多用途的生物聚合物环保助剂的优势

Versatile Biopolymer - Advantage of an Environmentally Friendly Additive

公众对可持续性和环境保护的日益关注使人们对环保产品的需求提高，甚至有了新的法规出台。因此，人们对所谓的创新“绿色”解决方案的需求达到了前所未有的关注，即使助剂在涂料配方中用量很小亦有了新的挑战。

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生物技术开启了一个全新的消光助剂的诞生，与蜡和二氧化硅等传统消光剂相比，该消光助剂具有前所未有的优良综合性能。这种全新的助剂基于生物聚合物，使用醣类经过细菌发酵而制成。此种生物聚合物的产品源于可再生资源，可完全生物降解，无转基因（**图1**）。低稳泡和低沈淀性使其易于添加使用，在高透明度配方中其涂膜，无雾影或浑浊。另有其它优点，如舒适的表面触感、良好的机械性能等。该助剂可在UV体系中体现出最佳效果，但也适用于无溶剂涂料、溶剂型涂料以及水性涂料。

Increased public awareness about sustainability and environmental protection has led to a high demand for eco-friendly products and even to new regulatory provisions. Thus, the need for innovative and the so-called “green” solutions is greater than ever before and challenges the components of a coating formulation, even if used in small quantities only. Biotechnology has opened the door to an entirely new matting additive with a hitherto unprecedented combination of properties compared to conventional matting agents such as waxes and silicas. The new additive is based on a biopolymer, which is obtained by means of bacterial fermentation from sugars. The biopolymer-based product originates from renewable resources and is fully

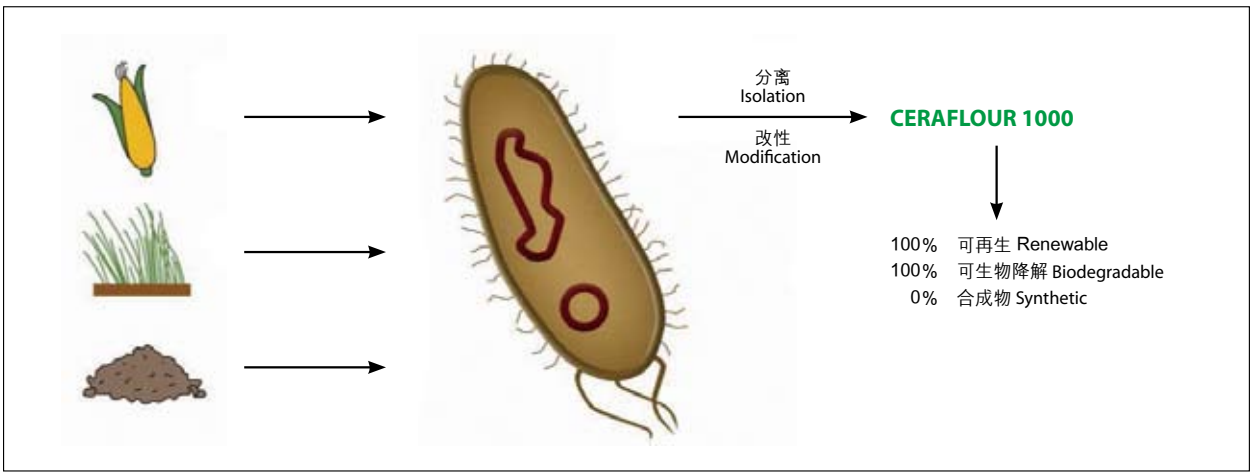

图1：生物技术带来的全新消光助剂
Figure 1 : New matting additive by biotechnology

高消光效率

在各种的涂料体系中，二氧化硅消光剂的使用都非常普遍和有效。与传统涂料体系相比，UV固化体系难以消光。一个重要原因是其不像溶剂型涂料有明显的涂膜收缩。尤其是低光泽的哑光涂料，所需的二氧化硅消光剂的使用量显著高于其它涂料体系。标准二氧化硅消光剂通常会导致粘度显著增加，并提高触变性，因此需要使用更多的活性稀释剂或特殊的润湿分散剂来降低粘度，并提供牛顿流动特性和防沉降性。有许多特殊有机改性的二氧化硅消光剂，它们对粘度的影响不大，但消光的效率也不高，而且经常有稳泡性，而且透明度不佳。

一般而言，蜡助剂对粘度的增加虽然不像二氧化硅的影响那么大，但它们在消光的效率也不够高。如使用酰胺蜡，也会遭遇到诸如稳泡、雾影等副作用。使用改性HDPE（合金）的蜡助剂，其优点是可改善涂膜性能，如耐机械性能。因此蜡助剂经常与二氧化硅一并使用，因为这样可带来更好的涂膜性能，特别是抗划伤性及耐磨性。聚合物消光剂也被经常使用在消光，由于容易添加、对粘度无任何影响。它也可与二氧化硅或蜡搭配使用。

生物聚合物展现出绝佳的消光效果，而且对粘度没有任何影响。与有机处理过的二氧化硅和蜡相比，其效率更高；在众多测试体系中，其效率等同于未经处理的二氧化硅（**图2**）在聚酯丙烯酸酯体系和聚氨酯丙烯酸酯体系中，使用5%的生物聚合物即可将光泽度降低至10~30。光泽度采用BYK-Gardner光泽度仪以60°测量。其消光效果通常接近未经处理的二氧化硅，并优于所有测试的有机处理过的二氧化硅。

添加生物聚合物非常容易，无需太高的剪切力。在添加过程中，不会有粉尘及稳泡的情况。光泽均匀的涂膜经常是UV体系中的主要挑战。即使是涂膜厚度差异很小的的状况下，也会导致表面光泽度的不同。利用此生物聚合物，表面的光泽度能不受涂膜厚度所影响。

在大多数的情况下，在水性1K、2K及UV体系中，其消光效果与其它消光剂相似。未经处理的二氧化硅具有最好的消光效率。在溶剂型体系中，其消光性能优于蜡助剂，而仅在某些体系下与二氧化硅相近。所以，生物聚合物与二氧化硅和聚合物消光剂以及蜡助剂皆可搭配使用。

透明度

透明度也是生物聚合物的一个关键优势。涂膜的吸收和散射特性决定有多少光可穿过以及其后方物体如何通过透明涂膜而显示出来。其显著特点为：

biodegradable and GMO-free (**Figure 1**). Minimised foam stabilisation and sedimentation ensure easy incorporation and deliver highly transparent formulations and coating films with no haziness or turbidity. Further beneficial effects, such as a pleasant surface touch and good mechanical properties, are observed. The best results have been achieved in UV systems, but the additive is suitable for solvent-free, solvent-borne and waterborne coatings.

High matting efficiency

Silica matting agents are very common and effective in every type of coating system. In comparison with conventional coating systems, UV curable systems are difficult to matt. One important reason is that there is no film shrinkage, as there is with solvent-borne coatings. The amount of silica needed, especially for deep matt coatings, is significantly higher than in other coatings. Standard silica matting agents often cause a marked increase in viscosity and provide additional thixotropy. Thus, either higher amounts of reactive diluents are needed or specially designed wetting and dispersing agents have to be used in order to reduce the viscosity, provide Newtonian flow behaviour and supply anti-settlement properties. There are many specially designed, organically modified silica matting agents available which do not affect viscosity so much, but these are not so efficient in terms of gloss reduction and often exhibit foam stabilisation and lower transparency.

In general, wax additives do not affect viscosity as much as silica, but they are not sufficiently efficient to achieve low gloss surfaces. With some amide waxes, negative side effects such as foam stabilisation and haziness are also observed. The benefit of using wax additives such as modified HDPE (alloys) is improvement to film properties such as mechanical resistance. Often, wax additives are used in combination with silica because of the improved film properties that this brings, notably scratch and abrasion resistance. Polymer matting agents are often used because of their easy incorporation and zero effect on viscosity. Combinations are also possible with silica or waxes.

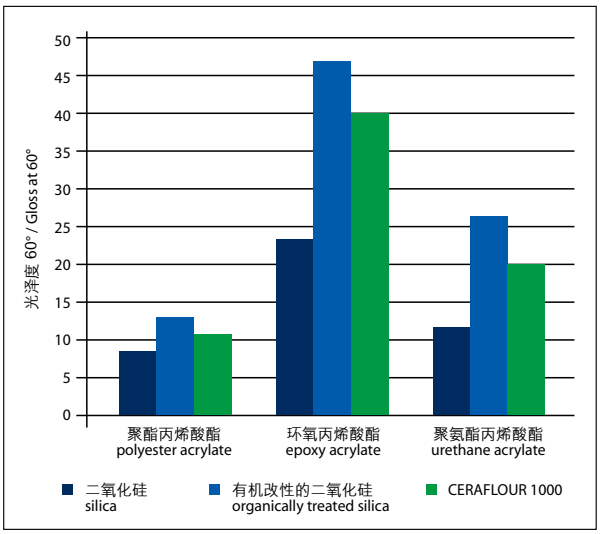

图2：三种常见100%UV体系中三种选定助剂的光泽度降低效果（助剂剂量为7.5%，干膜厚度为20μm）
Figure 2 : Gloss reduction of 3 selected additives in 3 common 100% UV-systems (additive dosage 7.5%, 20μm dry film thickness)

散射角广→ 雾影

（光线向四面八方扩散，导致对比度损失）

散射角小→ 透视度高

（光线仅在较小角度范围内扩散，高度集中）

该效果说明了透过涂膜可看到后方清晰的影像。如果哑光清漆透明性差，当涂布在黑色底漆上就会改变原来的颜色而成灰色。因此，透明度对深色或透明材质上的涂层均非常重要。例如，在木器涂料中，底部的木纹应清晰可见。

通过雾度测量技术证明了生物聚合物带来的视觉效果。雾度计的测量原理如下。一束光射向样本并进入积分球。球体的内表面均匀地涂布哑光白色材料，能使光线漫射。球体内的一个探测器测量总透光率和穿透性雾度。安装在球体出口处的环形传感器检测低散射角的光（清晰度）。

将涂膜与未添加消光剂的透明涂料进行了比较。与含有经过处理的二氧化硅或蜡助剂的涂膜相比，而使用生物聚合物的涂膜显示出更高的清晰度（**图3**）。

不仅在100%UV体系中具有高透明度，在水性涂料和溶剂型涂料中也是如此。这些颗粒的定向排列在所有体系中基本上一致。

绝佳的触觉特性、舒适的柔软触感

生物聚合物赋予涂料舒适、温润的触感，像蜡一样。根据作者的定义，触觉为具有柔软触感的平滑表面。没有设备可用于测试触觉。因此邀请了许多人评估样品。生物聚合物样品不约而同地被判定为最平滑、

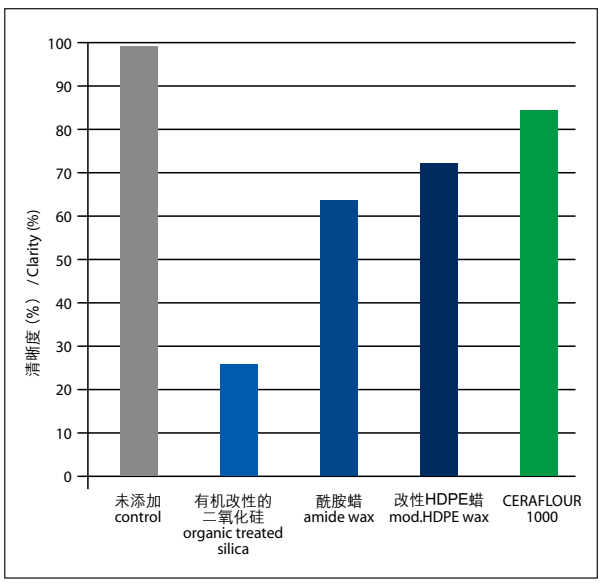

图3：采用不同助剂的涂层清晰度（助剂剂量为2%，干膜厚度为30μm）

Figure 3 : Coating clarity as a function of additive (additive dosage 2%, 30μm dry film thickness)

The biopolymer exhibits excellent matting combined with no impact on viscosity. In comparison with treated silica and waxes, efficiency is higher and, in many of the tested systems, equal to untreated silica (**Figure 2**). In polyester acrylate and urethane acrylate systems, it has been possible to reduce the gloss to 10-30 with 5% of biopolymer. The gloss of the hardened film was measured with a micro-Tri-gloss form BYK-Gardner at an angle of 60°. This is often comparable to untreated silica and better than all the treated silica tested.

Incorporation of the biopolymer is easy; no high shear force is required. During incorporation, dust and foam stabilisation have not been observed. A uniform gloss is often a major challenge in UV systems. Even small differences in film thickness can lead to gloss differences. Through the use of the biopolymer, the gloss level become independent of film thickness.

In waterborne 1K, 2K and UV systems, similar matting to other matting agents was seen in most cases. The highest matting efficiency has been found with the untreated silica. In solvent-borne systems, the matting properties were found to be better than with wax additives and only in some cases similar to silica. Combinations of the biopolymer with silica and polymer matting agents and wax additives were found to be possible.

Transparency

Transparency is also a key advantage of the biopolymer. The absorption and scattering behaviour of applied coatings determine how much light will pass through and how objects will appear through a transparent product. Distinguishing features are:

Wide angle acattering → haze

(Light is diffused in all directions causing a loss of contrast.)

Narrow angle scattering → see-through quality

(Light is diffused in a small angle range with high concentrations.)

This effect describes how well very fine details can be seen through the film. If a matt clear coat is hazy, an application on black primer appears grey. Transparency is not only important for applications on dark or transparent substrates. In wood coatings, for example, the wood grain should be clearly visible.

The visual impression provided by the biopolymer has been proven by haze measurement. The measurement principle of the haze meter is as follows. A light beam strikes the specimen and enters an integrating sphere. The sphere's interior surface is coated uniformly with a matt white material to allow diffusion. A detector in the sphere measures the total transmittance and the transmission haze. A ring sensor mounted at the exit port of the sphere detects narrow angle scattered light (clarity).

Films of coatings have been compared to the clear coat without matting agent. The biopolymer-containing film has exhibited a higher clarity compared to treated silica or wax-containing films (**Figure 3**).

High transparency has been found not only in 100% UV systems but also in waterborne and solvent-borne coatings. The orientation of the particles has been largely homogeneous in all systems.

Excellent haptic properties & pleasant soft-touch

The biopolymer imparts a comfortable and warm wax-like

最舒适。这种柔软的触感并不意味着具有更高的滑爽性。无论是否采用生物聚合物，涂膜表面的摩擦系数(Coefficient of Friction，COF) 都在相同水平。

三维显微镜图像显示：二氧化硅存在较小的尖状突起，聚合物消光剂存在圆形突起，生物聚合物存在更高的圆形突起。

涂料中的贮存稳定性

此生物聚合物助剂在所有体系中显现出良好的贮存稳定性。贮存前后的涂膜光泽度测试可保持一致。在100%UV体系中，生物聚合物在贮存测试中，同样显示出非常稳定，罐内的分布均匀。与之相比，二氧化硅易于沉淀，蜡易于上浮。

改善涂膜性能

从使用不同测试方法来观察的抗划伤性及耐磨性的结果来看，使用生物聚合物的效果比使用二氧化硅及聚合物消光剂效果更好。然而，当与改性HDPE蜡合金比较时，其效果没那么好。使用生物聚合物无法提高抛光或擦焦效果，对指痕印的改善也不明显。涂膜的流平性良好。通过使用SEM，可看到颗粒非常均匀地分布在涂膜的所有区域。

成果概述

通过生物技术开发了一种具有卓越性能的创新产品。该产品100%基于可再生资源且可生物降解。其主要特性为具有绝佳的消光效果（尤其是在UV体系中）和极高的透明度，而且具有温润、平滑的触感而不影响滑爽性。此外，该产品还可提高抗划伤性、耐磨性及抗粘连性。它可用于无溶剂涂料、溶剂型涂料以及水性涂料而不影响粘度。它使用时，无粉尘沈和无稳定性且易于添加，并且在涂料体系中具有良好的贮存稳定性。

touch to the coating. Haptic is, in the authors' definition, a smooth surface with a soft touch effect. There is no equipment for testing. Thus, a number of individuals were asked to evaluate the samples. The biopolymer sample was invariably judged to be the smoothest and the most pleasant. This soft touch does not correspond to a slip increase. The COF (coefficient of friction) of the coating with and without biopolymer is at the same level.

The 3D microscope pictures reveal small peaks for silica, round rises for the polymer matting agent and higher round rises for the biopolymer.

Storage stability in coatings

Good storage stability was observed for the bio based additive in all systems. Coatings were applied after storage and the same gloss level before and after storage were obtained. In 100% UV systems, the biopolymer showed very homogeneous in-can distribution, also after storage. In comparison, silica tends to settle and wax to cream.

Improved film properties

Regarding scratch and abrasion resistance, better results have been observed using different test methods in systems containing the biopolymer than with silica and polymer matting agents. However, the results when compared to a wax-like modified HDPE wax alloy have been less favourable. No burnishing or polishing effect has been observed with the biopolymer, and no finger marks likewise. The applied films exhibit good levelling. Very uniform distribution of the particles has been observed in all areas of the film using SEM.

Results at a glance

An innovative product with excellent properties has been developed by means of biotechnology. The product is 100% based on renewable resources and is biodegradable. The key benefits are excellent matting efficiency, especially in UV systems, combined with high transparency and a warm smooth haptic without any undesirable effect on slip. Additionally, the product improves scratch, abrasion and blocking resistance. It can be used in solvent-free, solvent-borne and waterborne systems without affecting viscosity. Easy incorporation without dust formation and foam stabilisation is combined with good storage stability of the coating systems.