X]-\log[Z_n/Z]+\log[Y_n/Y]\}$

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Radiation-curing and Cost-efficient – Versatile New High Performance Additives from Tego

TEGO® Rad 2010 and 2011 are an entirely new class of cross-linkable multifunctional additives for radiation-curing coatings and printing inks. TEGO® Rad 2010 and TEGO® Rad 2011 offer more than other non-cross-linkable additives.

Because of their high cross-linkability (5 to 6 reactive acrylic groups per molecule) they can be quickly incorporated and their effect lasts longer. Wetting, flow and leveling, slip and release can be easily adjusted either individually or in combination using these new radiation-curing additives. The good cost/benefit ratio enables cross-linkable high performance products to be used even in price-sensitive areas.

During application, TEGO® Rad 2010 results in greatly improved wetting and reduced surface smoothness. TEGO® Rad 2011 is particularly suitable for improving the flow of the formulation but can still be easily overprinted.

TEGO® Rad 2010 and TEGO® Rad 2011 do not generate foam reducing the need for defoamers and save cost. They are free of organic solvents and are 100% active substance.

Get the full information on these new products at the ECS!

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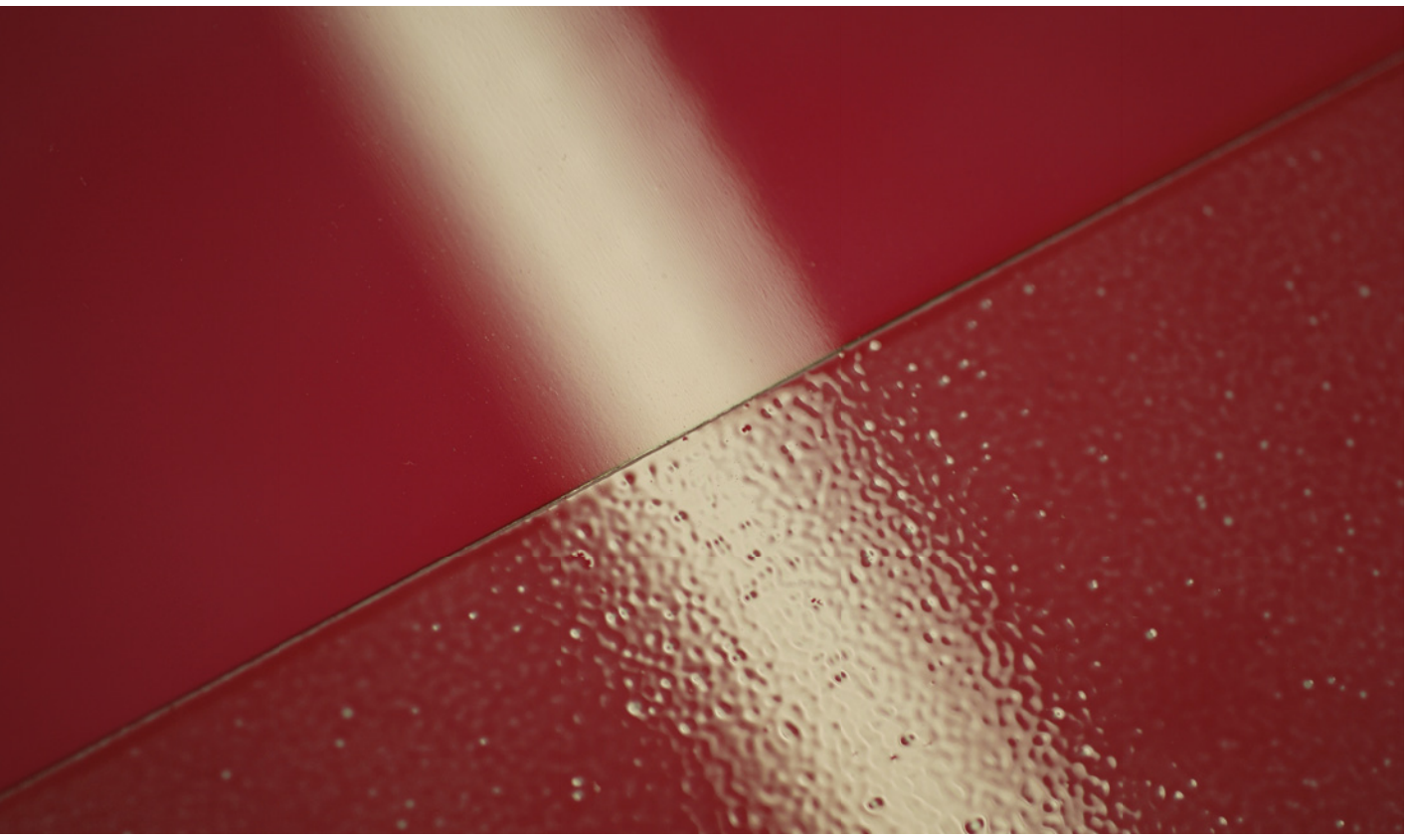
Substrate Wetting Can Be so Easy

Without doubt, waterborne coatings and printing inks are state of the art. Compromises in, for example, the optical properties of the final finish, are rarely acceptable nowadays. With optimal wetting of the substrate by the waterborne coating/printing ink, the formation of a continuous, defect-free film, plays a decisive role in achieving a perfect finish.



TEGO® Twin 4100 – Outstanding anti-cratering effect

Because of their relatively high surface tension, waterborne formulations, in particular, pose problems in wetting substrates such as metals, plastics, wood, printed paper or cards. If the substrate is contaminated by dirt, dust or fingerprints, it is almost impossible to obtain ideal wetting. The lower the co-solvent content of the formulation, the more problematical it is during application.

Substrate wetting additives are helpful as they significantly reduce the surface tension of waterborne coatings and printing inks thus permitting ideal wetting of diverse substrates. Siloxane-based structures are particularly effective anti-cratering additives where internal and external contamination is present.

One disadvantage is that additives frequently lead to foam stabilization in the waterborne coating.

Wetting without foam stabilization:
With TEGO® Twin 4100, the new substrate wetting agent from the family of Siloxane Gemini Surfactants, Evonik Tego offers paint formulators the capability of achieving optimal wetting without foam stabilization.

The unique combination of Gemini structure and siloxane surfactant confers maximum effectiveness on TEGO® Twin 4100 as well as a unique property profile in many applications.

Its very good wetting characteristics are accompanied by outstanding flow and leveling and excellent anti-cratering. With this combination of properties, this solvent-free additive is almost universally suited for use as a substrate wetting additive in waterborne formulations.

TEGO® Twin 4100 shows its strength particularly in modern waterborne formulations which are often formulated with low co-solvent content – and without stabilizing foam.

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REACH – A European Project

The European chemicals regulation REACH was introduced in the summer of 2007 to improve protection for humans and the environment.

The first stage of the regulation called for pre-registration. This gave manufacturers the opportunity to gather all necessary data before the submission of the actual data file – or dossier – to ECHA, the European Chemicals Agency.

According to the regulation, November 2010 was the deadline for registering all substances with an annual production volume exceeding 1,000 metric tons and those with certain hazardous properties as well as the corresponding imported chemicals. The registration of the next volume range will close in mid-2013, and the full scope of REACH will be implemented by 2018.

ECHA reviews every data set in great detail. Once a substance passes this review, manufacturers are given permission to continue production.

Evonik completed all required registrations for large-volume products successfully. This means that the registered products can be placed on the market furthermore. The new material safety data sheets include detailed descriptions of properties and registered product uses.

Additionally, these data sheets also include new classifications and labeling requirements that result from the regulation on the Globally Harmonized System (GHS) of classification and labeling of chemicals, which is to be observed in parallel. In Europe, this regulation is also known under the acronym CLP.

The **REACH Regulation** (**R**egistration, **E**valuation, **A**uthorisation and Restriction of **Ch**emicals) has been phased in since June 1, 2007 in the European Union. Under REACH, substances may only be produced or imported if they were registered in advance.

The **GHS Regulation** (**G**lobally **H**armonized **S**ystem of Classification and Labeling of Chemicals) regulates the classification of chemicals in accordance with a standardized global system. It also specifies the labeling of substances on packaging and in material safety data sheets.
The EU has specified the practical implementation of the GHS Regulation in its **CLP Regulation** (Regulation on **C**lassification, **L**abeling and **P**ackaging of Substances and Mixtures).

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Ambient-temperature Cure: Polysilane Coatings Exhibiting 2K-PUR Performance

The Business Line "Crosslinkers" of Evonik has developed a concept for isocyanate-free 2 component ambient temperature cured coatings exhibiting smooth surface appearance, superior scratch resistance with excellent overall chemical and weather resistance.

Aliphatic 2K-PUR coating technology is the global industry standard for high performance due to outstanding weathering durability, chemical resistance, balance of hardness and elasticity as well as low temperature cure response.

One of the main technical hurdles for alternatives to aliphatic 2K-PUR technology was the requirement for low temperature cure in various applications like construction, plastic coatings, fleet coatings, aircraft coatings, etc.. Nevertheless, there is a demand for specific performance in certain critical applications requiring for example superior scratch resistance which cannot be met sufficiently with conventional 2K-PUR.

Evonik introduced the original concept of silane-PUR-hybrid crosslinking for scratch resistant thermosetting automotive OEM clear coats by the use of partially silane-modified polyisocyanates in the past (1).

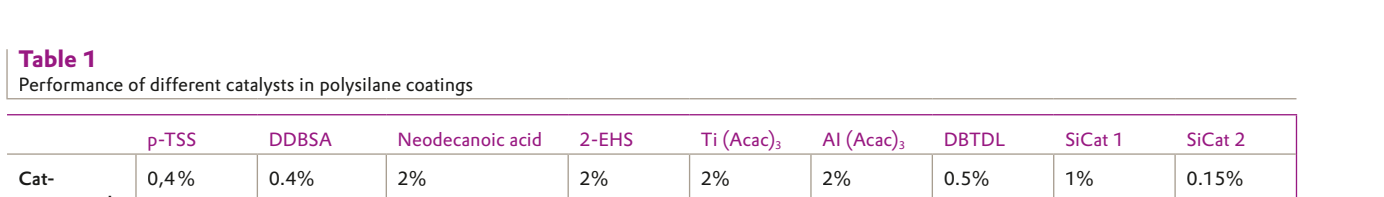
This concept was the basis for the newer concept of ambient temperature curing polysilane systems exhibiting superior scratch and chemical resistance described below.

The polysilane concept

Silane based coatings, e.g. sol-gel systems, very often exhibit poor flexibility due to the high crosslink density and high silicon content. This is one of the reasons why such silane based systems are typically used only as thin film coatings (< 5 µm).

In order to avoid the brittleness, Evonik designed a resin concept consisting of an oligomeric polyfunctional silane and an acrylic polyol providing good balance of organic and inorganic moieties.

Due to the potential reaction of silanes with polyols and water and their high tendency toward self condensation in highly catalyzed systems, the polysilane has to be separated from the other paint components by establishing a 2 component concept (Figure 1).



Coated panels after wet abrasive test: left: 2K-PUR control, right: polysilane clearcoat

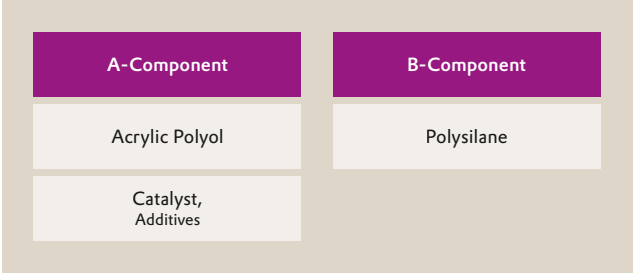


Figure 1
Polysilane coating concept

Results

The use of typical catalysts for silane crosslinking such as sulfonic acids and inorganic acids did not result in acceptable curing performance at the required low temperatures. Therefore a different catalyst approach had to be developed. Evonik succeeded to identify different catalyst types, "SiCat I" and "SiCat II", providing excellent ambient temperature cure response.

Table 1
Performance of different catalysts in polysilane coatings

	p-TSS	DDBSA	Neodecanoic acid	2-EHS	Ti $(Acac)_3$	Al $(Acac)_3$	DBTDL	SiCat 1	SiCat 2
Cat-concentration	0,4 %	0.4%	2%	2%	2%	2%	0.5%	1%	0.15%
Gelation time	< 1 h	10.5 h	> 24 h	> 24 h	> 24 h	> 24 h	2–3 h	8 h	11 h
Dust dry time	Gel particles, poor surface	Gel particles, poor surface	after 2 days: tacky	after 2 days: tacky	after 2 days: tacky	after 2 days: tacky	after 2 days: tacky	150 min	505 min

The results listed in table 1 demonstrate the superior activity of the SiCat-systems vs. standard silane catalyst: The balance of gel time and dry time was in the range of standard 2K-PUR coatings, whereas sulfonic acids exhibited a very unfavorable balance of potlife and reactivity of the paint. Carboxylic acids as well as Lewis acid catalysts like DBTDL or metal acetylacetonates failed.

In contrast to many other crosslinking chemistries like PUR or epoxy, a clearly defined stochiometry in silane/polyol systems cannot be established due to the fact that crosslinking of these systems mainly occur via self condensation of the silane groups.

To determine optimum performance parameters, a polysilane resin (VESTANAT-EP-SP 786) was formulated empirically with varying amounts of acrylic polyol (Setalux® C 1767, Nuplex Resins) while maintaining the catalyst (SiCat I) level at 1 pbw calculated on resin. Mixing ratios of resins were 70/30, 60/40 and 30/70 respectively.

The 70/30 and 60/40 blends displayed excellent hardness development with acceptable potlife and dry times ▸▸▸

Table 2
Performance data of polysilane coatings vs. 2K-PUR control (ambient temperature cure)

	blending ratio Polysilane/Acrylic[1]			PUR control Acrylic[2]/HT2500L
	70/30	60/40	30/70	OH: NCO = 1:1
Cat-level, SiPUR-Cat	1%	1%	1%	0.02% DBTDL
Gel time [h]	7.75	7.75	14.5	10
Dust dry time [min]	210	185	210	300
Touch dry [h]	3.25	3	3.5	appr. 6.5
Hardness, König [s]				
1d	85	36	21	48
3d	115	123	23	158
7d	144	136	26	178
Impact res. [inlbs]	60	40	30	>80
Erichsen cupping [mm]	3.0	3.5	9.0	8.0
Gasoline res. after 1d	++	++	++	++ 3d
MEK double rubs	>150	>150	20	>150
Scratch resistance: loss of gloss [% abs.]	2	3	11	36
Solids Content (pbw, calc.) at spray	48.8	47.5	45.0	47.0

[1] Acrylat = Setalux® 1767 (Nuplex Resins) [2] Macrynal® SM 510n (Cytec)

compared to a standard 2K-PUR coating based on a medium-solids acrylic polyol, which is known for its technical performance (Macrynal® SM 510, Cytec) and HDI trimer (VESTANAT® HT 2500), (table 2). Due to its lower crosslink density, the performance of the 30/70 blend was insufficient. The scratch resistance of all polysilane coatings, performed as a wet abrasive test, was outstanding (see photographs). The one slight disadvantage of these novel coating systems is poorer flexibility vs. the 2K PUR control.

Other relevant performance aspects like general chemical resistance, weathering durability, re-coatability, etc. were on a 2K-PUR level. However, owing to the higher molecular weight of the polysilane crosslinkers the VOC contents of the polysilane based clearcoats were on a similar level as medium solids 2K-PUR systems. This problem might be overcome by an improved polysilane resin design as a next step of development or by the use of VOC-excempt solvents.

Applications

Due to their excellent ambient temperature cure response, these isocyanate free polysilane coatings can, in principle, be used as an alternative to 2K-PUR coatings such as for fleet coatings, car repair- and OEM-coatings, wood- and plastic coatings, etc., or wherever superior scratch resistance is required.

Most developmental NISO systems (non-isocyanate) in the past could not reach the performance level of 2K-PUR coatings. Therefore, commercial success has been limited. The technology presented here can be considered as a very competitive alternative to both the NISO systems of today or 2K-PUR.

Silane chemistry does come with a higher cost compared to many other crosslinking technologies. This also applies to these experimental polysilane systems. As a lower cost alternative, the polysilane components can also be used as co-crosslinkers to improve the scratch resistance of 2K-PUR coatings, by addition of the polysilane to the B-component containing the polyisocyanate.

(1) Lomölder, Plogmann, Speier in "Proceedings of the 28th Intl., Waterborne, High Solids and Powder Coatings Symposium", New Orleans, 2001, p. 261–274.

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Evonik Plans Capacity Expansion in Isophorone Chemistry

Evonik Industries intends to construct a new production plant for isophorone and isophorone diamine. A suitable site is being sought, and economic and strategic market factors play an important role in this decision. Production is scheduled to start in 2013. The Board of Management of Evonik Degussa GmbH has now approved the plant project plan.

"We strive for meeting our customers' expectations and future needs best possible regarding costs and geographic proximity," says Gerd Brand, head of the Crosslinkers Business Line. "So we're particularly looking at attractive investment climates in South-East Asia and China and will take these into consideration when taking the final decision for the location of our new plant."

Evonik is the only company in the world to produce and market the entire isophorone line, consisting of isophorone, isophorone diamine, isophorone diisocyanate, and derivatives. These products are used as component in a wide range of applications, for example, in the production of industrial floorings, artificial leather, in a variety of coating applications like marine and anticorrosive paints, automotive OEM and repair or can-, coil- or powder coatings. Relevant non-coatings applications are high performance PUR elastomers, or epoxy composites for e.g. rotor blades for wind energy turbines.

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Life Cycle Assessments (LCA) for Isophorone and Derivatives

The environmental impacts of products along their entire life cycle are determined in what is known as life cycle assessments (LCA). In tradition to taking into account the production of each individual product, the LCA performed in accordance with DIN ISO 14040/14044 also analyses the ecological "backpack", like the raw materials used and their production. Also, the rest of the life cycle through consumption all the way to disposal can be discribed. The LCA currently focuses on the CO_2 balance, known as the "carbon footprint".

Together with the Life Cycle Assessment team of the Eco² Science-to-Business Center the Business Line Crosslinkers of Evonik has analyzed in accordance with DIN ISO 14040/14044 the major products of its isophorone chemistry such as VESTASOL® IP (isophorone), VESTAMIN IPD® (isophorone diamine), VESTANAT® IPDI (isophorone diisocyanate), VESTANAT® T 1890 (IPDI-Trimer) as well as VESTANAT H12-MDI®, the latter of which not being an isophorone derivative.

The environmental impacts during production itself were taken into consideration, as well as those of upstream processes (such as production of raw materials like acetone). The environmental relevant withdrawals from the environment (such as crude oil) as well as emissions into the environment (such as wastes and carbon dioxide) were also taken into account in the investigation.

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vestasol
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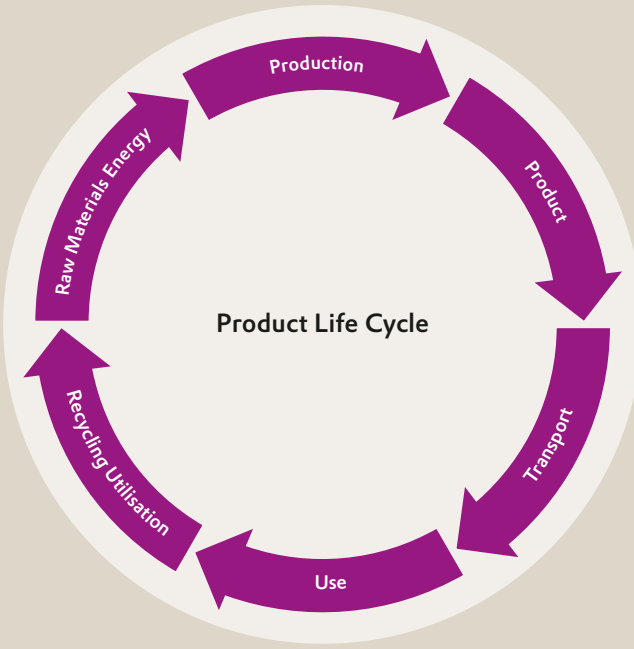

Evonik Colortrend Offers New Color Solutions for Industrial and Decorative Applications

Speed, reliability, flexibility and innovation are clearly the most critical success factors 'in the eyes' of Industrial and Architectural colorant customers. These are the findings from a 2009 survey conducted by Evonik Colortrend across 28 European countries.

Extensive Color Formulation support is part of Evonik Colortrends offering of customized Color Solutions

As a consequence a redefined customer strategy has been introduced, providing flexible color and performance driven colorant solutions. The recent investment in the High Throughput Equipment (HTE) not only shortens development and "Time to Market" but innovatively demonstrates this Evonik Colortrend focus.

Color solution development is a delicate "balancing act" of meeting environmental requirements & obtaining the broadest color space coverage whilst maintaining the performance & integrity of the customer's coating system. For decorative applications this apparent contradiction is solved by offering customers the required flexibility with a customized colorant selection supporting the widest color space and maximum flexibility to meet "ever-changing" market demands.

Significantly different requirements are necessary for colorants in Industrial applications. Here new colorant developments combined with a brand new "tailoring" concept achieve the optimum balance of color space coverage whilst maintaining the customer specific performance requirements of individual coatings.

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High Performance Combined with Eco-compatibility

Three new TEGO® Dispers products for pigment concentrates

The new products, TEGO® Dispers 653, TEGO® Dispers 656 and TEGO® Dispers 741 W have been developed with a clear focus on decorative coatings and offer the possibility of formulating pigment concentrates which meet ECO-Label requirements.

TEGO® Dispers 653 and TEGO® Dispers 656 are particularly suited for formulating universal pastes, i. e. waterborne pigment concentrates which can be used in *waterborne* paints and in *solvent-borne* decorators paints. Universal pastes based on TEGO® Dispers 653 and TEGO® Dispers 656 impress with their good compatibility and resistance to weathering. They are also suitable for tinting architectural paints.

Evonik Tego has enabled the use patented polyether technology in the development of both products. Because of their anionic character and special pigment-affinic groups, TEGO® Dispers 653 and 656 are equally suitable for stabilizing organic and inorganic pigments.

TEGO® Dispers 653 is the prime choice for developing a complete range of pigment pastes. TEGO® Dispers 656 is recommended for use as an alternative, or in combination, to optimize the compatibility of pigment concentrates in critical solvent-borne paints. It is also particularly good for wetting and stabilizing aluminium pigments and transparent iron oxides.

TEGO® Dispers 741 W is outstanding for formulating pigment concentrates for *waterborne* paints. It meets the toughest requirements for today's high performance, eco-compatible additives for waterborne applications. It is not subject to marking requirements and is based on a sustainable raw material. Because of its special chemical modification, TEGO® Dispers 741 W is suitable for use in the three important classes of pigments: organic, inorganic and carbon black.

TEGO® Dispers is ideal for use in pigment concentrates in cost efficient, high performance decorative coatings.

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Reliable Spray Application of Waterborne Coatings Independent of Co-solvent Content

Despite physical constraints, waterborne coatings should be as easy to process as solvent-borne ones. The innovative low-VOC coatings show a particular tendency to exhibit wetting problems on substrates such as plastics or inadequately cleaned metals.

TEGO® Wet 240 produces reliable substrate wetting in waterborne, spray-applied, industrial coatings. TEGO® Wet 240 is extremely effective irrespective of co-solvent content and enables the optimization of waterborne coatings on critical substrates. Previously, several products were needed, but nowadays TEGO® Wet 240 can optimize the reliability of spray application of coatings. Intensive research resulted in a molecular structure which satisfies various demands such as:

- atomization
- excellent wetting of contaminated substrates and plastics
- good re-coatability
- broad compatibility and effectiveness

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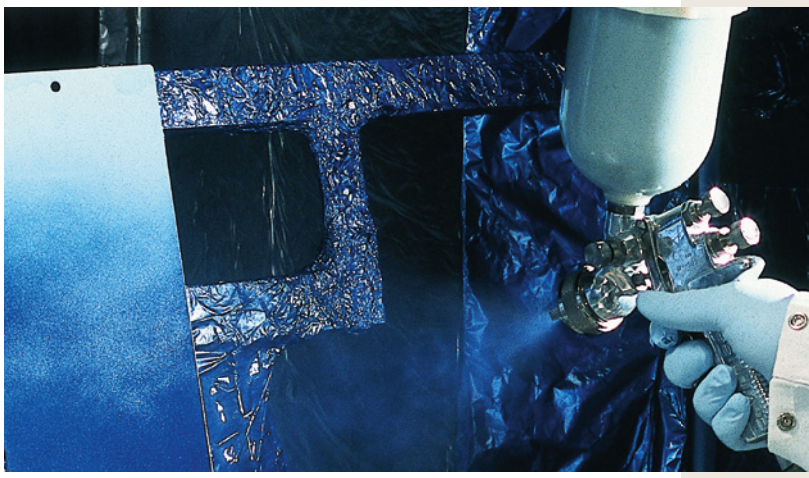

Special-purpose Silicone-free Defoamer for Waterborne Printing Inks for Food Packaging

TEGO® Foamex 831 is a special-purpose, silicone-free defoamer which meets strict new regulations for printing inks used on food packaging.

The product has been developed particularly for use in waterborne pigment concentrates. Strengths of this silicone-free defoamer include foam inhibition, rapid foam collapse and good long-term effectiveness.

TEGO® Foamex 831 does not contain silicones, mineral oils or solvents and can be used everywhere a positive approval for use with foodstuff is required (Swiss Ordinance 817.023.21, BfR XIV, Plastics Guideline 2002/72/EG).

Find out more at the European Coating Show 2011 or at www.tego.de

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European Coatings Show 2011 – A fixture in the trade show calendar for Evonik Industries

At the European Coatings Show in Nuremberg, Evonik presents innovative and forward-looking products and system solutions for the paints and coatings market as well as the adhesives and sealants industries. At this year's European Coatings Show between March 29 and 31, 2011, Evonik will be exhibiting a wide range of products.

The products will be presented at a large Smart Formulating booth, A-311, in hall 7A. The Smart Formulating concept has been used by the Group in the paints and coatings market for many years; it stands for our promise of close cooperation with customers for innovative, effective, and individual solutions for formulating modern coloring and coating systems. Presentation under the Smart Formulating concept is based on a division of a coating formulation into six "components", color coded as follows:

Reference color – Component:
- Additives
- Adhesives
- Coloring
- Matting
- Resins
- Crosslinkers
- Resin Components

The trade show booth and communication media are designed on the basis of these components and their color codes. With an outline sketch of the booth and a tabular listing of our product brands by component, we give you the option of immediately locating the right contact for your areas of interest without having to stop first at the information counter.

This year we've also pooled at the booth our range of products and services for the adhesives and sealants industries. The Evonik Adhesives & Sealants Team (EAST) consists of adhesives experts from the Coatings & Additives, Inorganic Materials, Performance Polymers, and Consumer Specialties Business Units. "The experts concerned meet regularly to exchange views and information. In this way we're able to exploit synergies, learn from one another, and, most importantly, offer our customers the best possible solution," says Dr. Wilfried Robers, spokesperson for the Coating & Bonding Technologies area of competence. EAST as part of this area of competence is headed by Dr. Ralf Düssel.

Dates

Smart Formulating
Trade Fair Appearances 2011

29–31 March 2011 | ECS | Germany, Nuremberg

13–14 July 2011 | Latin American Coatings Show 2011
Mexico, Mexico City

27–28 September 2011 | Eurocoat | France, Paris

28–30 September 2011 China Adhesives
China, Guangzhou

18–20 October 2011 | RadTech Europe
Switzerland, Basel

21–23 October 2011 | Abrafati | Brazil, Sao Paulo

23–25 November 2011 | Chinacoat | China, Shanghai

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