



HUBER ENGINEERED MATERIALS



PERGOPAK<sup>®</sup>

ORGANIC MATTING & EFFECT AGENTS



FOR THE COATING  
AND INK INDUSTRIES

## AN INTRODUCTION

Pergopak® matting and effect agents are organic thermoset polymethyl urea resins (PMU). They allow the creation of surface properties and visual and physical effects, which cannot be achieved by standard matting agents like silicas or waxes. Due to their chemical nature and structure, Pergopak matting and effect agents can be used alone or in combination with other matting agents in a variety of coating formulations.

The four Pergopak matting and effect agent grades provide a high performance balance of matting, clarity, rheology and abrasion resistance along with a pleasant feel versus that of matting agents alone.

As thermoset polymers, Pergopak products provide advantages in the overall resistance of the coating due to its hardness and non-melting properties.

Pergopak grades can be used in air-dry, baking and two component systems, including water-based, solvent-based and UV curing systems. However, Pergopak products cannot be employed in moisture-curing systems.

### The Four Pergopak® Product Grades

<b>Pergopak® M3</b>	D90 = 17 µm
<b>Pergopak® M4</b>	D90 = 14 µm
<b>Pergopak® M5</b>	D90 = 11 µm
<b>Pergopak® M6</b>	D90 = 6 µm



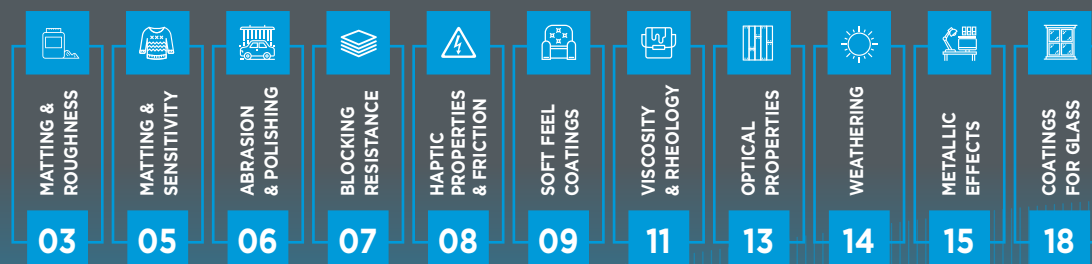
## PHYSICAL PROPERTIES AND DISPERSION

Pergopak is a voluminous powder of low bulk density and has an excellent degree of whiteness resulting from an almost 100% reflection over the entire ultraviolet and visible wavelength range. Primary particles, with an average particle diameter of 0.1 – 0.15 µm, form nearly spherical agglomerates of 3 – 9 µm. These agglomerates have a relatively high specific surface area and pore volume. Because of this special structure, Pergopak products achieve distinguished matting effects.

There can be manufacturing drawbacks with some low bulk density flattening

agents. Silica matting agents, for example, disperse well in the grind, but not in the let-down. Poor dispersion in the let-down means that it may be difficult to adjust the gloss of a batch during manufacturing.

Pergopak® organic matting agents disperse quickly and easily with relatively little dusting - in both the grind and the let-down. To see for yourself the power of Pergopak, visit [www.pergopak.org](http://www.pergopak.org) to see a visual comparison of Pergopak® M4 organic matting agent versus a silica matting agent when added to the let-down of a water based coating.





# THEIR VALUE VS. SILICA MATTING AGENTS





## MATting & ROUGHNESS

The particle size distribution of the matting agent is one of the key elements in determining the degree of matting in the coating. The rougher the surface, the more incident light is diffusely reflected, resulting in a matte surface. As Pergopak® organic matting and effect agents are available in different particle size distributions, the amount of matting can be directly influenced by the grade choice.

Other important factors that influence the degree of the matting effect include the coating application method, the binder type, coating thickness and pigment/volume concentration (PVC). Of course, all components of a coating, including wetting, dispersing, flow control agents, solvents and other ingredients influence the end performance of the coating. And external drying conditions like temperature and air ventilation have an impact on the shrinkage time, thus influencing the surface structure.

In figure 3 on page 6, different matting agents are compared as a function of loading level.

The particle size range of the different Pergopak product types and their effect on matting can be directly related to the roughness of the coating

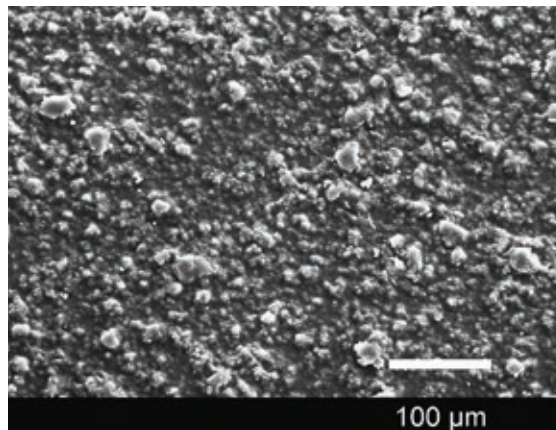


Figure 2: SEM image of a coating surface matted with a Pergopak® organic matting and effect agent

surface. The rougher the surface, the more matting effect is achieved. If a high matting effect is desired, a coarse Pergopak product grade should be used. On the contrary, if very smooth coating surfaces are desired, then the finer Pergopak product types are recommended. However, it is important to remember that more of the finer Pergopak types may be needed to achieve the desired matting effect.

Formulators may find that combining Pergopak organic matting agents with other types of matting agents like silica or waxes may lead to a synergistic effect. However, reduced levels of the Pergopak organic matting agent result in lower abrasion resistance or other properties. Therefore, laboratory tests are always recommended.

### Coating Gloss at 60°

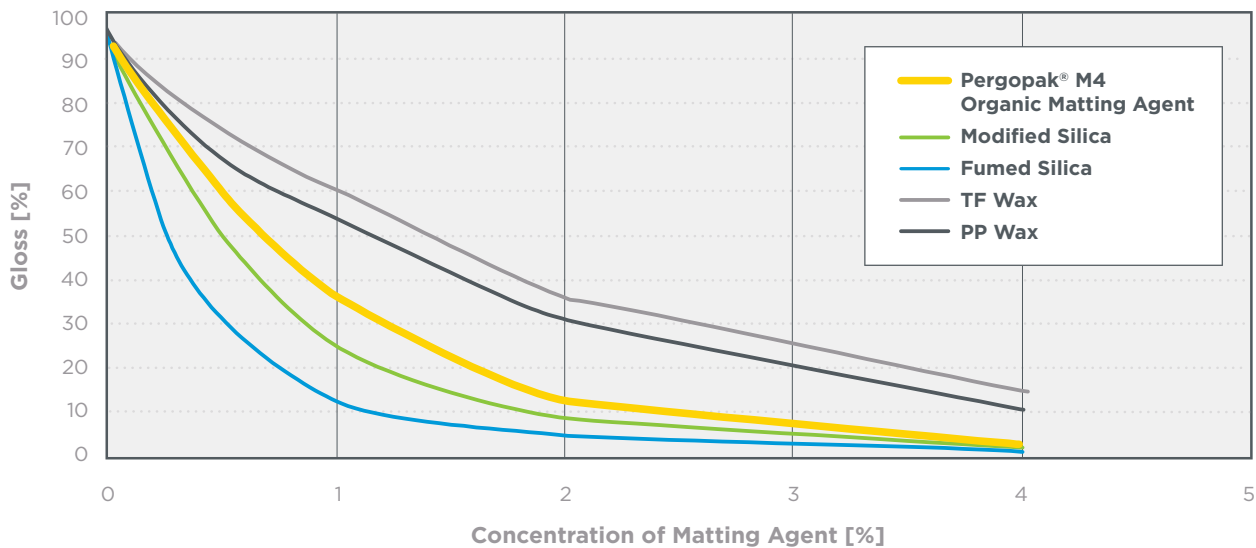


Figure 3: Comparison of different matting agents in a universal, solvent-based, two-component acrylic coating (solid content of the binder plus hardener ca. 30%)

### Comparison of Coating Gloss and Roughness of the Four Pergopak® Product Grades in a Coil Coating: Wet Film Thickness Approximately 25 µm

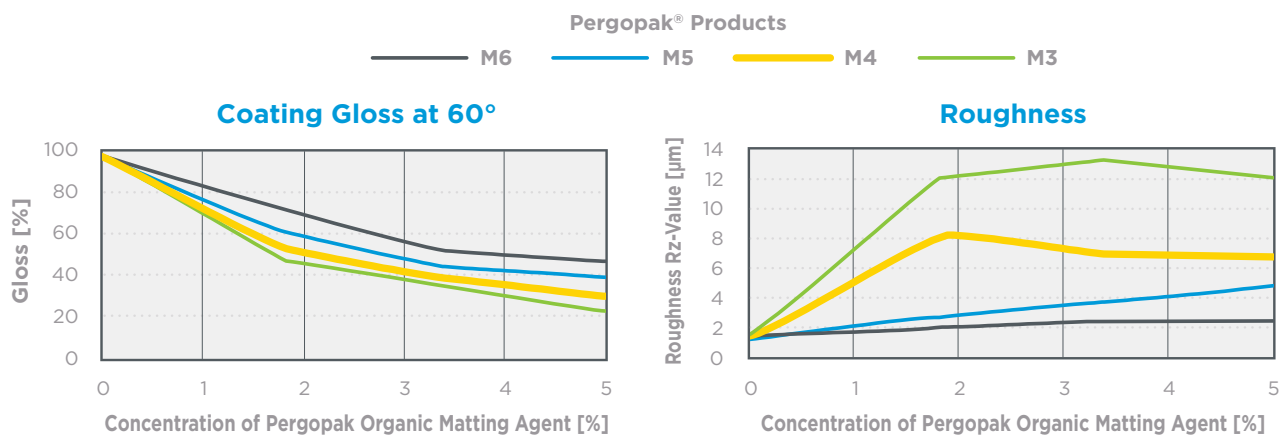


Figure 4

Figure 5: The graph shows the Rz values = the maximum roughness profile height

### Particle Size Distribution of Pergopak Products

Figure 6: Graphical comparison of the particle size distribution of different Pergopak products: This illustrates the relationship between the coarseness of the matting agent and the resulting roughness in the coating

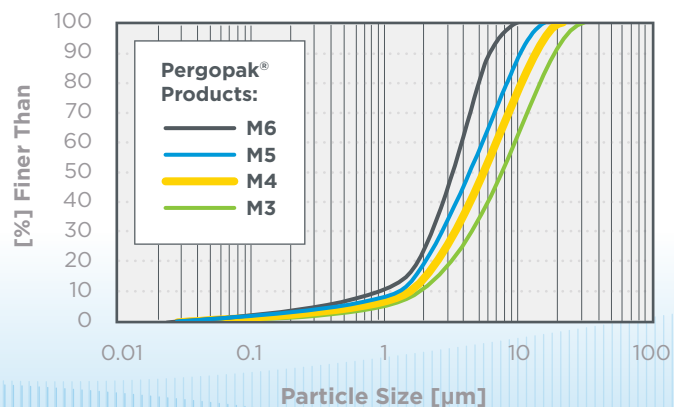


Figure 6





## MATting & SENSITIVITY

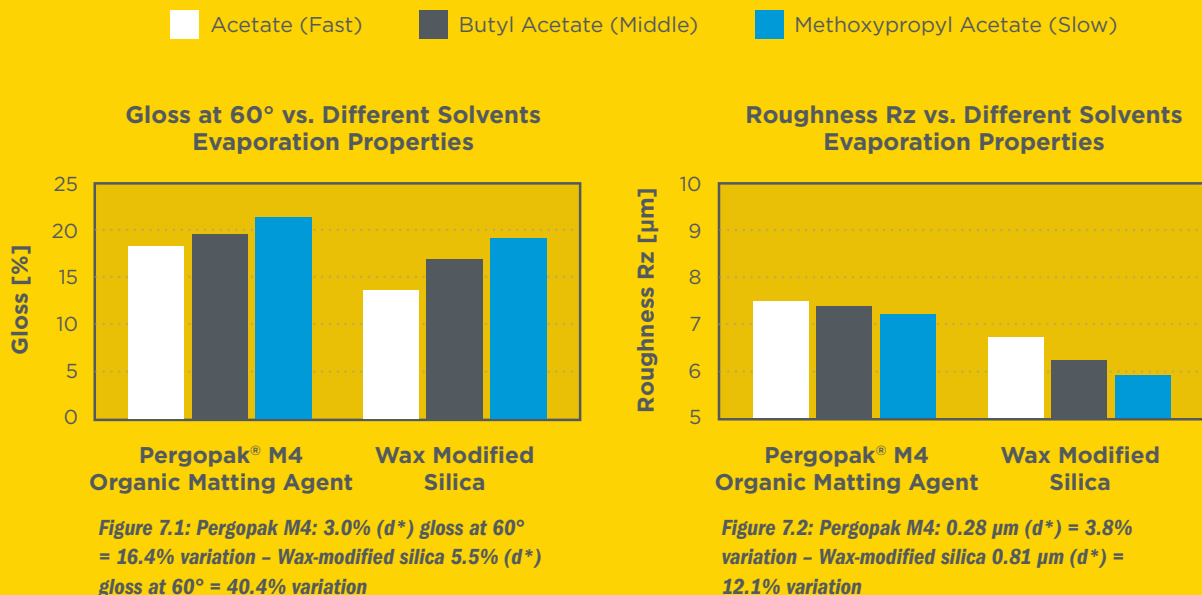
Coating formulations contain differing amounts of solvents. The intrinsic evaporation rate of the solvents and ventilation or temperature conditions influence the resulting matting effect. These factors determine the alignment of the different components of the coating, including the orientation of the matting agent particles.

Studies with Pergopak® organic matting and effect agents comparing different solvents in the same coating show

that the gloss development of organic matting agents is **less** sensitive to the solvent choice than coatings containing silica matting agents. Varying the drying temperatures or application conditions also shows the same trend.

Coatings containing Pergopak product grades are less sensitive to different applications and formulation conditions, so that the properties of the coating surfaces are more consistent.

**Two component acrylate coatings with about 35% solids contain 22% of the compared solvents. The solvents, having different evaporation properties, result in coatings with significant differences in the degree of gloss and roughness.**





## ABRASION & POLISHING GREATLY IMPROVES COIN-MARKING RESISTANCE

Experiments show that coatings containing Pergopak® organic matting and effect agents are more resistant to abrasion forces than coatings containing silica. This can be explained by the special properties of Pergopak products, which consists of very hard, near-spherical agglomerates. Their presence on the surface of coatings leads to higher mechanical resistance than other conventional matting agents. First, the resistance of Pergopak particles on the surface has to be overcome before the coating matrix can be damaged. Naturally, this effect greatly depends on the properties of the total system. Differences of the resistance of the coating to abrasion or polishing are also influenced by its mechanical properties (hard/brittle or elastic/tough).

Organic matting agents are very effectively incorporated into the organic matrix of coatings so that particles are difficult to remove. The near-spherical shape of the agglomerates along with the favorable slip and haptic properties enhances the mechanical resistance. These properties may allow the reduction of surface modification agents.

To test the mechanical properties of coatings, a modified scrub method was developed. Instead of using a hammer on which a scrubbing pad is bonded, an automatic oscillating device was employed. This method resulted in more reproducible test results as subjective factors are eliminated. Parameters like surface pressure, number of strokes and the kind of the scrubbing pad can be modified. A reflectometer measured the treated surface by using an image analysis method. This method combined techniques that compute statistics and measurements based on grey-level intensities.

When a polishing effect was observed the image analyses showed an increase in the number of darker grey pixels (blackening effect). If a scratching effect was observed then more pixels of lighter grey (whitening effect) were measured. The statistical evaluation of the reflectometer measurement results in a histogram that counts and graphs the total number of pixels of each grey scale in a diagram where the x-axis represents the color of the pixel. The numbers of the x-axis are by definition: 0 is equal to black and 8 is equal to white. The y-axis represents the intensity or frequency of the pixel.

A comparison of the position of the curve from the treated surface in the diagram to the curve of the control surface shows whether polishing or abrasion is occurring. When two different products are compared, then the position of the curves can be compared to distinguish which sample is more or less sensitive to abrasion or polishing. The figures below show that coatings with Pergopak® products are less sensitive than coatings containing silica matting agents.

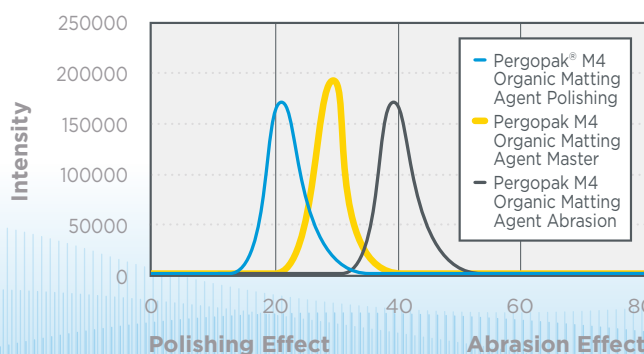


Figure 8.1

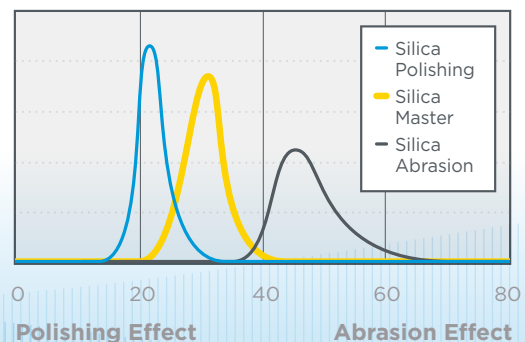


Figure 8.2



## BLOCKING RESISTANCE

Blocking resistance is an important factor for many coatings. If the blocking properties of a coating are insufficient, then the items will stick together.

Investigations with different matting agents and their influence on the drying process showed that organic matting agents have advantages regarding blocking resistance and the

development of early mechanical strength. The drying speed is enhanced by the high absorption capacity of Pergopak® matting and effect agents, and, in this case, this effect is not dependent on the particle size distribution of the Pergopak products used.

Investigations comparing different kinds of matting agents also show that sometimes synergistic effects of mixtures can be observed.

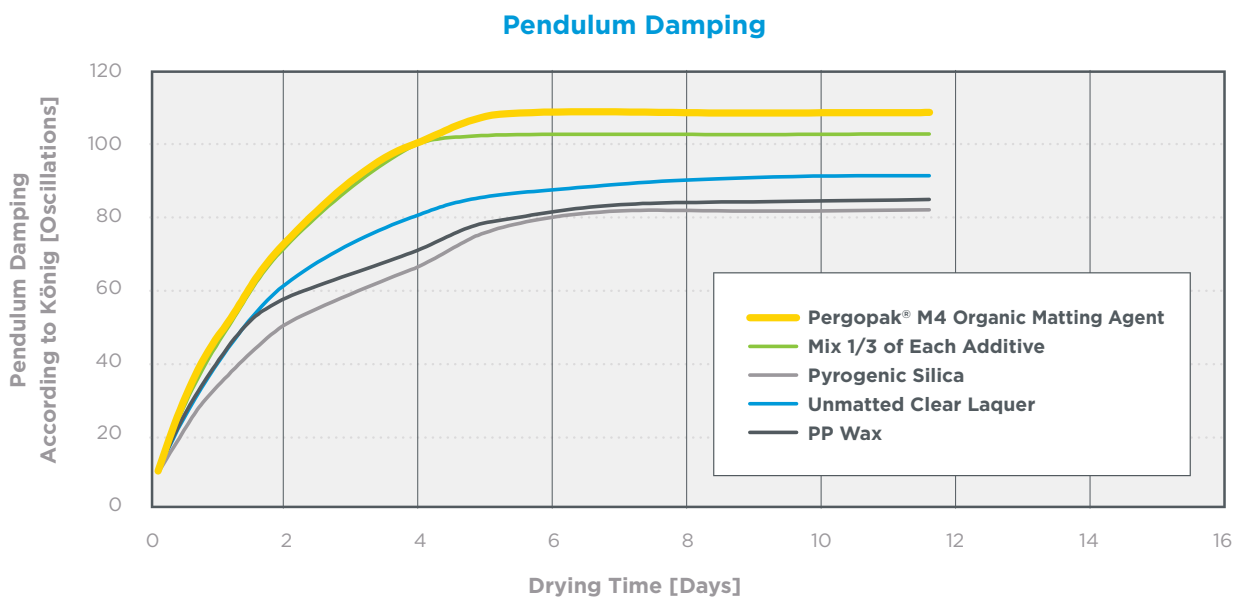


Figure 9





## HAPTIC PROPERTIES & FRICTION

Since Pergopak® matting and effect agents are organic molecules, they impart a significantly softer feel than silica matting agents. This desirable surface feel effect is comparable to surfaces modified with waxes, without adversely affecting recoatability.

The near spherical shape of the Pergopak agglomerates helps to produce the velvet soft feel and increases the slip of the surface. The round particles lead to sliding properties in the surface, resulting in a reduction in friction.

Compared to silica, Pergopak organic and matting agents decrease the static and dynamic friction especially when high levels of matting agents are used.

Explanation of static and dynamic friction: two surfaces will stick together until the sliding force (dynamic friction) is greater than the static friction. The surface will then slide over the other. Less force is usually needed to keep the object moving, thus the dynamic friction is less than the static friction. This is shown in the figure with a peak of the friction before the sliding starts.

The figures at right show the effects on the static and dynamic friction of a nitrocellulose coating by using varying amounts of different types of additives.

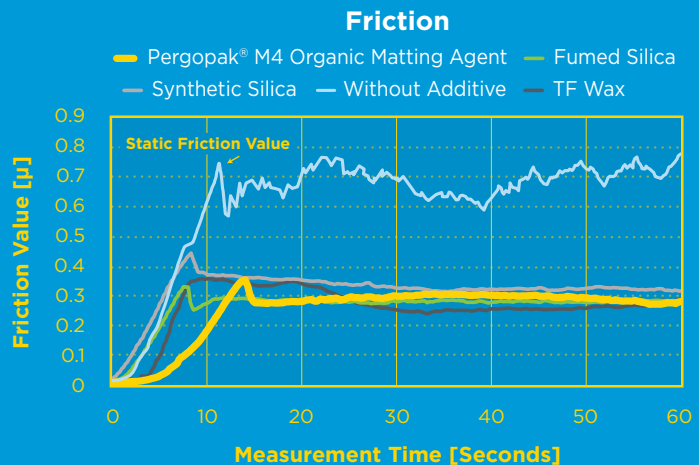


Figure 10: Difference in friction measurements for different additives (amount added ca. 2.5%) at similar degree of gloss 16-22% (nitrocellulose coating)

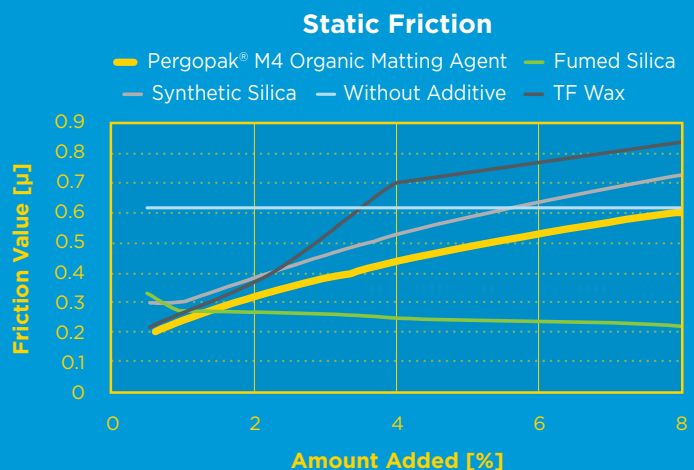


Figure 11

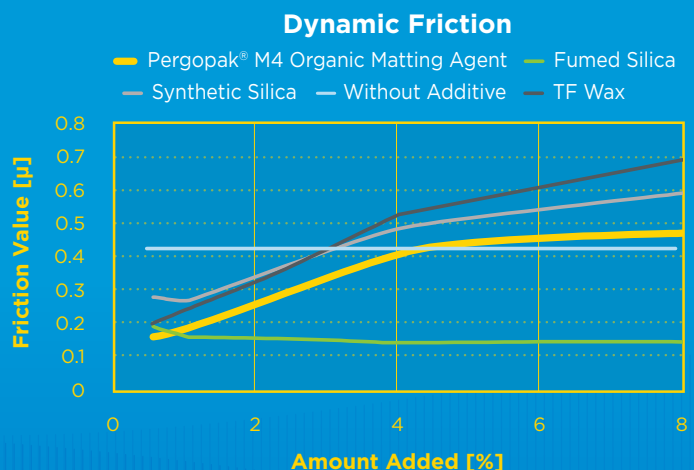


Figure 12



## SOFT FEEL COATINGS

Soft feel coatings give surfaces a pleasant, warm and soft “leather-like” feel. Typically these coatings, such as interior automotive dashboards, have a high degree of matting and demanding requirements for abrasion and scratch resistance. Pergopak® organic matting and effect agents are ideal for use in soft feel coatings when combined with appropriate binders. The narrow particle size distribution and the shape of the particles intensifies and promotes the soft-feel effect. The special organic structure of a Pergopak product incorporates readily into the organic matrix, producing highly scratch and abrasion resistant coatings without affecting the elastic properties. The surfaces are smooth and have a vibrant leather-like texture that makes the soft feel effect.

The high degree of matting in these coatings may make it necessary to employ silica in combination with the Pergopak products. Laboratory tests must be carefully conducted to find the optimum ratio of organic to inorganic matting agents. One important consideration is that the mechanical surface properties like scratch resistance and flexibility can be adversely affected by the presence of silica. In principle, the use of waxes is also possible to meet certain coating parameters. However, waxes have a softening point and their reduced temperature resistance may cause coatings containing them to have a reduced resistance to polishing. Polishing resistance is a special requirement for interior automotive coatings, so the use of waxes is limited in this application.

### Applications

- + **Dashboard Car Interiors**
- + **Entertainment Electronics**
- + **Furniture**
- + **Leather & Upholstery**
- + **Communication Electronics**

### Coating Systems

- + **Solvent-Based**
- + **Water-Based**
- + **UV Curing**





## VISCOSITY + RHEOLOGY

Silicas are efficient matting agents, but when high amounts of silica are required, the viscosity of the coating is often greatly increased. A viscosity increase can lead to application problems.

The advantage of Pergopak® organic matting and effect agents is that significant gloss reduction can be achieved with an increased amount of Pergopak, but the viscosity is lower than formulations containing silica. Another benefit is that rheological properties like thixotropy remain unchanged when a Pergopak product is used.

Often, formulators opt for a combination of silica with a Pergopak product, which enables one to optimize the gloss and viscosity values. This leads to more formulation flexibility as the rheological properties are no longer the limiting factor.

Coating application methods require a shear-thinning behavior. An ideal rheological behavior is that the viscosity builds up after application, slow enough so that the coating shows good leveling, but also fast enough to prevent dripping or sagging of the coating. These rheological properties demand a significant amount of optimization work by the formulator.

The figures on the following page shows the viscosity values versus shear rate. The continuous lines of the curve represent the viscosity values with increasing shear rate and the dashed lines represent the values of decreasing shear rate (back). Since the viscosity decreases with increasing shear rate, the coating is considered shear-thinning. Also the samples where the increasing and decreasing shear rate curves do not track exactly on top of one are examples of thixotropic behavior.



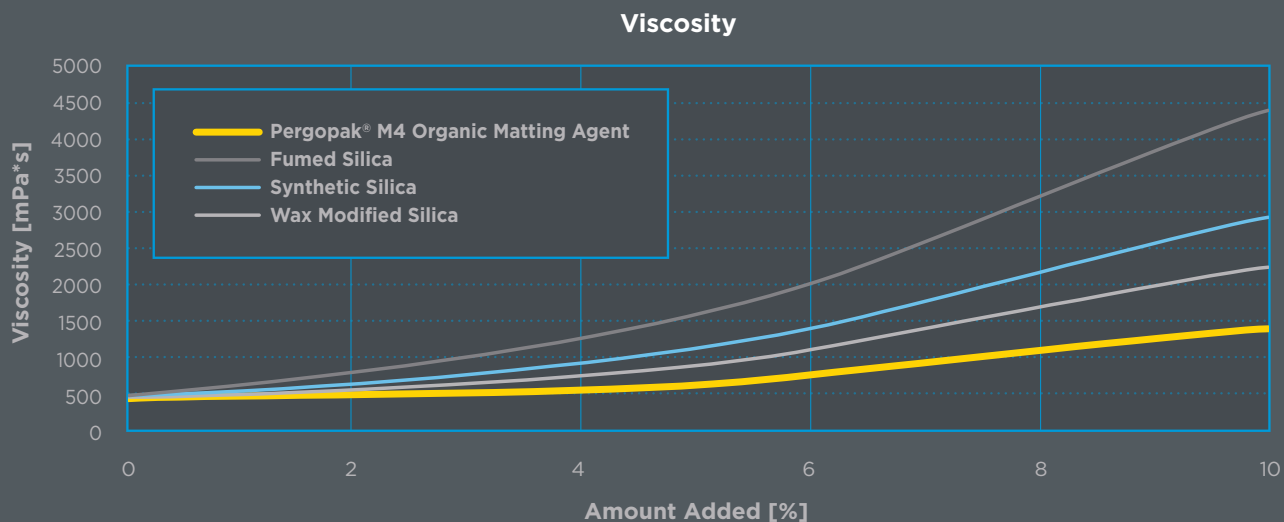


Figure 13: Viscosity as a function of the amount of additive in a high solid alkyd coating for DIY use

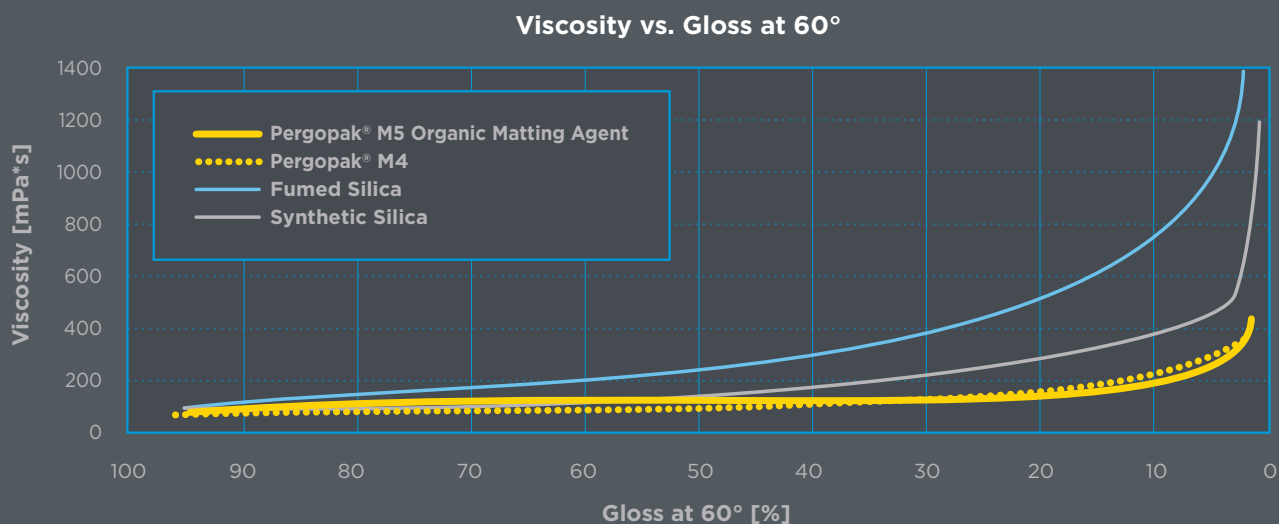


Figure 14: Viscosity as a function of gloss in a 2-C acrylic / nitrocellulose universal coating

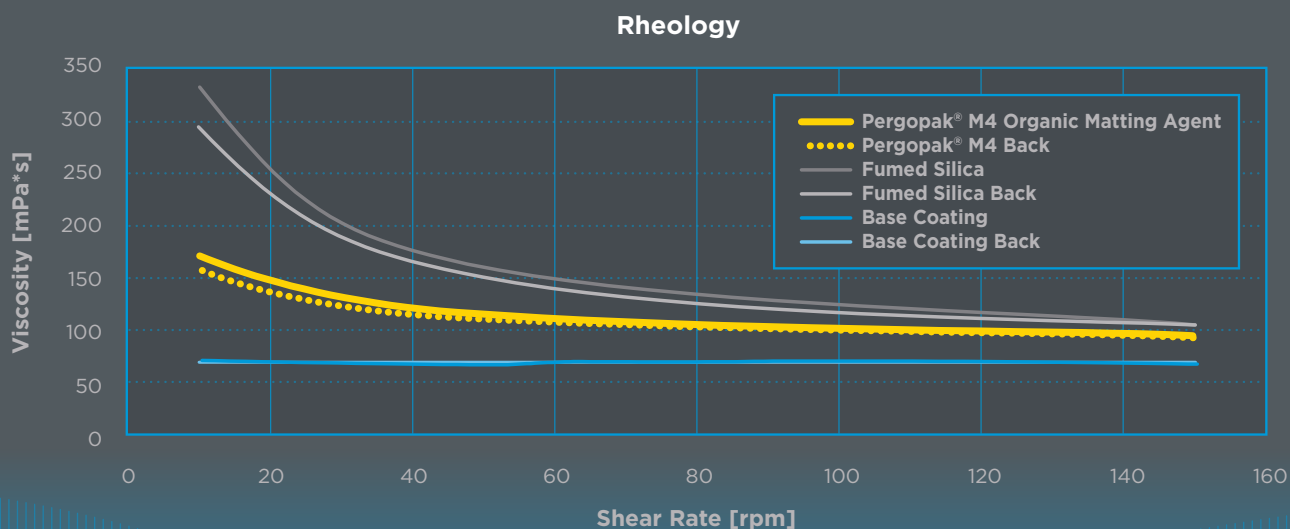


Figure 15



## OPTICAL PROPERTIES

### TRANSPARENCY

Pergopak® organic matting and effect agents are almost transparent in many coatings because the refractive index of a Pergopak product is often very similar to the refractive indices of dried binders. The incorporation of a Pergopak organic matting agent into the wet, unprocessed coating system may lead to a cloudy appearance, but this disappears upon drying.

Even with a high degree of matting, it is still possible with a Pergopak product to produce coatings with relatively low film turbidity. This allows formulations with a Pergopak organic matting agent to help comply with strict requirements concerning little change of color shade. When high levels of Pergopak are needed to create dull matte systems, the matte effect imparts a cloudy appearance. However, there is still a positive effect on the brilliance of the base shade.



Without Matting Agent



Fumed Silica



PP Wax



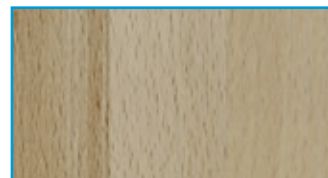
Pergopak® M4 Organic Matting Agent

### ANFEUERUNG (WARM-LOOK)

Especially for wood coatings a “warm-look” is desired. Pergopak organic matting agents help accentuate the “warm-look” of wood as the organic matting agents have a reduced impact on the optical characteristics when compared to silica matting agents which appear more “synthetic.” This is still the case even if higher amounts of organic matting agents are required to achieve the same degree of gloss.



Untreated Wood



3.5% Silica



4% Pergopak® M5 Organic Matting Agent

**Unvarnished beech wood compared to two matted 2-C acrylic varnishes. Gloss at 60° ca. 15%**



## WEATHERING

Lab experiments and long-term real world experiences show that Pergopak® organic matting agents in coating applications have positive effects on the UV stability of the film. In combination with some binders, the weathering resistance of the coating is improved. Since Pergopak is a hydrophilic matting agent, some tests

involving moisture or humidity may lead to turbidity. This turbidity normally does not affect the durability of the coating such as its resistance properties or its gloss. The choice of special binder systems or the use of hydrophobic additives can enhance the stability against moisture.

**Pergopak® has an excellent UV stability resulting from an almost 100% reflection over the entire wavelength range of 290 - 1100 nm**

- Pergopak® M4 Organic Matting Agent
- Fumed Silica
- Wax Treated Synthetic Silica

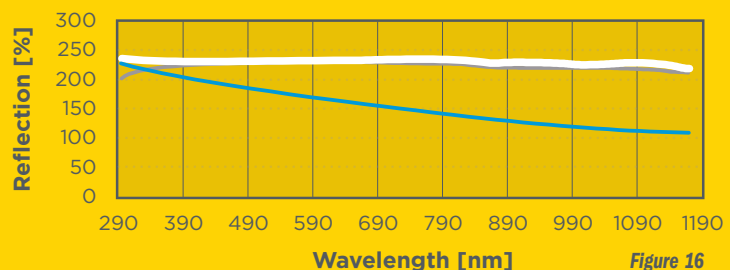


Figure 16

**2000 Hours QUV Test:**  
Four hours UV exposure at 360 nm, four hours 60°C condensation - alkyd coating, 200 µm spiral-draw-down

- Pergopak® M4 Organic Matting Agent
- ..... Pergopak® M6 Organic Matting Agent
- Synthetic Silica
- Fumed Silica
- Baseline Without Matting Agent

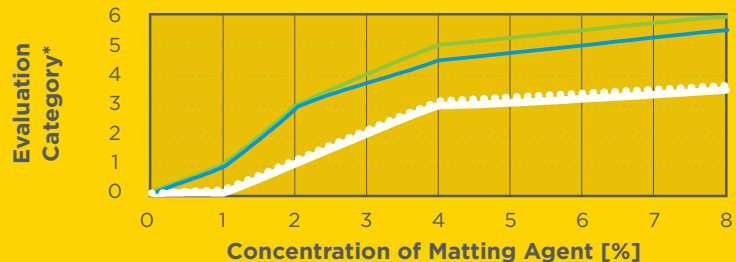


Figure 17: \*0 = Good stability; no visible change; 6 = bad stability: surface extremely damaged

**Change of Gloss at 60° - 1% Matting Agent**

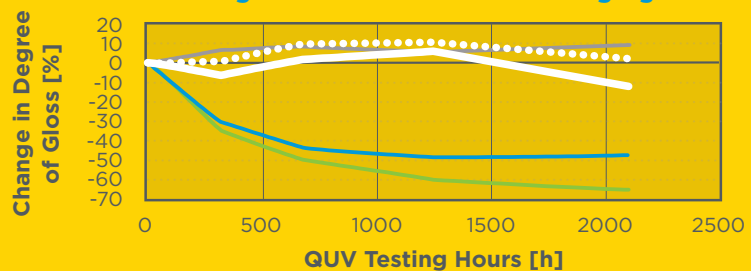


Figure 18

**Change of Gloss at 60° - 8% Matting Agent**

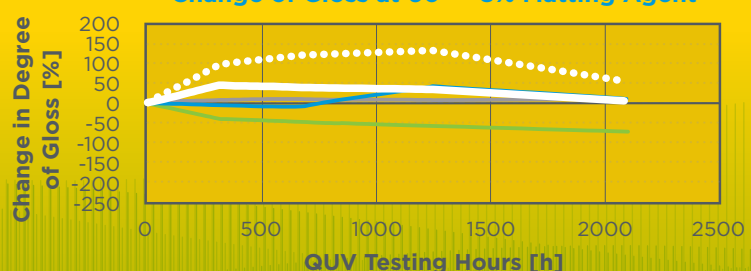


Figure 19



## METALLIC EFFECT COATINGS

Metallic effect coatings are typically produced with aluminum pigments being available in the form of flakes or platelets. In addition to the metallic appearance, the characteristic feature of metallic effect coatings is the so-called flip-flop effect. This is the change of brightness observed when the viewing angle is modified. This effect depends on the type of pigments and upon their alignment. Due to the platelet structure of these effect pigments, they orientate themselves in the medium parallel to the substrate.

The near-spherical shaped particles of Pergopak® organic matting and effect agents and their narrow particle size distribution influence the flip-flop effect of most metallic effect pigments. The incorporation of the Pergopak particles between the metallic pigment platelets leads to defined spatial separation of the pigments in the coating.

In contrast to wax additives that enhance the flip-flop effect, Pergopak grades will attenuate this effect. The brightness remains constant over a larger angle range and generates a more

uniform appearance. With a Pergopak organic matting agent, metallic effects become adjustable and this provides opportunities to reduce the flip-flop effect when it is not desired.

In applications where the change from dark to light with the viewing angle is distracting, Pergopak products can be used to reduce the magnitude of this color change. Pergopak grades generate greater diffuse reflection over a large viewing angle and, thus, allows very different optical properties without suppressing the metallic effect and brilliance.

The parallel alignment of the pigments is promoted by the fine Pergopak product particles that act as spacers between the metallic platelets. Preventing the platelets from tilting helps create a uniform brilliance at different viewing angles.

A combination of Pergopak with flip-flop enhancing wax additives may suppress a distinct flip-flop effect but this may help achieving the desired visual effect. Laboratory tests are necessary to confirm the optical properties for each specific application.

### General dosage recommendation of Pergopak® organic matting and effect agents to adjust metallic coatings:

To adjust metallic and effects coatings, a dosage of only 0.1% to 1% in the total system or 2% to 20% based on the metallic pigment is recommended.

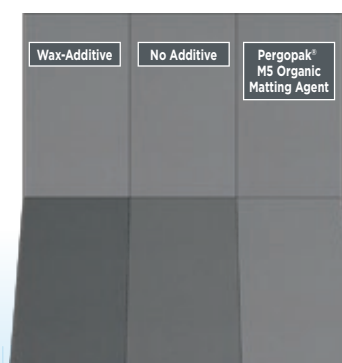


Figure 20

*Light 45° to the surface  
Observer 90° to the surface (45° to the light source)*

*Light 45° to the surface  
Observer 45° to the surface (90° to the light source)*





## CASE STUDY: THE USE OF AN ORGANIC MATTING AGENT TO MODIFY THE AESTHETICS OF INDUSTRIAL COATINGS MADE WITH ALUMINUM FLAKE PIGMENTS

BY STEVEN SERFASS, TECHNICAL SERVICE REPRESENTATIVE FOR COATINGS, SILBERLINE;  
AND MITCH HALPERT, SALES MANAGER, HUBER ENGINEERED MATERIALS

### BACKGROUND

Aluminum flake pigments are used to impart a brilliant look to coatings in a wide number of applications. Both the metallic effect itself, as well as the change in appearance from bright to dark as the viewing angle changes, are eye-catching. Formulators have a wide variety of metallic pigments from which to choose to achieve the aesthetics they seek, and this article introduces yet another option for modifying the appearance.

Organic polymethyl urea matting agents are used to lower the gloss of industrial coatings and overprint varnishes on their own or in combination with silica

matting agents. They are inert and, compared with other matting agents, impart more abrasion resistance and less thickening in coatings. The use of these same polymethyl urea matting agents impacts the aesthetic appearance of a coating made with a metallic pigment in two ways: it reduces the Flop Index and increases the “sparkle” effect.

### EXPERIMENT

A solvent-based coating consisting of a thermosetting acrylic resin and a 20 micron silver dollar aluminum flake pigment from Silberline was used as the control formulation. Formulations containing 5%, 10% and 15% (weight percent of aluminum

flake pigment solids) of a polymethyl urea matting agent (Pergopak® M4 organic matting agent) with a D50 of 6 microns were also produced. The metallic basecoats were applied using a robotic gun to reduce variability to a film thickness of 0.6-0.8 mils onto metal panels and cured at 250°F for 25 minutes. A clear acrylic topcoat with a film thickness of 2 mils was then applied to the basecoat and dried in a 250°F oven for 30 minutes.

The L values (brightness readings) from an X-Rite multi-angle spectrophotometer were measured at five different angles. (The higher the L value, the brighter/whiter the appearance.)

### RESULTS : CONTRAST / FLOP INDEX

The chart below shows the L value readings using an X-Rite color instrument at 15°, 25°, 45°, 75° and 110° angles:

SAMPLE	L@15°	L@25°	L@45°	L@75°	L@110°	FLOP INDEX A	FLOP INDEX B
SPARKLE SILVER® XTREME 20 CONTROL	153.98	109.97	55.23	31.57	27.90	10.82	18.33
SPARKLE SILVER® XTREME 20 5% PERGOPAK®	141.33	113.39	66.97	39.32	32.96	8.60	13.13
SPARKLE SILVER® XTREME 20 10% PERGOPAK®	136.21	114.20	70.42	40.18	33.90	8.15	11.80
SPARKLE SILVER® XTREME 20 15% PERGOPAK®	131.31	113.58	73.91	42.60	37.71	7.54	10.62

Aluminum flake pigments show a bright metallic look at one angle and a dark metallic look as you turn the panel. This is known as flop or movement. This is calculated with a “Flop Index.”

There are two flop index readings in the chart:

- Flop Index A uses the 25°, 45° and 75° measurements with the formula of  $\text{Flop Index} = (2.69 * ((L_{25} - L_{75})^{1.11})) / (L_{45}^{0.86})$ .
- Flop Index B uses the 15°, 45° and 110° measurement angles with the formula of  $\text{Flop Index} = (2.69 * ((L_{15} - L_{110})^{1.11})) / (L_{45}^{0.86})$ .

(<sup>1.11</sup> - indicates raised to the power of 1.11)

If a formulator needs to reduce the contrast (Flop Index) between the brightest and darkest angles, the addition of a polymethyl urea matting agent was found to reduce the high brightness values and increases the low brightness value.



## CASE STUDY CONTINUED: THE USE OF AN ORGANIC MATTING AGENT TO MODIFY THE AESTHETICS OF INDUSTRIAL COATINGS MADE WITH ALUMINUM FLAKE PIGMENTS

### RESULTS : SPARKLE INDEX

The Sparkle index (Si) and Sparkle area (Sa) were measured on a BYK MAC unit at 15°, 45° and 75° angles. The graininess was also measured on the BYK MAC. The table below shows that the addition of a Pergopak® organic matting agent increases the Sparkle index, Sparkle area and graininess as compared to the aluminum flake control panel without Pergopak.

SAMPLE	Si15°	Si45°	Si75°	Sa15°	Sa45°	Sa75°	GRAININESS
SPARKLE SILVER® XTREME 20 CONTROL	13.75	22.77	24.44	30.51	31.23	22.75	7.20
SPARKLE SILVER® XTREME 20 5% PERGOPAK®	15.56	26.70	29.38	35.79	33.31	27.31	9.07
SPARKLE SILVER® XTREME 20 10% PERGOPAK®	16.71	24.31	25.81	37.20	36.20	29.48	9.66
SPARKLE SILVER® XTREME 20 15% PERGOPAK®	17.24	27.23	27.36	36.81	34.90	29.68	9.88

### OBSERVATIONS

- There seems to be a linear correlation between the addition rate of polymethyl urea matting agent with the reduction in Flop Index.
- In addition to the reduction in the Flop Index, the samples containing the polymethyl urea additive appear to have more sparkle or graininess compared to the control.
- The authors believe the graininess increase is further evidence that the polymethyl urea is disrupting the flake orientation, which therefore gives the appearance of a higher sparkle and lower Flop Index.

### CONCLUSIONS

- The addition of the polymethyl urea additive reduces the Flop Index.
  - Aluminum flake pigments show a bright metallic look at one angle and a dark metallic look as you turn the panel. If a customer perceives that the contrast (Flop Index) is too large, they could add a Pergopak organic matting agent to reduce the high brightness value and increase the low brightness value.
- The addition of the matting agent slightly increases the "sparkle" and graininess appearance.

### THE FORMULATION INGREDIENTS INCLUDE:

- SPARKLE SILVER EXTREME 20, a 20µm silver dollar aluminum flake pigment, Silberline, <http://www.silberline.com>
- Pergopak M4 organic matting agent, Huber Engineered Materials, [www.hubermaterials.com](http://www.hubermaterials.com)
- A thermosetting acrylic resin system.

SPARKLE SILVER® EXTREME is a registered trademark of Silberline for aluminum flake pigments.

Pergopak® is registered trademark of J.M. Huber Corporation and Martinswerk GmbH for organic matting agents.



## COATINGS FOR GLASS

Pergopak® grades are particularly suitable for matting and effect creations in coatings for glass and transparent plastic. Due to the unique properties of Pergopak organic matting agents, these coatings form special effects ranging from wax-like and velvet-soft to silky-gloss, and appearances ranging from dull to frosty looking surfaces.

The visual nature of the base surface still remains transparent, as the particles are colorless. The turbidity observed from the matte surface is unavoidable because this is due to the diffuse reflection of light at the surface.

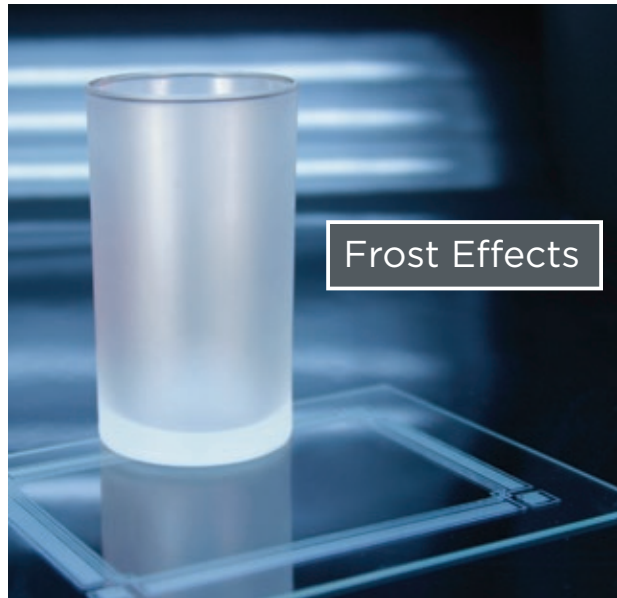
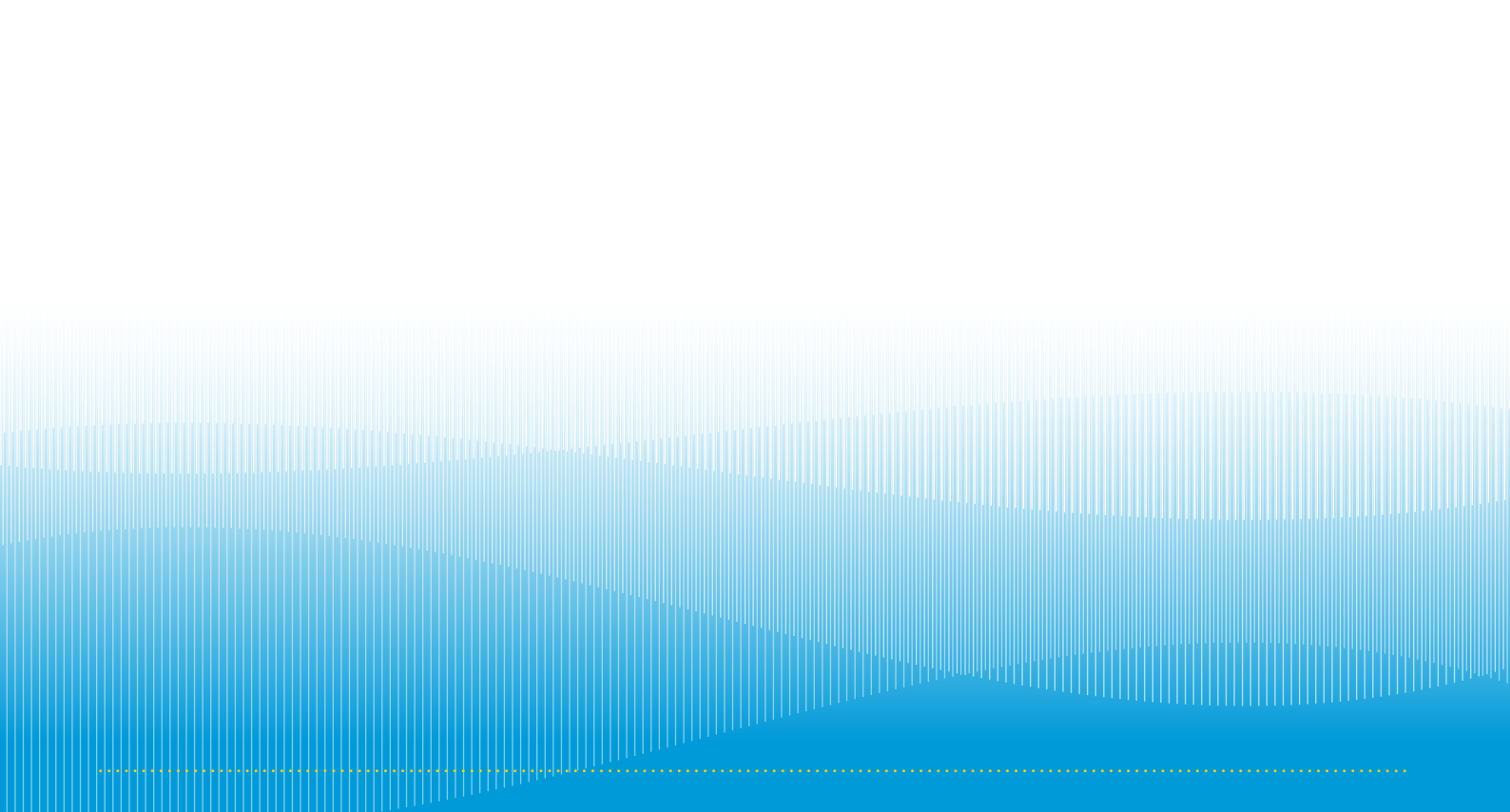


Figure 21



Figure 22



Pergopak® organic matting and effect agents have been used effectively and successfully for over 20 years to improve the rheology and performance of coatings, compared with other similar products on the market.

We're interested in learning more about your specific application and how our Pergopak grades can go to work for you to enhance your product's surface properties and physical effects.

For more information about the array of Pergopak® organic matting and effect agents available and to obtain product samples, please contact us:

**Email:** [hubermaterials@huber.com](mailto:hubermaterials@huber.com) **Click:** [www.pergopak.org](http://www.pergopak.org) [www.martinswerk.de](http://www.martinswerk.de) **Call:** 866-JMHUBER (866-564-8237)



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