



SOLVAY

CHEMICALS SECTOR - SBU ADVANCED FUNCTIONAL MINERALS

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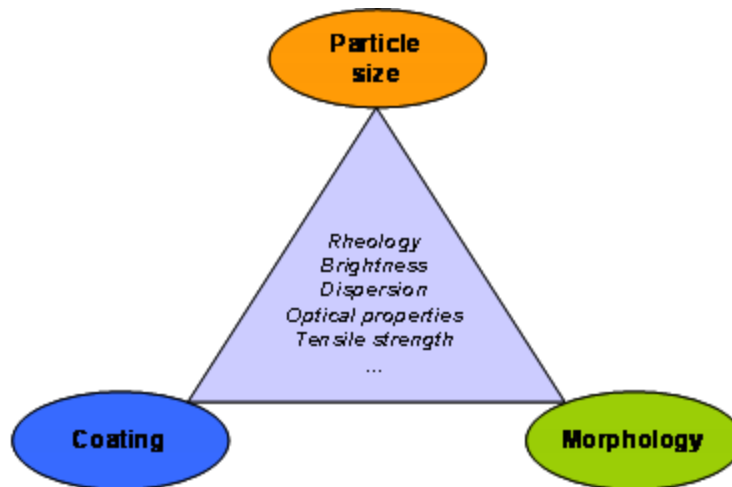


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Introduction

The properties of SOCAL® and WINNOFIL®, such as the fineness and grain size distribution, the crystal structure and the type and quantity of surface treatment, determine the respective applications with regard to the optical, rheological, mechanical and other properties.





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1 Abrasivity

The low mohs hardness qualities of SOCAL® and WINNOFIL® makes it a synthetic mineral that respects dental enamel (used in toothpastes) and mechanical parts in processing equipment (rotating cylinders, compounder screws, grinding media, etc.)

Mohs hardness scale: some typical materials

Talc	1.0
Kaolin	2.5
Calcite*	3.0
Aragonite*	3.5
Dental enamel	4.0
Wollastonite	4.5
Stainless steel (18-8)	5.5
Glass	6.0
Titanium dioxyde (rutile)	6.0
Silica	7.0
Alumina	9.0

* The results refer to synthetic Calcite and Aragonite crystalline varieties obtained by precipitation process.

2 Anti-sedimentation

SOCAL® and WINNOFIL® are commonly used in various formulations, such as printing inks, solvent-based and water-based paints.

In printing inks, Precipitated Calcium Carbonates have an anti-sedimentation effect preventing pigment flocculation.

In low viscous solvent-based paints, the coated grades of SOCAL® and WINNOFIL® are also used as anti sedimentation agents. The ultrafine particle size with its high specific surface supports the dispersion of fillers and pigments and increase the thixotropy and viscosity of paints.





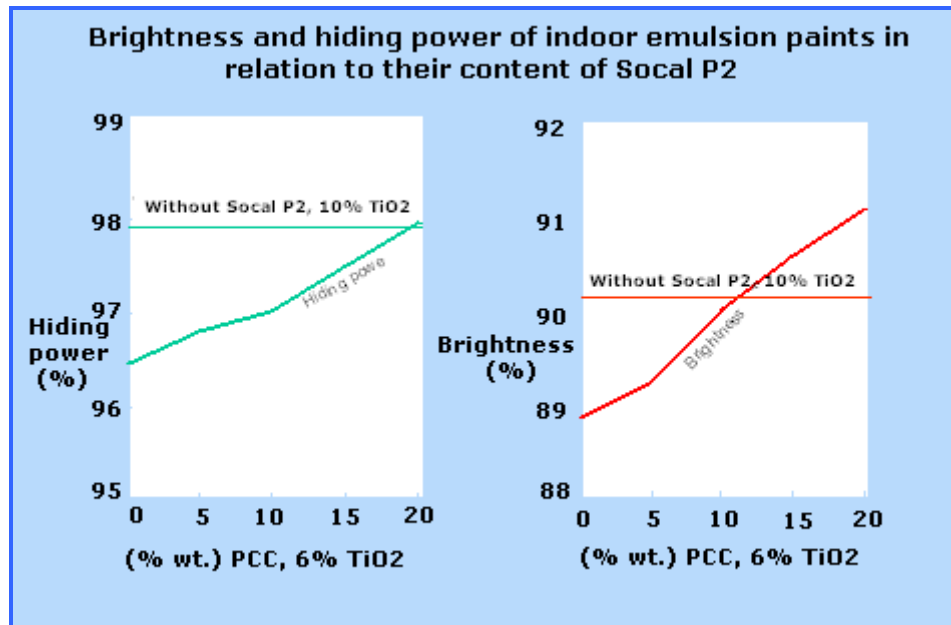
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3 Brightness

SOCAL® and Winnofil® increases brightness and avoids the yellowish appearance caused by non-synthetic minerals in paints and sealants applications.

Due to its chemical purity and its high refractive index, the use of SOCAL® in paint and paper formulation is cost effective. It permits partial or total replacement of expensive TiO_2 .





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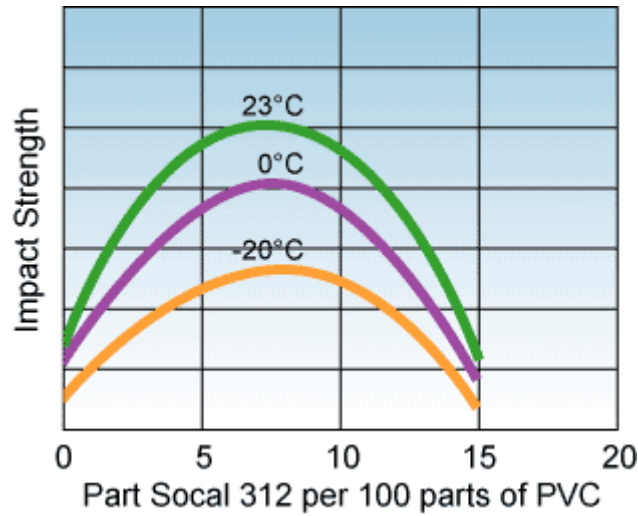
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4 Impact Resistance

The decisive advantage which results from the incorporation of ultrafine precipitated calcium carbonate in rigid PVC formulations relates to the significant improvement that is seen in the impact performance. This improvement is seen in rigid PVC compounds without the addition of any organic impact modifier. In the presence of both acrylic and CPE type modifiers, this improvement in the impact properties is repeated from the levels seen with the modifier alone. Whereas polymer modified compounds can display a sharp decrease in impact strength at low temperatures, the ultra-fine coated PCC modified system possesses residual impact resistance even at low temperatures.

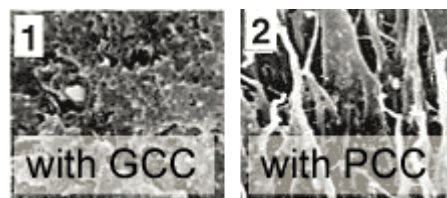
		Reference	Window profile formulation with Precipitated CaCO ₃						
		7,5phr IM	7,5phr IM	6,5phr IM	6phr IM	5phr IM	4phr IM	3phr IM	
		5,5phr GCC	5,5phr PCC	5,5phr PCC	5,5phr PCC	5,5phr PCC	5,5phr PCC	5,5phr PCC	
Charpy Impact ISO 179 (kJ/m²)	23°C	20 ± 2	Ductile failure	Ductile failure	Ductile failure	Ductile failure	Ductile failure	Ductile 70% 23 ± 3 30%	19 ± 2
	10°C	12 ± 1	Ductile 40% 23 ± 3 60%	17 ± 2	16 ± 2	13 ± 2	11 ± 1	9 ± 2	
	0°C	9 ± 2	19 ± 2	13 ± 1	11 ± 0.5	10 ± 1	9 ± 1	9 ± 1	
	-10°C	6 ± 1	14 ± 2	9.5 ± 0.5	9 ± 1	7 ± 0.5	6 ± 1	7 ± 0.5	
Impact Strength by falling weight (1kg, 1,5cm)	-20°C	Ductile failure	Ductile failure	Ductile failure	Ductile failure	Ductile failure	Ductile failure	Ductile failure	
Impact properties with GCC and PCC measured on pressed PVC sheets									

As can be seen in the table above, it is possible to **reduce significantly the amount of impact modifier** without compromising impact strength. The strengthening effect of PCC is seen at room temperature but also at -20°C . PCC offers a more economic formulation alternative with equivalent or even improved mechanical properties.



In contrast to organic impact modifiers precipitated calcium carbonate increases the E modulus of the extruded component and increases the impact strength without reducing the rigidity. The explanation of this positive behavior can be found in both the processing improvements that synthetic calcium carbonate provides along with its ability to improve the dispersability of other components of the formulation i.e. organic impact modifiers.

The more complete gelation that results from the inclusion of precipitated calcium carbonate provides a matrix that in comparison to natural calcium carbonates has fewer defect sites and opportunities for a crack propagation process leading to reduced mechanical properties. The micrographs show the differences in failure mode for PVC containing precipitated calcium carbonate from those containing a natural calcium carbonate derived by milling. It is possible to obtain ductile failures with reduced impact modifier levels by using precipitated calcium carbonate.





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5 Neutralisation

5.1 Foodstuffs and pharmaceutical preparations

The basic pH value (the typical pH of a 20% solution of PCC in water is around 10) combined with the rapid reaction with excess acid makes it suitable as a neutralizing or buffering agent for foodstuffs and pharmaceutical preparations.

The rapid reaction showed by PCC is linked both to the high surface area (generally from 7 to 10m²/g) and to the presence of carbonates, which reacts with acids with a fast production of carbon dioxide (CO₂).

5.2 Polymer based applications

Thanks to their high surface area and their chemistry, Socal & Winnofil allow absorption of acid released in case of degradation incineration or thermal recycling of polymer, which contributes to corrosion resistance and environmental protection”

6 Opacity

SOCAL® improves the opacity of paints and papers applications by increasing the light scattering coefficient. The high level of opacity allows to reduce the amount of titanium dioxide or to have a high level of opacity at a limited content of SOCAL®.

For paint, high opacity is crucial to achieve high hiding power.

For paper, this is especially interesting in light papers and top quality printing/writing papers where high optical performances are requested.

As a coating pigment, SOCAL® increases the coverage of the base paper. It also allows to reduce the coating weight to keep the same opacity, which reduces costs.

7 Porosity

Porosity is an important property for technical papers like cigarette paper or coating paper:

- In the cigarette paper, porosity controls the burning process.
- In coating application, porosity of the coating provides enhanced ink reception (ink jet papers, thermosensitive and carbonless papers).

The use of Socal in these technical papers increases their final porosity thanks to the morphology of the primary particle and the size of the agglomerates.

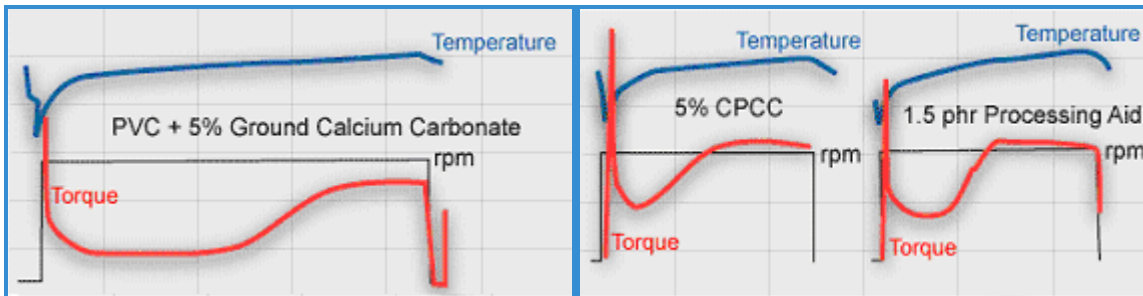
8 Processing aid

In rigid PVC formulations, ultrafine coated SOCAL® and WINNOFIL® can remove the need for lubricant additives. At a level of 2 to 3%, the effect of SOCAL® and WINNOFIL® is equivalent to Zinc or Calcium stearate one, providing a cost effective and environmentally friendly alternative.

When ultrafine coated PCC is compounded into rigid PVC several quite specific effects are observed. Amongst those seen are:

- Shorter fusion/gelation time.
- Improved surface finish and gloss.
- Elimination of plate out.
- Elimination of surface defects, i.e. sharkskin which occurs under conditions of high shear gradients, such as those seen in injection molding operations.

Gelation behaviour



These observed effects are usually associated more with the use of organic processing aids and impact modifiers than with the use of only an inorganic additive. However, the fact is that they are real effects seen with coated PCC and clearly offer performance and economic benefits.

9 Rheology

Solvay's coated ultrafine Precipitated Calcium Carbonates, SOCAL® and WINNOFIL®, are effective in the management of rheology of paste formulations. They are used in automotive, aerospace and construction applications where light-weight, flow, adhesion and consistent performance are all premium requirements.

SOCAL® and WINNOFIL® ultrafine coated grades efficiently provide desirable sprayability, flow and slump properties with excellent recovery and adhesion.

10 Sheen

SOCAL® is predominantly used in matt interior emulsion paints, making it possible to reach a cost effective matity while optimising other properties such as hiding power, brightness and scrub resistance.



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11 Stiffness

Precipitated Calcium Carbonates SOCAL® and WINNOFIL® are used to increase the stiffness of PVC window frames because in addition to this particular property, they also offer impact resistance, whiteness and excellent surface aspect.

Window Frame





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12 Surface appearance

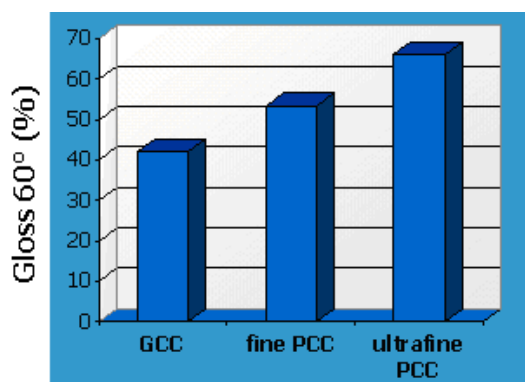
12.1 Paper

Use of SOCAL® makes it possible to obtain a better surface aspect: particularly the surface is smoother. This improvement of the surface smoothness is linked to the homogeneous dispersion and the small particle size of Socal®.

12.2 PVC

SOCAL® and WINNOFIL® can also be used in extruded, calandered and injection molded PVC to enhance surface appearance while reducing formulation costs and plate-out and increasing output.

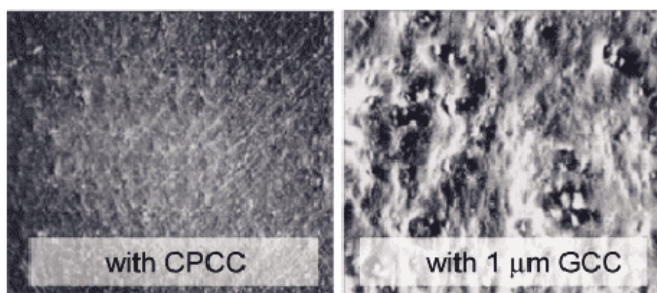
Coated PCC containing compounds exhibit excellent gloss in extrusion and injection molding applications. In pigmented rigid PVC, coated PCC gives an unparalleled degree of gloss as a consequence of its ultrafine particle size and absence of the large particles present in ground fillers that produce surface defects thereby increasing light reflection.



Materials sometimes difficult to process such as CPVC (chlorinated polyvinyl chloride) are made more manageable if coated PCC is included in the formulation.

The photographs below clearly show the smooth surface finish on the coated PCC formulation compared to that with ground calcium carbonate.

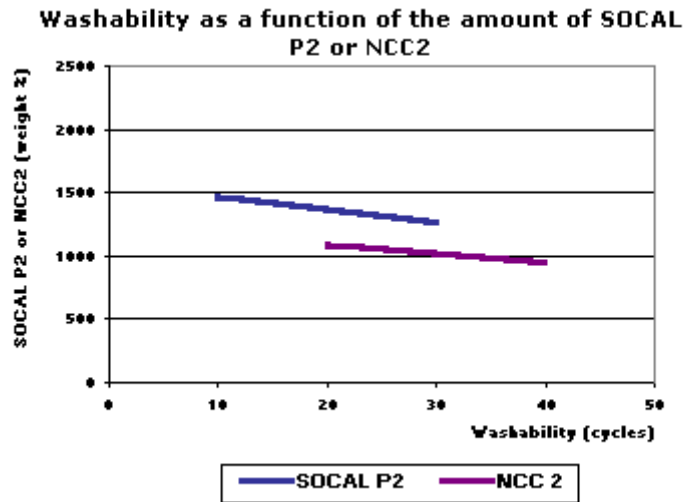
The relatively large particles of the latter cause surface defects which increase light scattering.





13 Washability

Socal® improves the washability of the paint. Then, the wash resistance can be improved by 30% for indoor emulsion paint by using PCC like Socal®, thanks to its small particle size.



14 Weathering resistance

The resistance of unplasticised PVC to degradation due to exposure to the elements depends on a number of different factors. These include the nature of the stabilisation system, pigmentation used, the grade of PVC and also other additives in the formulation. It is clear that all these formulation ingredients have a role to play. Rigid PVC formulations that contain synthetic precipitated calcium carbonate show excellent color durability and retention of mechanical properties in particular impact strength. This positive effect on weatherability is due to a number of differing factors some which have their origin in the improvements in dispersion and processing behavior seen when precipitated calcium carbonate is included in exterior formulations. The chemical nature and purity of the calcium carbonate is also a factor as is the much enhanced surface finish.

14.1 Coated PCC in rigid PVC has a positive effect on weathering by:

1. A more effective compounding of the PVC which ensures that the stabilisers present are dispersed in a homogenous way. The presence of coated PCC in the formulation removes the need to overwork the PVC which itself provides a more stable polymer.

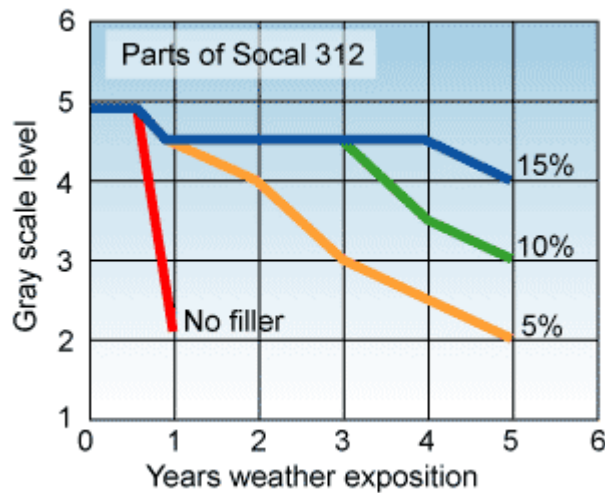


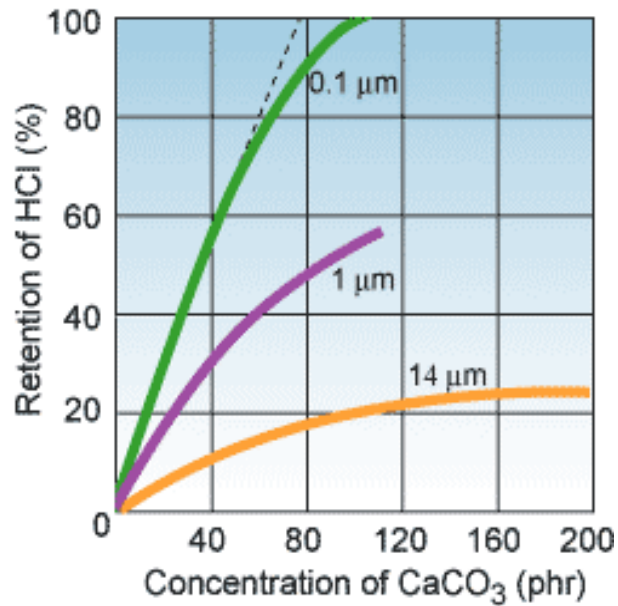
Figure 1: weatherproofness of a brown, lead stabilized rigid PVC section containing different levels of filling materials (exposition area (Rheinberg/Germany))



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- The ultrafine nature of the synthetic calcium carbonates acts as an efficient radical trap for any evolved HCl thereby inhibiting dehydrochlorination giving reduced yellowing.





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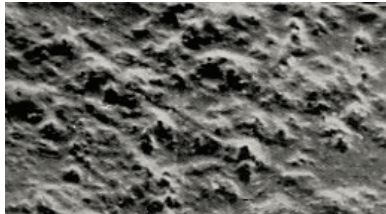
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3. The enhanced surface finish and gloss are a major factor in the surface resistance to degradation (see table 1)

Ground Calcium Carbonate

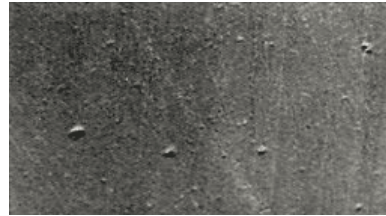


Mag X 250
Before Weathering



Mag X 250
After 8GJ/m2
Weathering Xeon 1200

Precipitated Calcium Carbonate



Mag X 250
Before Weathering



Mag X 250
After 8GJ/m2
Weathering Xeon 1200

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Socal® improves the washability of the paint. Then, the wash resistance can be improved by 30% for indoor emulsion paint by using PCC like Socal®, thanks to its small particle size.

