New Nanoparticle Laytex offers Natural Advantage

Skyrocketing oil prices have generated interest in chemicals based on natural materials

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In May 2006, TAPPI held its first International Conference on the subject of nanotechnology. Although a lot of exciting possibilities were discussed, most are years or even longer from practical commercial application.

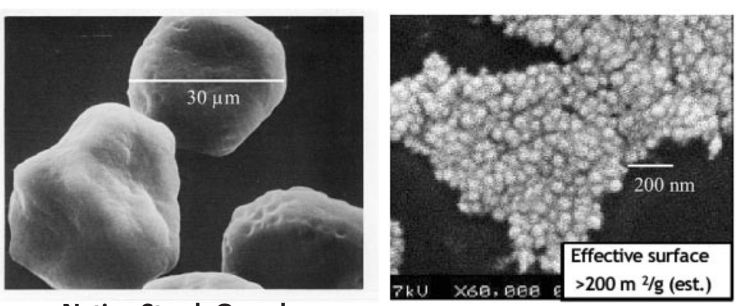
The recent run up in oil prices has generated a lot of interest in chemicals that are based on natural materials, such as ethanol made from corn or biomass. This article describes new nanoparticle biopolymer latexes that are commercially available.

Because they are made from natural products such as corn starch, costs of these materials are relatively stable and not tied to the price of crude oil. Another benefit: The products are lower in price than synthetic emulsion latexes.

NANOPARTICLE BIOPOLYMER LATEX

EcoSynthetix Inc. has developed a technology platform that produces biopolymer latexes from corn starch and potentially other natural materials. The products are being marketed under the trade name *EcoSphere*® and are commercially available. The nanoparticle biopolymer latex is produced by a patented extrusion process that combines crosslinking and reduction of corn starch particles to 50 to 150 nm particle size (See **Figure 1**). The resulting product does not require cooking and can be readily dispersed in water. In fact, cooking the product would reduce its usefulness.

Figure 1. A patented extrusion process reduces native starch granules to nanoparticles.



Native Starch Granules

ECOSPHERE® Biopolymer Nanoparticles

EcoSynthetix was founded in Lansing, MI, in 1996, to develop a bio-based nanotechnology technology platform as replacement for petroleum-based adhesives (polyvinyl acetate latex, polyvinyl alcohol, etc.) and paper coating binders (styrene-butadiene, acrylic and acetate latexes).

The company has developed two distinctive proprietary technology platforms; each is based on re-engineering base raw material molecules to provide a unique set of properties that have performance characteristics similar to petroleum-based synthetics used for adhesives and binders, at a lower cost:

1. Sugar macromer technology was developed as a first harmless reactive bio-based monomer that can be co-polymerized to create a unique set of pressure-sensitive adhesive properties, including recyclability, wash-off and high shear adhesion, that turn off under controlled conditions. This product line is already commercialized and being marketed under the trade name *EcoStix*®. It provides a key to solving the problems with stickies in paper mills recycling pressure-sensitive labels and matrix.

2. The **biopolymer nanoparticle technology** is the world's first bio-synthetic, water-borne starch latex. It imparts adhesive qualities to starch that were previously unachievable. The first applications of this technology were in corrugating and laminating adhesives. There are current commercial applications in Asitrade laminating replacing polyvinyl acetate at lower cost. The biopolymer latex is dispersed in water and does not require cooking. As a formulated adhesive, its solids content is similar to polyvinyl acetate. It can be applied at a solids content similar to or higher than polyvinyl acetate.

The product is also being developed as a high-solids corrugating adhesive to replace conventional Stein Hall-type starch adhesives. When the biopolymer nanoparticle-based adhesive is applied by a thin film applicator such as the Kohler glue machine (See **Figure 2**), it facilitates cold corrugating. This results in substantial energy savings; reduction in warp, scrap and wash boarding; and an improved printing surface.

PAPER AND PAPERBOARD COATING APPLICATIONS

The successful applications in laminating and corrugating adhesives were used as a springboard to the development of biopolymer nanoparticle coating latexes. The processing conditions were modified to produce nanoparticles in the range of 80 to 120 nm—compared with a typical range of 150 to 400 nm for styrene butadiene latexes.

Laboratory and pilot coater evaluations showed the nanoparticle biopolymer latex to be equivalent in binding strength to typical styrene-butadiene latex. It was substituted at ratios up to 75% for styrene-butadiene latex in typical coating formulations. The nanoparticle biopolymer latex also provides good water holding, and can reduce the need for natural or synthetic water holding agents. Results of pilot coating trials showed a number of favorable properties, including:

- Increased bending stiffness.
- Increased CIE whiteness.
- Improved water retention performance.
- Increase in IGT dry pick.

The nanoparticle biopolymer latex is made with a crosslinker, and it can be practical to reduce or eliminate the use of a crosslinking resin additive.

The product is dry when produced and can be shipped in dry form. Because it readily disperses in water, it can be dispersed and shipped as a liquid at about 40% solids. Availability in dry form provides the potential to use it in ultra-high solids coating formulations, which could be a key to improved performance in applications such as high-carbonate pre-coatings.

It is important to realize that the nanoparticle biopolymer latex is very different from regular cooked starch. It forms transparent films that are flexible rather than brittle—key to eliminating fold and score cracking. Thus, it may find use in paperboard coatings and coated free sheet applications where starch is not normally used as a co-binder.

OTHER POTENTIAL APPLICATIONS

The applications developed to date for this technology appear to be only the tip of the iceberg. The improved stiffness observed in pigment coating trials led to preliminary evaluation for improvement of dry strength.

Application by metered size press at relatively low levels resulted in improved stiffness, ring crush and bursting strength. This could be a key to reducing fiber content of paperboard while still maintaining stiffness and other strength properties—resulting in substantial economic benefits.

Application of the nanoparticle biopolymer latex via calender box could potentially achieve similar results on both containerboard and multi-ply recycled board. In addition to improving strength, it could also provide improved holdout of pre-coating—especially free-draining, high-carbonate-content coatings.

The nanoparticle biopolymer latex dispersions exhibit ultra-high shear stability. Rheology is shear thinning and similar to synthetic colloids, such as styrene-butadiene latexes. The products are approved by the U.S. Food & Drug Administration (FDA) for food packaging applications.

The nanoparticle biopolymer latex can also be made from cationic starch, facilitating its use as a wet-end additive to replace synthetic dry strength resins such as glyoxalated polyacrylamide, at significantly lower cost to achieve equivalent or better results.

The production processes for nanoparticle biopolymer latex are not as capital intensive as those for synthetic emulsion polymer latexes. Thus, it could be practical to supply it from regionally located satellite plants, similar to the concept used for precipitated calcium carbonate.

In summary, the new biopolymer latex provides some exciting new potential applications of nanotechnology that are here today and readily available for economic and quality benefits and for future product development. 360

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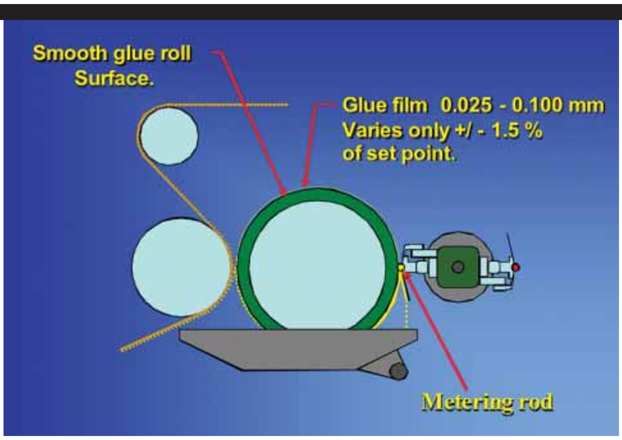

Figure 2. Kohler Thin Film Metering glue machine.

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