Available online at www.elixirpublishers.com (Elixir International Journal)

Nanotechnology

Elixir Nanotechnology 50 (2012) 10546-10548

ISSN: 2229-712X

Nano technology- changing the challenges in pulp and paper industries in India

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ARTICLE INFO

Article history:
Received: 1 August 2012;
Received in revised form:
31 August 2012;
Accepted: 20 September 2012;

Keywords
Nano technology,
Pulp,
Nano- Pigment.

ABSTRACT
Today's pulp and paper industry is rapidly becoming a globalized industry which belongs to the Red category that is positioning itself to deliver low-cost, high-value, fiber-based products to consumers. Employing advanced chemical- and mechanical-based technologies. pulp, paper, and tissue manufacturers have sought to provide high-quality consumer. To overcome the challenges, new synthetic nonrenewable materials have been developed that have now begun to challenge the traditional dominance paper products has had in many applications. This paper will review emerging developments of these technologies and how these new research avenues will change paper from a pass. This presentation deals the vital role of Nano technology in pulp and paper manufacturing sector.

Introduction

Paper making has two operations. One is unit operation and another one is unit process. From these we find ourselves started with the richness and breadth of phenomena that concurrently occur in papermaking processes. Gas, solid, and liquid phases are put into contact in different states of dispersion, where surface and colloidal forces, together with hydrodynamic effects shape the final outcome, i.e. the familiar sheet of paper. To begin with, while librarians expect paper to last for hundreds of years, [1-2] most paper either gets thrown away or recycled within a matter of days or weeks. Whereas we treat the paper is one of the least expensive manufactured items, its production involves use of some of the most expensive systems of equipment.[3-4] Paper is among the most recyclable and environmentally compatible products – made mainly from naturally renewable materials,[5] but at the same time the industry has faced great pressure related to its environmental impact.[6-10].To manage the pollution problems due to the bleaching process all over the world the pulp and paper manufacturing sector goes to TCF bleaching to avoid the formation of 2,4,7,8 TCDD , 2,3,7,8, TCDF .. There are a number of apparent contradictions inherent in the papermaking process, which continues to make this a fascinating field of science and art. Even as we begin to understand the principles behind what at first appears to be magic, we owe profound respect to the craftspeople in China and elsewhere that discovered and developed this subtle and economically important process

Nano Technology

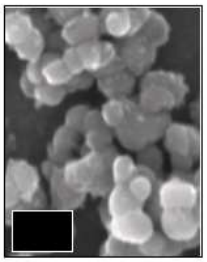
The new buzz word in the 21st century is "Nanotechnology" which was proposed by Professor Taniguchi from Tokyo University of Science in 1974[11]. He predicted that the production technology to get the extra high accuracy and the ultra fine dimensions, i.e. the preciseness and fineness, would reach to the order of nanometer by the year 2000.

At present, the nanotech-products have been widely spread as his prediction, especially in the area of electronics and new materials like carbon nano tube discovered by Professor Iijima from Meijo University[12]. We apply nanotechnology to papermaking in the area of stock preparation especially in filling and Refining as a materials like fillers, chemicals and pulps under the concept of "more function for new paper products while saving natural resources".

Role of nanotechnology in paper industry

Nano enhanced photocatalytic coated paper (nano- pigment)

Titanium dioxide (TiO2) strongly works as a photocatalyst oxidizing organic substances under the UV-light. This effect is well-known as the "Honda-Fujishima effect" discovered in Japan[13]. With the photocatalytic effect, organic substances can be decomposed into CO_2, H_2O and so on. In paper industries, the photocatalytic TiO_2 used as filler has already applied to some paper products. However, in this experiment this material as coating pigment because it must be better in retention and more effective than that as filler. TiO_2 pigment of about 10 nm in diameter works much more effectively as a photocatalyst than that of bigger size, which effect is brought by larger specific surface area (Photo 1). With using this 'nano-size TiO_2',



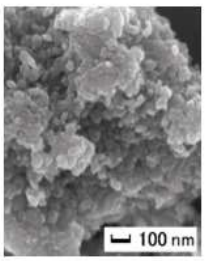


Photo 1 : TiO_2 commonly used in paper industry (Specific surface area; 9 m^2/g)

Photo 2: Nano-size photocatalytic TiO_2 (Specific surface area; 280 m^2/g)

New nanotechnology Refining of pulp

All the paper manufactures have a look into power consumption in the refining area. Refining changes the fiber surface nature by means of Fibrillation or by cutting. We

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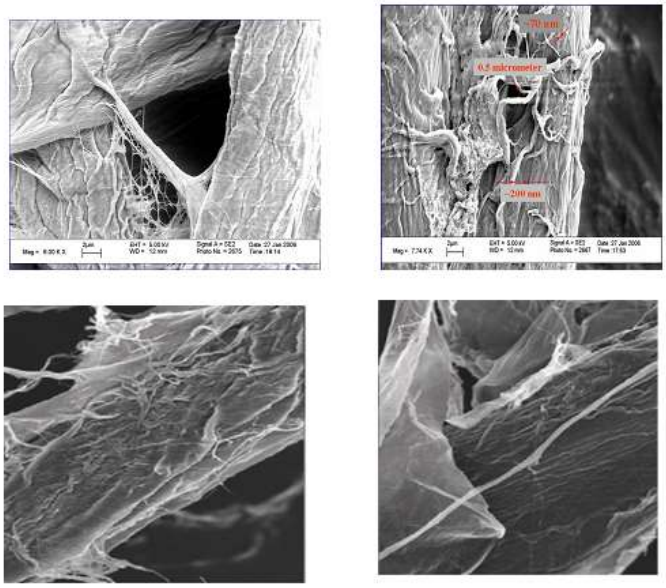
approach the nano-fibrillation of fibers by new beating technology by means of nano sized particles emulsion with minimizing the loss of strength which leads to strength improvement. This new technique gives a characteristic fibrillation to fibers, i.e. the surface of each fiber can be selectively beaten and extremely thin outer layer which thickness is only scores of nanometer is peeled off, and minimizes the generation of fines and also the damage of fibers. Nano-dispersed chemicals which mean nano-size particles of emulsion such as latex, pigment and bulky agent realize maximizing its effect and easy handling simultaneously. Nano-fibrillation fibers make the paper sheet bulky with smooth surface.

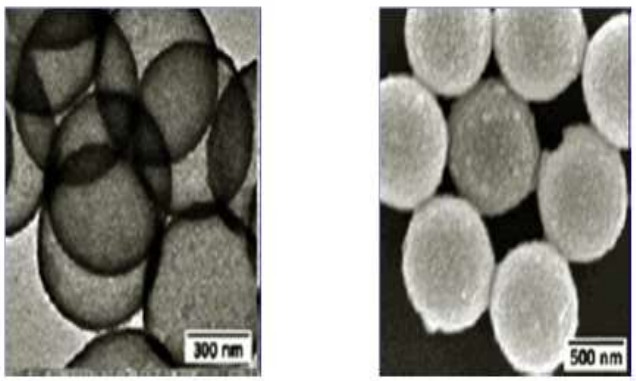


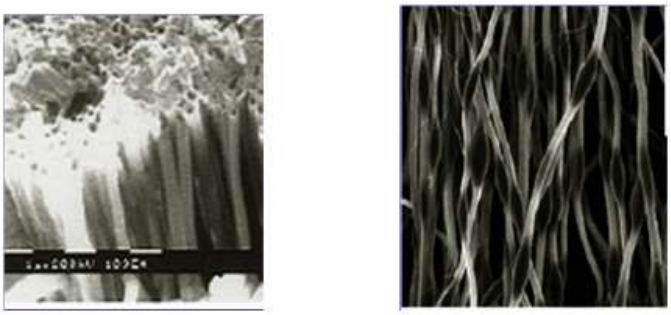
SEM Photo 2. Left; Pulp refined by conventional technique (Cell wall is damaged.)
Right; Pulp refined by new technique (Surface is thinly peeled and cell wall is not damaged

Nano Structured Filling Engineering

Another approach is nano-composite fillers that consist of calcium carbonate and silica. Paper containing these fillers shows better optical properties, ink absorptivity, higher internal strength and lower density compared with usual fillers.

Nano sized TiO_2 materials enhance titania's unique properties by giving large surface areas . It is given in the photos and the improvement of strength properties using nano silicate fibril fillers is depicted as given below.





Nanoparticle retention systems in modern papermaking

Retention of fibre fines and filler using nanoparticle retention system has taken a front seat in the modern day high speed paper making. The mechanism has gone through a phase change from micro particle system to nano particle system.

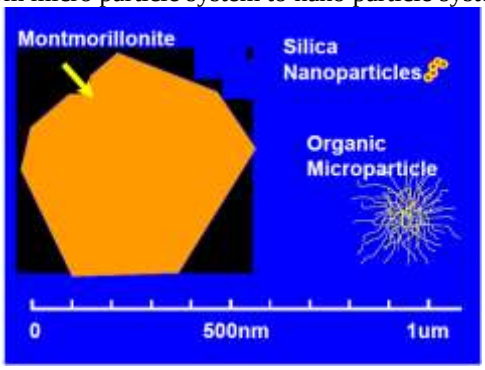
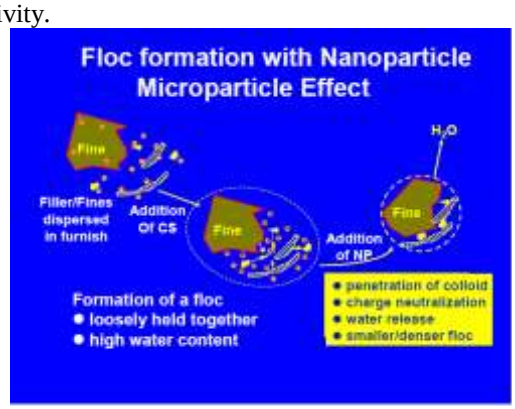
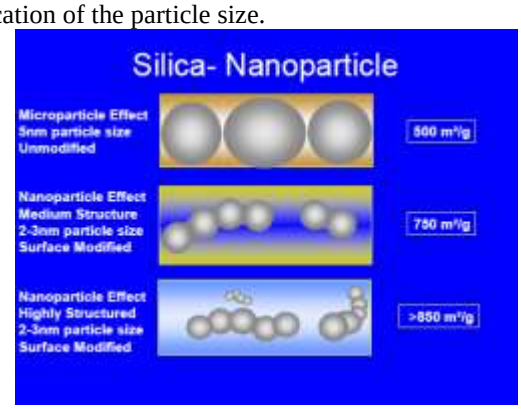


Figure below depicts the mechanism of floc formation in a nanoparticle based system, incorporated into papermaking. The nanoparticle addition improves retention and aid faster water removal, which is the need of the hour for improving productivity.



The nanoparticle effect of silica is engineered to improve retention and improve water drainage, by structured modification of the particle size.



The nanoparticle retention and drainage system thus gives the following additional advantages

- Increased Speed
- Steam Savings
- Improved Texture
- Improved ZDT and Plybond
- Improved Sizing
- Reduced Dye usage

Conclusion

The new materials and final products by the application of nanotechnology have been developed thro out the world. In future, nanotechnology has made impact on our paper manufacturing processes such as preparation of raw materials, pulping, papermaking, coating, printing and environmental process. From the surface property of a nano coated paper Gloss , wax pick , Printing opacity shows a improved quality as compared to ordinary pigment coating . The refining of cellulose fiber to enhance the fibrillation by ordinary refining in medium or high consistency leads to cutting of fiber surface will produce lower strength properties while the nano technology improves the good fibrillation and produce better strength properties. Nanoparticle retention and drainage system has made papermaking reach very high speeds of manufacture at the same time provide improved benefits.

Future work

Further Research and Development on Bleaching, Chemical Recovery and Effluent treatment process add higher value by nanotechnology will have to be continued. Cost reduction technology and user friendly way may increase the application of Nano Technology in pulp and paper industry and will boom the profit by cost control.

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