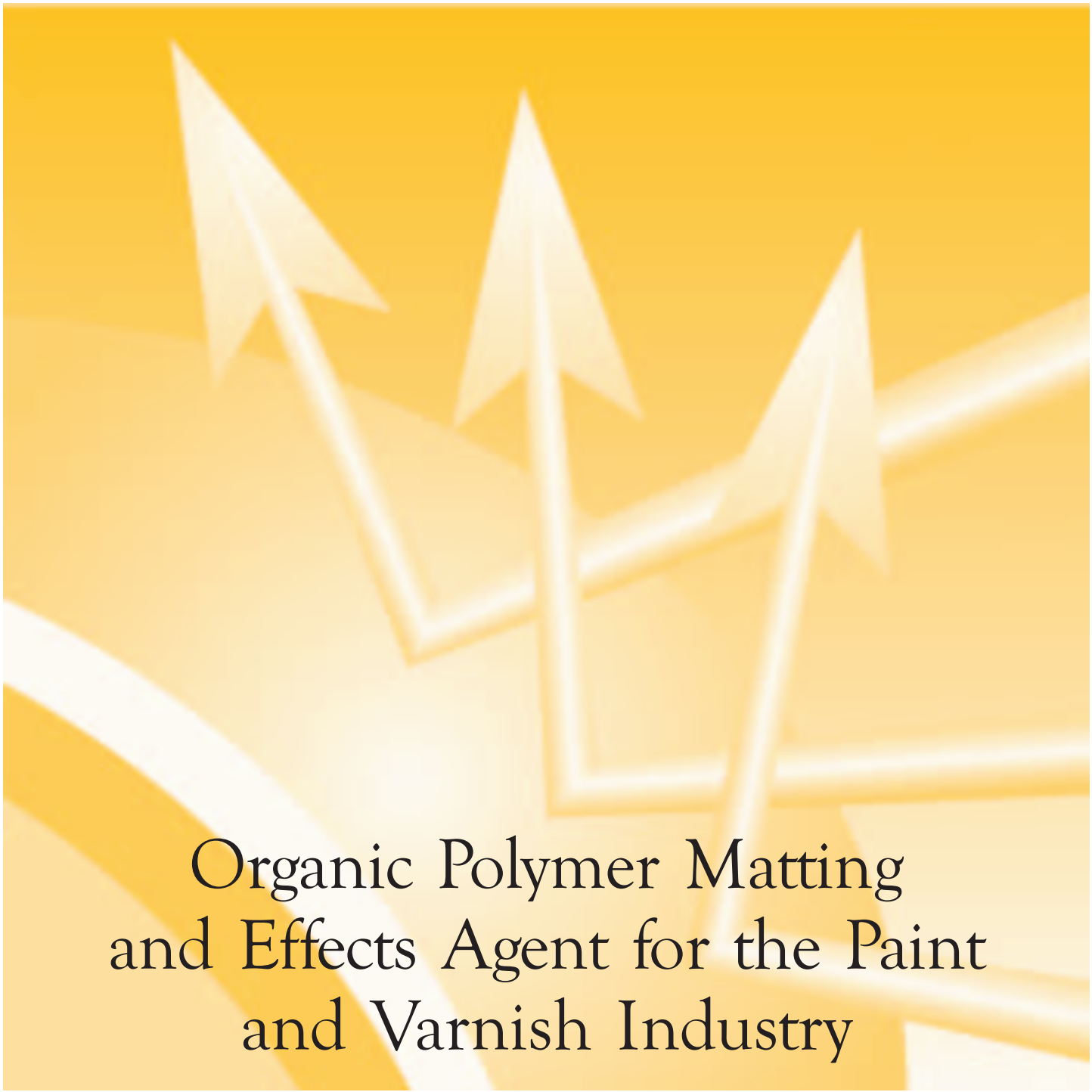
PERGOPAK®

ALBEMARLE® CORPORATION



Organic Polymer Matting and Effects Agent for the Paint and Varnish Industry

martinswerk

PERGOPAK®
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PERGOPAK – product advantages and interactions in lacquer

PERGOPAK® is an organic polymer matting agent that has been especially adapted to the requirements of the paint and varnish industry. It is a polymethyl urea resin containing a negligible quantity of free methylol groups. As a result of this chemical composition it functions as a polymer cross-linking agent during film forming. PERGOPAK® is also used in a modified form as a pigment in the paper industry. The name is derived from parchment and opacity.

Practice has shown that the properties of lacquers are greatly improved by incorporating PERGOPAK® as a matting agent. The resulting reactions in the course of film formation exert a decisive influence on the elasticity, hardness and degree of cross-linking the lacquer film. The formation of multi-functional cross-linking points, by way of the methylol groups, radically improve the elasticity and surface hardness of the films at an increasing pigment volume concentration. Such cross-linking reactions are associated especially with resins containing hydroxyl groups (acrylates, alkyd resins, etc.) on account of etherification at higher temperatures.

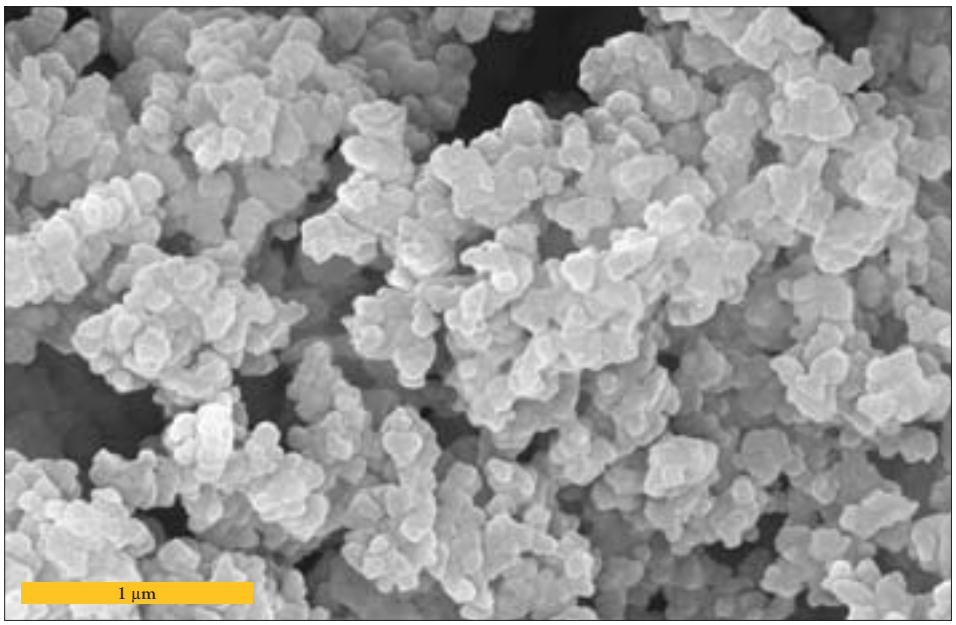
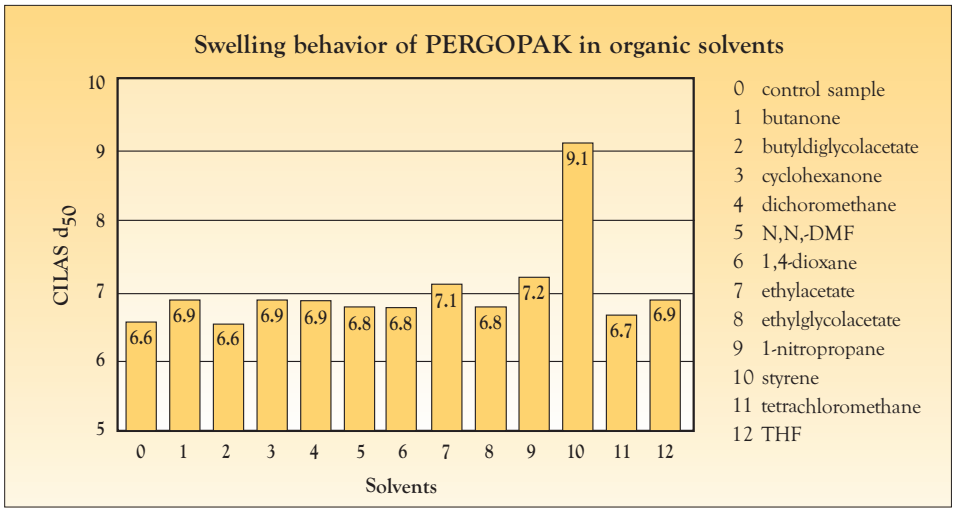


Fig. 1: PERGOPAK® EHT = 10kV WD = 2 mm

Solubility and swelling behaviour

PERGOPAK® is completely insoluble in water and the organic solvents commonly used in the paint industry. However, PERGOPAK® contains free methylol groups, which – under certain conditions – can interact with some solvents. For instance, such aldol reactions are possible with ketones.

The swelling behaviour in a number of solvents, some of which were quite aggressive, was established by measuring the mean grain size for an exposure period of 2 months. No significant swelling was found in the individual solvents. The negligible increase of the d50 – value can be explained by the partial attachment of the solvent to PERGOPAK®.



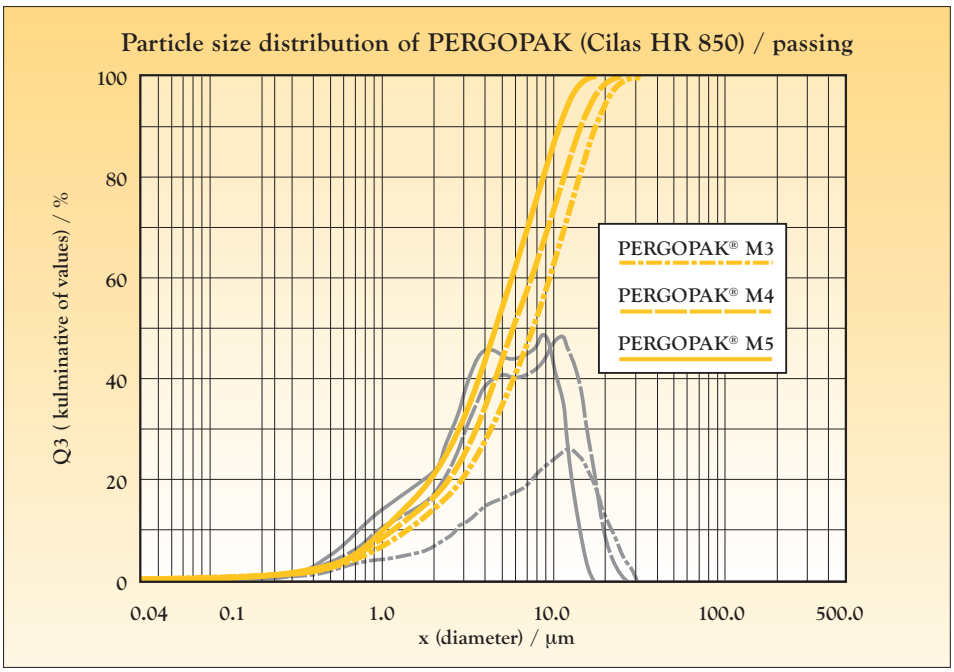
Processing:

Due to its excellent dispersing properties PERGOPAK® can be incorporated easily into the lacquer (also into aqueous systems) by stirrer or dissolver. The use of wetting agent is not necessary. PERGOPAK® has a good resistance to temperature and shear rate, so it can also be added to the mill base at pigmented systems.

Physical properties of PERGOPAK®

PERGOPAK® is a voluminous powder of low bulk density, has a large surface and an excellent whiteness degree resulting from an almost 100 % remission over the entire UV and visible wavelength range. Primary particles with an average grain diameter of 0.1 – 0.15 µm form agglomerates of approx. 5 – 9 µm.

This results in a high pore volume and a steep grain distribution – two important factors which form the precondition for an excellent matting effect. As a result of the almost ideal spherical form of the particles, virtually no influence is exerted on the lacquer rheology, as opposed to the more needle-shaped silica. With very high matting effects silica are associated with a considerable increase of the thioxotropy which, in most cases, is undesirable.



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Flop- or two-tone effect

In addition to brilliance, brightness and metallic colouring power, the characteristic feature of metallic effect lacquers is their flop or two-tone effect.

This is the change of brightness that is perceived when the viewing angle is changed. This effect depends upon the type of metallic pigments used and upon their alignment.

The incorporation of PERGOPAK® in the formulation of metallic base coats results in a significant enhancement of this effect as a result of steric screening and spatial separation. At an adequately thick adsorption layer, the individual metal flakes are sufficiently separated. The PERGOPAK® prevent metal flake reunion und act as a spacer.

PERGOPAK® has a barrier effect in such lacquers. In this manner the pigments are encompassed by a flexible structure that greatly restricts their free mobility.

PERGOPAK Product-Information

Chemical composition:	polymethyl urea resin with approx. 0.6 % reactive methylol groups	
Density	(g/cm^3)	1.47
Bulk density	(kg/m^3)	80
Packed bulk density compressed	(kg/m^3)	200
Particle size	Primary particles of 0.1 – 0.5 µm forming agglomerates of:	
Cilas d_{50}	(µm)	3.5 – 8.5
d_{100}	(µm)	< 18 – 36
Specific surface (BET)	(m^2/g)	14 – 22
Oil absorption	($cm^3/100g$)	approx. 310
Refractive index		1.607
pH-value		8 – 9.5
Solid content	(%)	> 83 %
Decomposition temperature	(°C)	> 220
Abrasion	(mg)	1.8
Storage stability	(years)	> 1

Fig. 2: The above mentioned values should be taken only as indication and not as guaranteed properties

Cupping / Elasticity

The cupping test establishes the behaviour of a coating when the base is subjected to a certain extent of deformation, thereby determining the elasticity of the coating. The cupping test is also used to establish the adhesion strength of the coating when the base is deformed.

PERGOPAK® M3 and PERGOPAK® M4 were added to Metallic Base Coat (control sample) in varying quantities, and applied on 1 mm thick steel plate in a relatively thick dry coating.

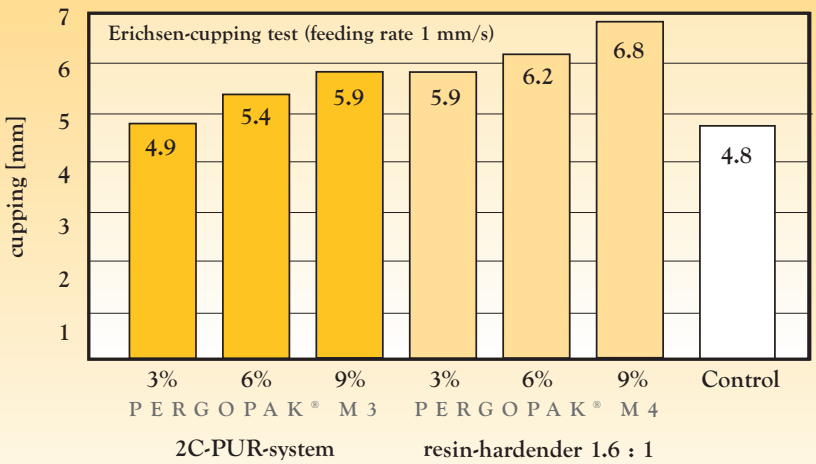
PERGOPAK in metallic base coat

excellent weather resistance
high surface smoothness
improved flop effect

- **minimum effect on rheology**
- **easily dispersible**
- **improved elasticity**
- **improved adhesion on the substrate**
- **improved scratch resistance**
- **gloss retention**

The significant improvement of the elasticity can be seen from the higher cupping values in relation to the given PERGOPAK® concentration.

Elasticity of metallic base coat when PERGOPAK is added



PERGOPAK product advantages:

- Maximum matting agent efficiency
- Minimum effect on rheology of coating when used as matting agent
- High scratch resistance
- Improved elasticity (binder-pigment-system)
- Improved adhesion on substrates
- High surface smoothness (easy achievement of soft-feel coatings)
- High transparency (refractive index nD20 = 1.607) in clear coats
- Superior „touch effect“ (leather feeling) in soft-feel coatings
- Excellent gloss retention and temperature resistance
- Improved resistance to chalking in photo-active pigments
- High UV-permeability (electron beam / UV curing)
- Excellent weather resistance
- Easily dispersible
- Constant reflectance between 290 and 1100 nm
- Resistant to chemical warfare agents (in camouflage coatings)
- High amenable to decontaminations (in camouflage coatings)
- Insoluble in standard solvents

PERGOPAK®
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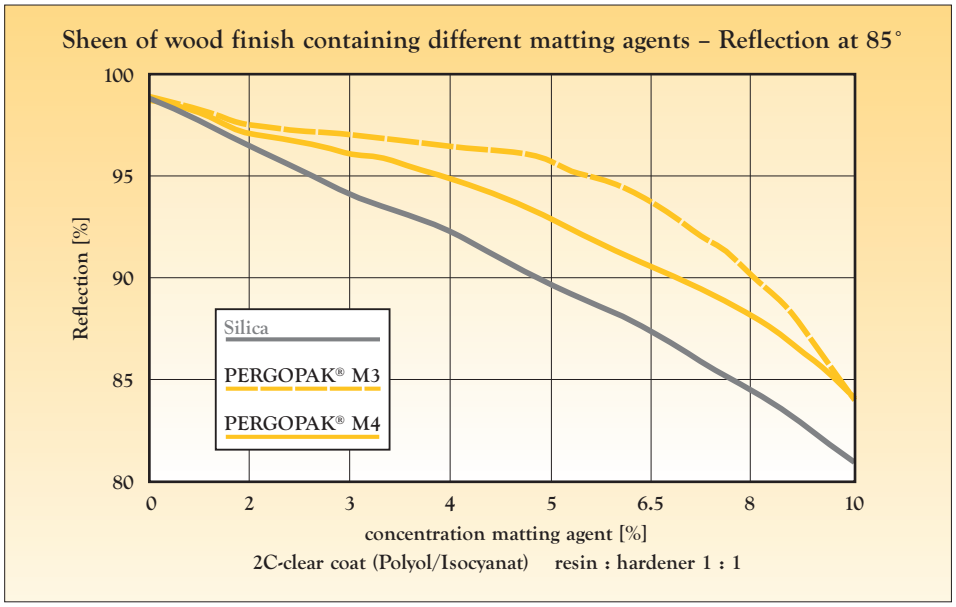
PERGOPAK® gives wood lacquers a high matting effect, high scratch resistance, enhanced elasticity and excellent UV permeability over the entire spectrum.

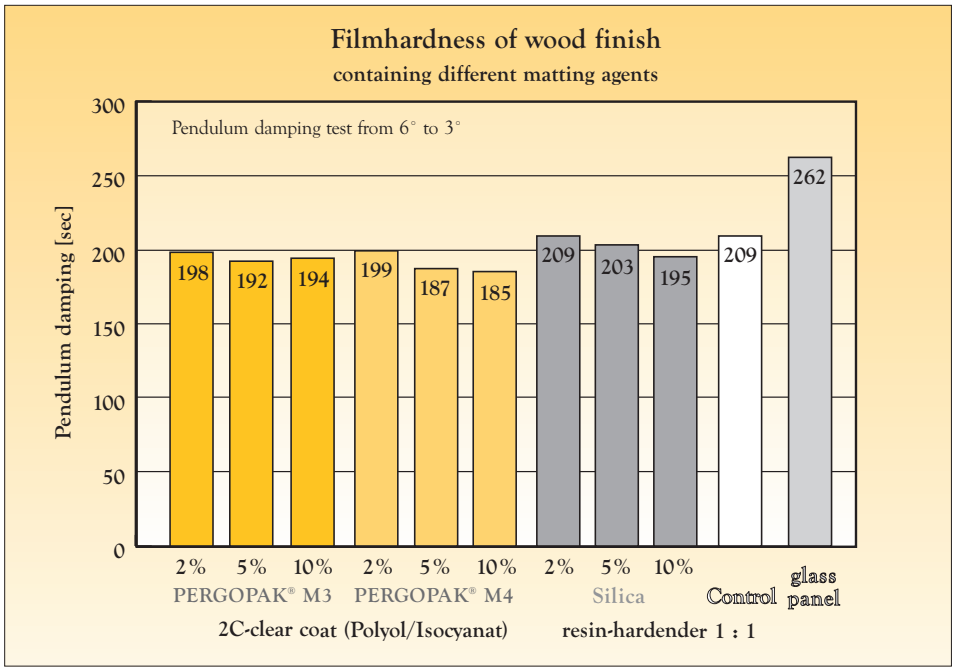
A 2-component (2C)-clear coat containing polyester polyol as a binder was examined. This relatively brittle binder type was hardened with an aromatic aliphatic polyisocyanate (Desmodur HL). (Stoving condition: 40 minutes at 120°C).

Silicic acid, PERGOPAK® M3 and PERGOPAK® M4 were added in different concentrations to this clear lacquer for the examinations.

The degree of gloss, abrasion resistance, adhesion to the substrate and the pendulum impact hardness were measured.

The lacquer film, incorporating silica for matting, was more turbid compared with films containing PERGOPAK® for matting. The matting effect of silica is slightly better than PERGOPAK® with this choice of binder, but serious differences result regarding the abrasion resistance of the lacquer film.



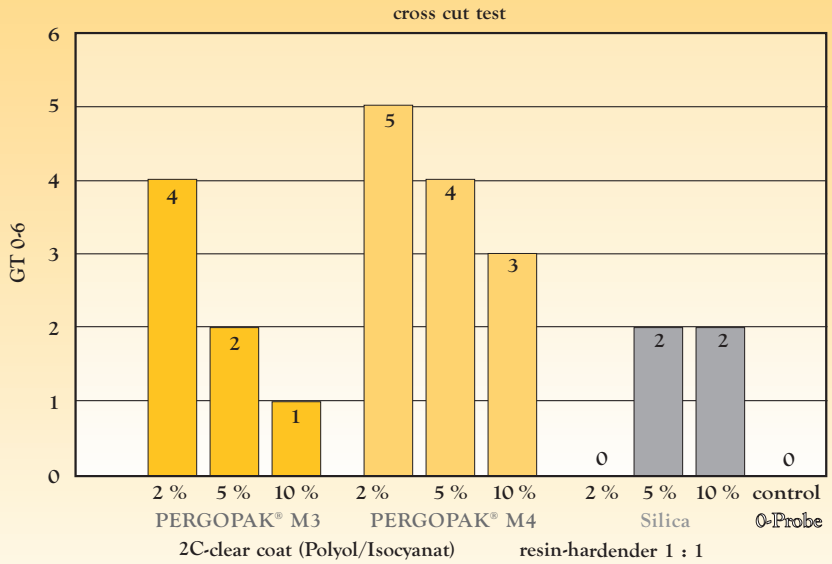


PERGOPAK for wood and furniture lacquer

UV-curing lacquer

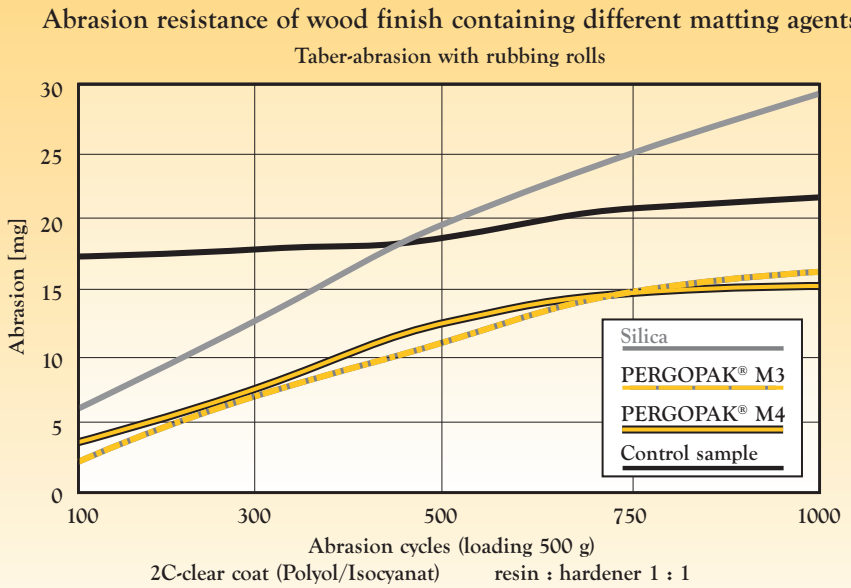
high scratch resistance
UV-permeability
high transparency

- minimum effect on rheology
- easily dispersible
- improved elasticity
- improved adhesion on the substrate
- gloss retention



The fact that the abrasion resistance of films containing PERGOPAK® is approximately twice the abrasion resistance of a formulation based on silica, speaks very much in favour of the product advantages of PERGOPAK®.

The cross-cut test (adhesion) clearly proved that adhesion was definitely improved, depending upon the added amount of PERGOPAK®:



Starting formulation for WOOD LACQUER:

	Variant I	Variant II
Polyester polyol	94.5 %	94.5 %
PERGOPAK		5.0 %
Silica	5.0 %	
Wetting agent	0.4 %	0.4 %
Rheology additive	0.1 %	0.1 %
	100.0 %	**100.0 %**
Desmodur HL	93.0 %	93.0 %
OH-NCO equivalent:	406.5 g polyol	/ 400.0 g Desmodur HL
Application:	Spray-gun	
Dry film thickness:	65 – 73 µm	
Silica:	Amorphous silicon dioxide, particle size d50 : 3 µm,	
specific surface BET:	184 m^2/g	

PERGOPAK®
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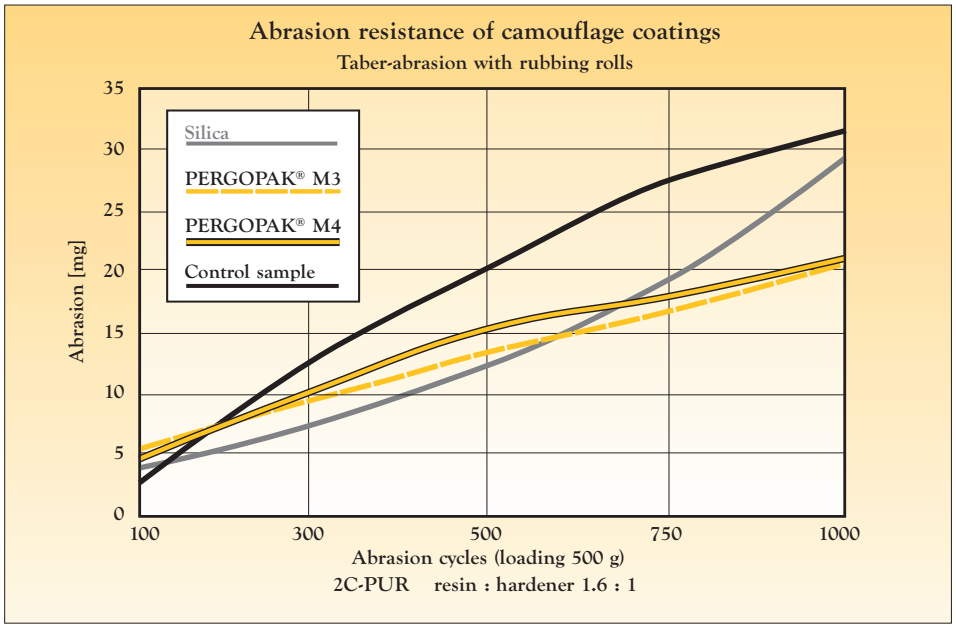
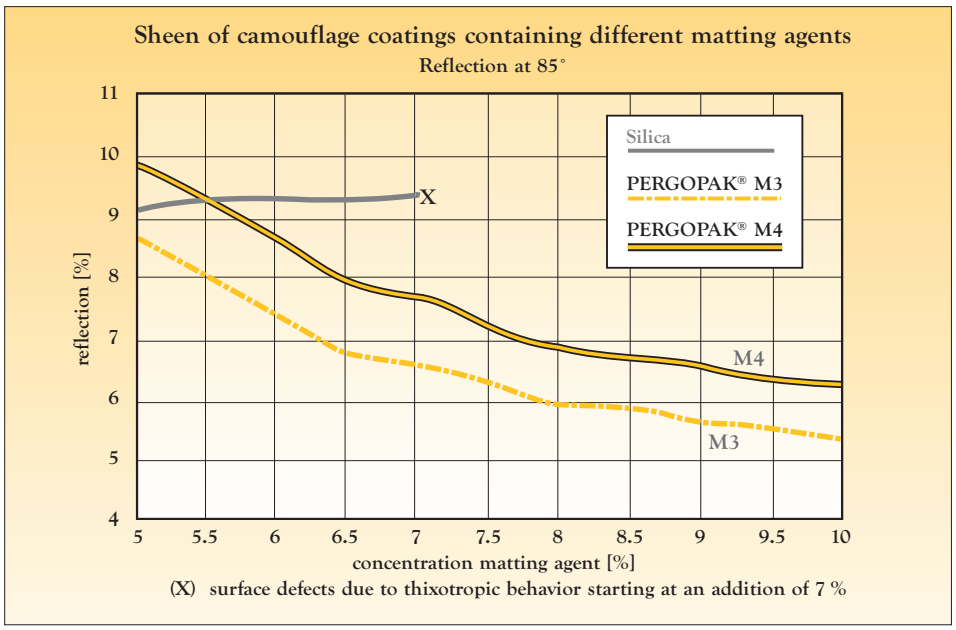
PERGOPAK® is ideal for military camouflage paints due to the intense matting effect, high scratch resistance, superior elasticity and excellent film hardness, without any thioxotropic effect. On account of the very uniform reflection curve over the entire wavelength range of 290 – 1100 nm, camouflage paints containing PERGOPAK® as a matting agent offer the additional advantage of not having any additional IR reflectance.





PERGOPAK® M3, PERGOPAK® M4 and silica were added in different concentrations to a standard formulation (source: Bayer AG).

The degree of gloss, abrasion resistance, elasticity and film hardness of these formulations were measured.

All results with this lacquer system clearly show that PERGOPAK® is superior to silica. The dull matt formulations, as specified by the armed forces, can be achieved by adding relatively small quantities of PERGOPAK®.

Such paints containing matting agents still have excellent flow properties and contrary to formulations incorporating silica as a matting agent, they do not have any thioxotropic effects. The abrasion resistance is improved by adding PERGOPAK®, and at the same time the elasticity of the lacquer film is not as adversely influenced by PERGOPAK® as it is by silica.

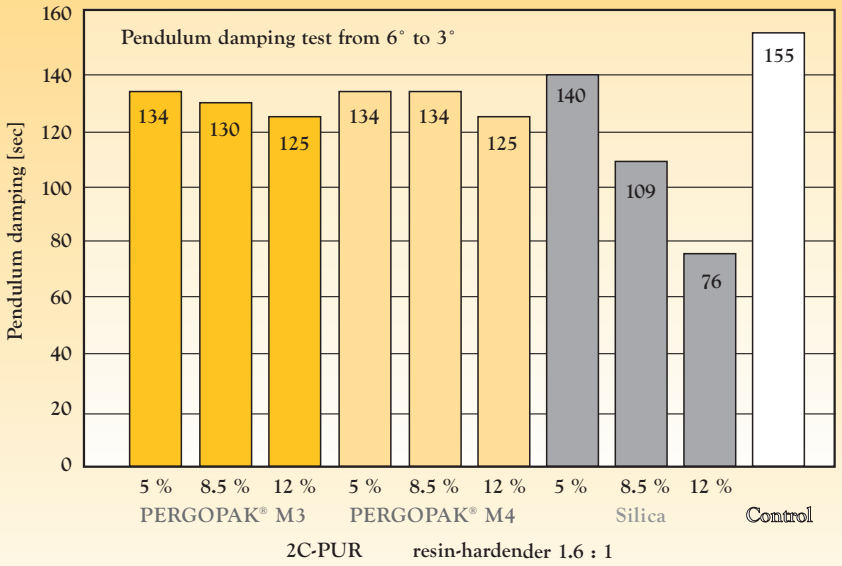
PERGOPAK for camouflage coatings

high scratching resistance
maximum matting efficiency
high weather resistance
resistance to chemicals

- minimum effect on rheology
- easily dispersible
- improved elasticity
- improved adhesion on the substrate
- gloss retention

Filmhardness of camouflage coatings

containing different matting agents

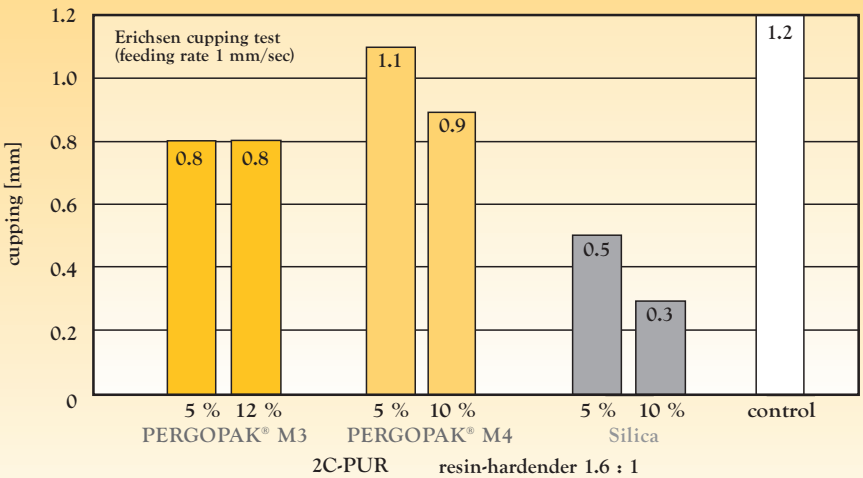


Starting formulation for CAMOUFLAGE COATINGS:

	Variant I	Variant II
Synthalat A-075	41.0 %	41.0 %
Deaerating agent	0.2 %	0.2 %
Wetting agent	0.6 %	0.6 %
Pigment mixture	19.7 %	19.7 %
Talcum	10.2 %	10.2 %
PERGOPAK	7.0 %	
Silica		7.0 %
Butyl acetate	7.2 %	7.2 %
Ethyl glycol acetate	7.0 %	7.0 %
Xylene	7.1 %	7.1 %
	100.0 %	100.0 %
Desmodur N75	25.8 %	25.8 %
OH-NCO equivalent:	406.5 g	255.0 g
	A-075/Desmodur N75	
Application:	Spray-gun	
Dry film thickness:	106 – 131 µm	
Silica:	Amorphous silicon dioxide, particle size d50 : 3 µm,	
specific surface BET:	184 m^2/g	

Elasticity of camouflage coatings

containing different matting agents



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Examination results of „soft-feel“ lacquer formulations

„Soft-feel“ lacquers are formulations that give coated plastic surfaces a pleasant, warm and soft leather-like feel. This effect is achieved by using micronized waxes in combination with silica. However, as a result of the interface activity of the waxes, surfaces treated in such a manner are very sensitive to scratches. The use of PERGOPAK® results in coatings of high abrasion resistance, excellent flexibility, an intense matting effect and superb surface smoothness.

A 2C-PUR lacquer (control sample) mixed with a wax/silica combination as well as with PERGOPAK® produced the best grain distribution for an optimal soft-feel effect. The purpose was to achieve a dull, matt suede-like finish. This is where gloss measurements confirmed the superior matting effect of PERGOPAK® compared to the silica/wax combination, while the Taber abrasion test corroborated the much higher abrasion resistance.

This abrasion resistance was also confirmed by the superior cupping values because the „soft-feel“ lacquer films, formulated on the basis of micronized waxes, are softer than corresponding PERGOPAK® formulations and therefore are far more susceptible to scratches.

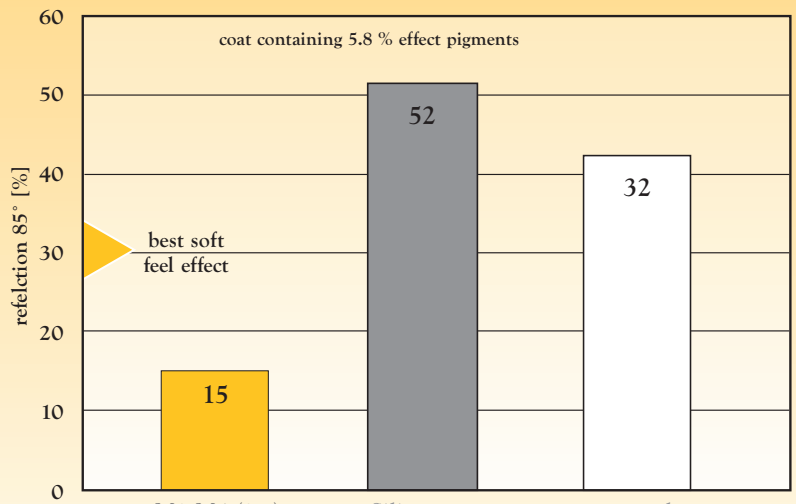
PERGOPAK for soft feel coatings

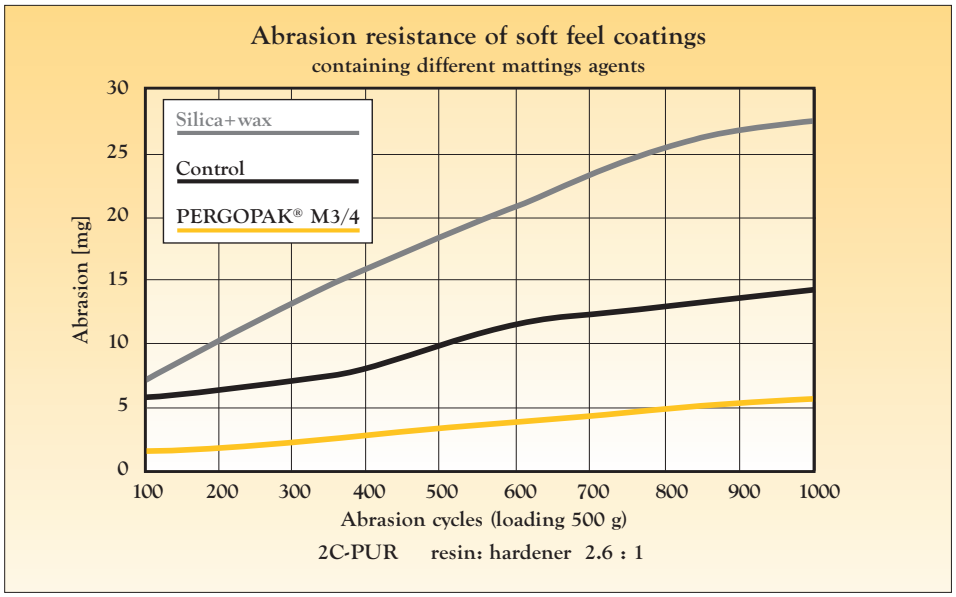
- **superior soft feel effect**
- **improved scratch resistance**
- **high surface smoothness**

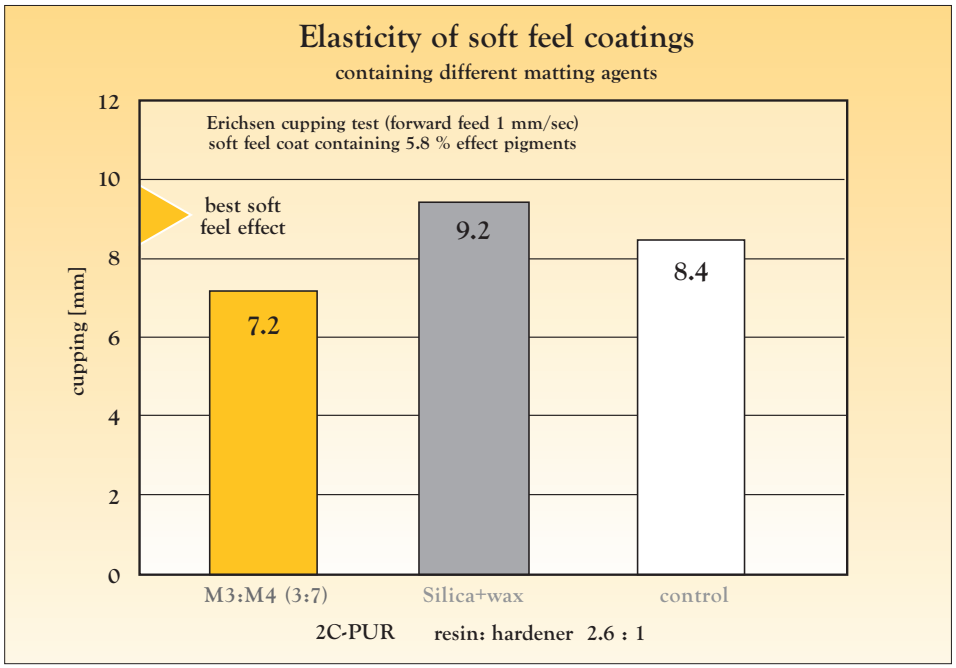
- minimum effect on rheology
- easily dispersible
- improved elasticity
- improved adhesion on the substrate
- gloss retention

Sheen of 2C-PUR soft feel coating

containing different matting agents







Starting formulation for „SOFT-FEEL“ LACQUER:

	Variant I	Variant II
Synthoester HD-080	32.0 %	32.0 %
Colour pigments	5.0 %	5.0 %
Talcum	11.0 %	11.0 %
PERGOPAK mixture		5.7 %
Silica	2.3 %	
Wax (micronized)	3.4 %	
Anti-foaming agent	0.1 %	0.1 %
Wetting agent	0.2 %	0.2 %
Butyl acetate	21.0 %	21.0 %
Xylene	20.0 %	20.0 %
	100.0 %	**100.0 %**
Desmodur N75	12.5 %	12.5 %
OH-NCO equivalent:	653.85 g	255.0 g
	HD-080	Desmodur N75
Application:	Spray-gun	
Dry film thickness:	117 – 138 µm	
Silica:	Amorphous silicon dioxide, particle size d50: 3 µm,	
specific surface BET:	184 m^2/g	

Examination results Coil-coating

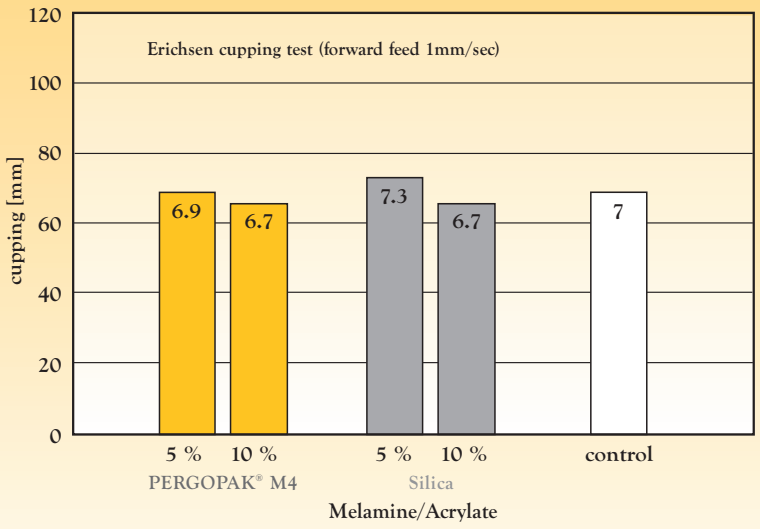
Coil-coating means continuous coating of metal strips with firm or fluid coating materials. Special demands are expected of the coating system with regard to rheology, adhesion and drying behaviour. Fluid coating materials for the traditional coil-coating process are usually applied by rollers where both the front and the rear sides of the coils are simultaneously coated. Effective strip speeds between 40 and 120 m/min can be achieved. Curing or cross-linking is performed in continuous multi-zone dryers using circulating air and involving object temperatures of 180 – 260°C.

PERGOPAK in coil coating

- **excellent matting efficiency**
- **improvement of elasticity**
- **improvement of adhesion**

- **minimum effect on rheology**
- **easily dispersible**
- **improved scratch resistance**
- **gloss retention**
- **UV-permeability**

Elasticity of coil coating containing different matting agents

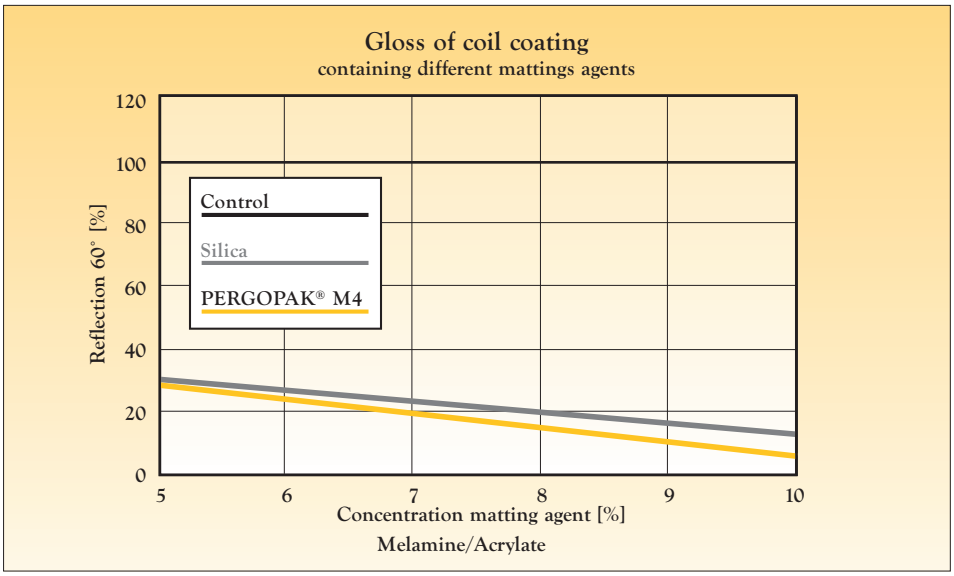


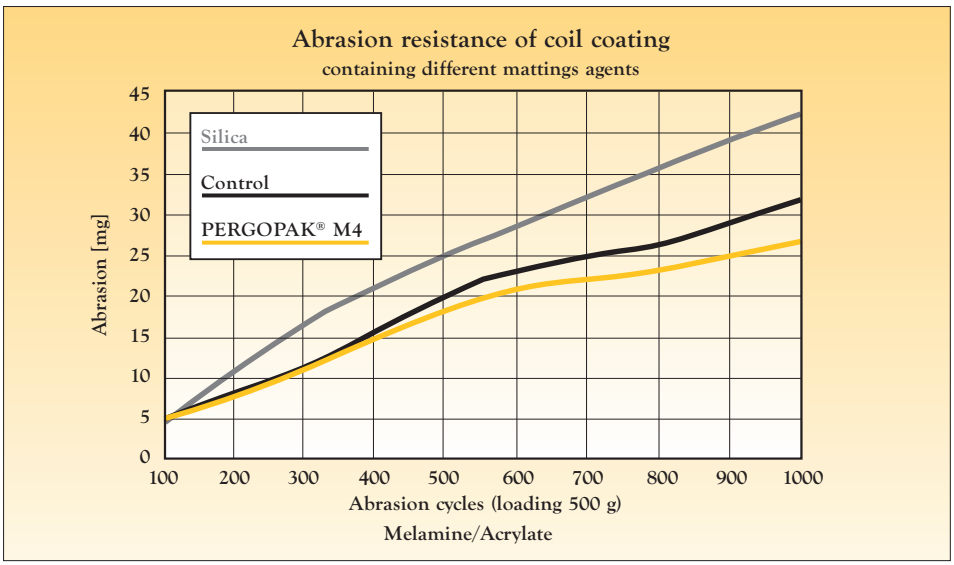
Since the dry layer of the top coat is no thicker than approx. 15 – 22 µm, the grain of all pigments, fillers and matting agents must be extremely fine. Binder/matting agent systems incorporating PERGOPAK® result in coatings of greatly improved elasticity compared with inorganic matting agents. This is due to the free methylol groups in PERGOPAK® which can interact with the binder. An acrylate melamine resin combination was used as binder, titanium dioxide Kronos RN 59 as pigment, and two different matting agents: PERGOPAK® M4 and silica.

The degree of gloss, the abrasion resistance and the elasticity of the coating were examined. Measurements of the degree of gloss revealed that the most intensive matting effect was achieved with PERGOPAK® M4. The superiority of PERGOPAK® M4 compared to silica was clearly confirmed by measurements of the abrasion resistance.

Starting formulation for WOOD LACQUER:

	Variant I	Variant II
CC-clear laquer	59.5 %	59.5 %
Wetting agent	0.5 %	0.5 %
Kronos RN 59	35.0 %	35.0 %
PERGOPAK	5.0 %	
Silica		5.0 %
	100.0 %	100.0 %
Binder basis:	Melamine / acrylate	
Application:	Roller doctor (80 µm)	
Dry film thickness:	49 – 61 µm	
Silica:	Amorphous silicon dioxide, particle size d50 : 3 µm, specific surface BET: 184 m^2/g	





Practice has confirmed the outstanding weathering stability of CC-lacquers containing PERGOPAK® as matting agent. The temperature and gloss stability are also excellent in spite of the high object temperatures achieved during drying. Uniform coating is also assured at high strip speeds. Firm adhesion of the coating system on the metal presupposes chemical pre-treatment to obtain a perfectly clean and grease-free surface.

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