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SNIPPETS
FOR THE PAPER INDUSTRY

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NANOSCIENCE FOR PULP & PAPER

Nanoscience and technology concerns itself with the study of material at size of 100 nanometers down to atomic magnitudes (~0.2nm). As a unit of measure, a nanometer is one-billionth of a meter.

Viewing the Nano World: It is the Atomic Force Microscope (AFM) which opened up a new vista in the world of material science. For the first time it enabled the observation of material at a nano scale. This was followed by the Scanning Tunneling Microscope (STM). 3D Measurement of surface structures and features at micro levels was now possible.

Why Nano?: It has for long been believed by physicists that manipulation of chemical structures at the sub atomic level could give rise to newer materials composed of building blocks which defy the classical laws of physics. Such materials could be smaller yet stronger, lighter and more resilient.

NANOSCIENCE FOR THE PULP & PAPER INDUSTRY

The Forest Products industry in general and the Pulp and Paper industry in particular have always been governed by the nano phenomena. **Bonding of pulp fibers occurs on a nanoscale and fibers themselves are made of nature's nanotubes known as fibrils.** A single papermaking fiber, measuring 1-4 mm, is constituted of thousands of smaller chemical units called 'cellobiose' molecules. The nano dimensional components in the fiber are attributed to the unique properties of wood. The invention of the AFM made it possible, for the first time, to see the fiber in 3 dimensions, exhibiting characteristics considered vital in conceptualizing the future of paper technology. It was also possible to view the nano structural configurations of pigments, binders, and other additives directly, using these ultra high resolution microscopes.

Presently the paper industry is concerned with using nanotechnology in two ways:

- *To enhance current products and create new ones*
- *To discover ways by which cellulosic fibers can be used for products outside the industry*

In a bid to transform the forest products industry through innovation in its manufacturing processes and products, the Forest Products Industry in the US has initiated **Agenda 2020**.

Agenda 2020's **Novel Materials Task Group** promotes the development of knowledge and techniques that can enable companies to develop new products and innovative features in existing products.

The application of nanotechnology and nanomaterials in the paper and forest industry is a primary focal point for this work group, with a special emphasis on cellulosic nanomaterials.

The current priorities of this group are:

- *Provide understanding to enable companies to improve strength-to-weight ratio of paper and paperboard by 20-50%.*
- *Develop new wood-derived nanomaterials and advanced composite structures.*

The implications of nanotechnology for the paper industry ranges from wet-end chemistry, fabrics, and roll cover materials to adhesives as well as pigments.

But to use nanotechnology effectively, a lot still remains to be understood, interpreted and reproduced.

HAPPENINGS ON THE NANO FRONT

Nano Material: Nanocellulose (*also called microfibrillated cellulose, MFC or nanofibrillated cellulose, NFC*) has been one of the best nano innovative product derived from wood fibers. It has exceptional strength characteristics - at par with Kevlar, (*a lightweight material used to manufacture high-strength, durable materials*). However, in contrast to Kevlar and other materials based on fossil fuels, nanocellulose is completely renewable.

It is produced by delaminating cellulosic fibers in high-pressure homogenisers. Fully delaminated nanocellulose consists of long microfibrils (1-2 micrometres in length & 5-20 nm in diameter) and has the appearance of a highly viscous, shear-thinning transparent gel.

Previously, the production process was too energy-intensive to make the commercialisation of nanocellulose a viable option. However, recent process developments have enabled energy consumption to be reduced by more than 50%. There are a wide variety of potential applications for nanocellulose. In the manufacture of paper / board, nanocellulose could be used as a strengthening agent in paper with a high filler content.

Other areas of application may be surface sizing and coating, e.g. as a barrier material (against oxygen, water vapour, grease/oil) in food packaging.

Then there are applications in the field of nanocomposites, non-caloric food thickeners, emulsion / dispersion, oil recovery applications, and applications in the electronics sector.

Nanotechnology For Stickies Control: Nanoparticles formed out of montmorllite clays are being used for control of 'stickies' in

INDUSTRY NEWS

Indian paper mills were recipients of awards at the **PPI Awards 2012** at Brussels.
TNPL won in the category ***"Green Energy and Bio-fuels"***
BILT Graphic Paper Products won in the categories ***"Water Efficiency"*** & ***"Mill Manager of the Year".***

the paper making process. At first the clay is exfoliated (opened up) with a high speed disperger. The exfoliated nanoparticles have a surface area upto 800 sq. m per gm. This high surface area is able to adsorb micro stickies as well as the potential stickies which are still in the colloidal state. The nanoparticles containing the adsorbed impurities are taken out of the system with the paper. Due to their submicroscopic size they do not create specs on the paper.

Continuous use of this product in the wet-end will keep the papermaking system clean of deposits.

Paper Coating: "Selfassembling" nanocoatings will provide low cost ways to make coated paper without the traditional infrastructure. Some nanoparticles could assemble like nanocomposites in an oyster shell, so a nanocoating could "self coat" during the papermaking process without extensive pressing and calendering.

Current research at IPST, Georgia Tech. shows a potential for replacing paperboard wax coatings with a nanoclay coating. This coating provides great barrier properties and simplifies recycling operations by eliminating use of hardtoremove waxes.

The coating of paper and board can also undergo a revolution with the introduction of new composites working at the nano structural level. Nanocoatings with ultra thin layers of polymers, nano clays or lumen filling with polymers, calcium and magnetic materials are in the horizon.

Barrier Coating: Other nano composites under development constitute barrier coatings for oil / grease resistance and anti-bacterial paper. In semi-crystalline polymers, the crystalline regions are considered to be gas impermeable. Due to relatively high crystallinity, in combination with the ability of the nanofibers to form a dense network held together by strong inter-fibrillar bonds (*high cohesive energy density*), it has been postulated that nanocellulose might act as a barrier material.

Strength Improvement: Nanocellulose may be useful as a wet-end additive to enhance retention, dry and wet strength in commodity type of paper and board products.

Packaging: Nanocellulose based foams are being studied for packaging applications in order to replace polystyrene based foams (eg. thermocol).

Plantations: Genetic manipulation to achieve low lignin, high pulp yielding and short rotation crops.

Effluent Treatment: Advanced membrane nano-technology has applications in raw and wastewater treatment. Today, the concept of zero-effluent discharge mills appears to become a possibility because of innovative nanofiltration and membrane technologies.

Paper Machinery Equipment & Processes: Manufacturers have started producing paper machine rolls and fabrics with a micro and a nano base.

Nanotechnology can also assist in the small scale designing and tailoring of sensors for process control as well as product development and quality.

Another nanotechnology research is directed at developing new or improved properties for lignocellulosic fibers, such as those from mechanical and kraft pulping.

CONCLUSION

The benefits of nanotechnology are potentially revolutionary in nature. At the very least, a big leap in the evolution of today's products as well as manufacturing fundamentals can be expected. It is anticipated that in the next decade, advances in nanopapermaking additives will eliminate many existing problems, including those of paper strength for recycled and virgin furnishes and printability. This will be especially true for high filler content paper and board.

It is interesting to note that currently, the paper industry is the largest user of nanotechnology among all industries. With increased funding from both governments and venture capitalists, the innovation process is bound to accelerate.

QUOTABLE QUOTE	***Three things cannot be long hidden - the sun, the moon, and the truth*** *- Gautam Buddha.*
SCRABBLE	What does **M B F** stand for? (Hint : Paper Lab. Equipment) First correct answer will win a Parker Vector Roller Pen (Maximum two prizes for one person in a year). Post / Fax / Email your answers to EDITOR-W&F SNIPPETS by 20th February, 2013.
WINNER JAN'13	**Mr. Pradeep Kr Shibahare, Dy. Manager, ITC Ltd. PSPD, Unit : Bhadrachalam, Sarapakka-507128 Dist. Khammam** **Answer : A Z C** : **A**mmonium **Z**irconium **C**arbonate
?QUIZ	**Brightness values of paper vary as per testing method. Which of the three will give the highest and the lowest value for the same paper sample?** **a)** TAPPI (GE) **b)** ISO **c)** D 65 Post / Fax / Email your answers to EDITOR-W&F SNIPPETS by 20th February, 2013.
WINNER JAN'13	**Mr. H. K. Maheshwari, Sr. Manager (R&D), Emami Paper Mills Ltd., Balgopalpur, Balasore-756020** **Quiz :** Check the right options : Functionally, 'Microparticles' used in the papermaking system are always 1) Inorganic particles 2) Anionically charged 3) Improve dewatering 4) Improve formation **Answer :** 3) Improve dewatering 4) Improve formation
Prizes	**1. Best / first correct answer** received will win one-year subscription to **IPPTA Journal** *(Maximum one prize for one person in a year).* **2. Best of the 12 monthly winners** in a year, will win one-year subscription to **Paper 360° Magazine, USA.**
☺ ***Telepathy***	*Question : Name the three fastest ways of communication.* *Answer : Telephone; Television and Tell-a-woman.*

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