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Manufacturing and Application Development of Phosphorylated Cellulose Nanofibers

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In order to realize a sustainable society, multifaceted utilization of woody biomass is expected. Among them, cellulose nanofibers (CNFs) are attracting attention as a new nanomaterial derived from cellulose, one of the major components of trees. We have established a unique CNFs production method by introducing phosphate groups to the hydroxyl groups of some of the cellulose molecules in wood pulp and mechanically processing the resulting phosphorylated pulp. The obtained phosphorylated CNFs were completely nanosized (about 3 nm in width) with high yield, and its aqueous dispersion was highly transparent, highly viscous, and stable at pH 3-11. The aqueous dispersion of phosphorylated CNFs can be dehydrated and dried to form transparent CNFs sheets with densely intertwined CNFs. This sheet has high transparency, strength, and thermal dimensional stability, and at the same time, it has paper-like flexibility. In order to promote the practical use of this technology, we are currently operating a demonstration plant for the production of phosphorylated CNFs aqueous dispersions and phosphorylated CNF sheets. As the first stage of practical application, the aqueous dispersion of phosphorylated CNFs are used as a thickening agent for cosmetics and a leading agent for concrete pumping, and the sheet is used as a material for table tennis rackets. Furthermore, by modifying the functional group, the phosphorylated CNFs could be dispersed in organic solvents. The modified CNFs can be converted into powder, and its solvent dispersion has the sametransparency and viscosity as water dispersion. This has increased the applicability to solvent-based applications. We will continue to take advantage of the features of phosphorylated CNFs to develop further applications.

Characteristics and Applications of Xanthated Cellulose Nanofiber

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Our company, Rengo, found that xanthated cellulose nanofiber (XCNF) with a diameter of about 3-10 nm can be generated efficiently by controlling mercerization and sulfurization conditions. Such obtained XCNF can be easily converted to a non-substituted cellulose nanofiber (RCNF) form by treating XCNF with either heat or acid[1]. As RCNF, our product have extremely small in diameter and with high transparency. Moreover, since it is still cellulose, its heat resistance is almost same as normal pulps. Furthermore, RCNF slurry exhibited emulsifying performance for many oily substance[2),3)]. Based on these characteristics of RCNF, various applications are under development. In this presentation, we reports about making method of RCNF drying thing, the heat resistance and the addition effect to polyurethane.

All-Cellulose Structural Material

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Vulcanized fiber is a robust all-cellulose material in which cellulose micro fibers are adhered with cellulose nanofibers (CNFs). In order to expand the potential of this all-cellulose material as a structural material, we investigated adhesives and press molding. The values of adhesive strength of commercially available adhesives and a conventional metal rivet were 0.7 to 8.5 N/mm^2 and 2.4 N/mm^2, respectively. A hot melt adhesive could bond the materials by irradiating ultrasonic waves only for 1 second and the highest adhesive strength was 2.9 N/mm^2. Furthermore, a small string of the all-cellulose material could be used as a bonding material like a stapler, showing the strength of 4.0 N/mm^2. In press molding, by optimizing the conditions on both the press and the material, wrinkle-free molded products were obtained. In conclusion, we could expand the processing technology and possibility of this all-cellulose material as a structural material.

Characteristics of Bamboo- and Wood-derived Cellulose Nanofibrils Produced by Aqueous Counter Collision

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The surface characteristics of materials provide significant information for design and feasible applications. Especially, the anisotropic surfaces of materials are expected to have great potential as building blocks for self-assembly due to the unique surface characteristics and have inspired widespread applications in various fields. Therefore, it is required the understanding and evaluation of the surface characteristic of materials.

The surface characteristics of cellulose nanofibrils (CNFs) produced by aqueous counter collision (ACC), which called ACC-CNFs, were focused in this study. ACC-CNFs were assumed to have amphiphilic surfaces due to exposure of both hydrophobic faces derived from glucopyranose rings and hydrophilic faces derived from hydroxyl groups on their surfaces. ACC-CNFs are likely to exhibit specific phenomena because of their anisotropic two faces with different physicochemical properties, which are individually present along the entire single fiber axis in aqueous systems. In previous studies, it was also found that ACC method provided CNFs with different surface characteristics from various cellulosic raw materials having different hierarchical structures depending on their species.

In this study, surface characteristics of ACC-CNFs derived from Bamboo bleached kraft pulps (BBKPs) and Leaf bleached kraft pulps (LBKPs) were evaluated. To evaluate amphiphilic surfaces of ACC-CNFs, degree of hydrophobicity on ACC-CNFs was quantitatively determined by measuring monolayer adsorptive amounts of Congo red (CR), which is the site-specific probe for the hydrophobic planes of cellulose crystalline surfaces. Occupied area ratio of CR was calculated from monolayer adsorption amounts of CR, specific surface area of ACC-CNFs, and cross-sectional area of CR. As a result, degree of hydrophobicity on ACC-BBKPs was higher than that on ACC-LBKPs. Furthermore, the degree of hydrophobicity was corresponded to thermal decomposition and emulsification properties of ACC-CNFs. Thus, these results indicate that the starting raw material species of ACC-CNFs affect their hydrophobic surfaces and characteristics. It is expected by these understanding that more feasible material design for advanced materials will be possible in a wide range of field utilizing the ACC-CNFs.

TEMPO-oxidized pulp related products in Nippon paper Industries: -Expanding the utilization technology of chemically modified cellulose not only for CNF-

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Since people's interest in the environmental problem has grown significantly over the recent years, it is widely expected that low carbon society or sustainable society will be implemented. Pulp or paper products are expected to become an alternative materials of current fossil fuel based products, because biomass are sustainable which repeat planting and harvesting. Nippon Paper Industries Co., Ltd. provides wide variety of biomass based products by adding novel function to wood based paper or paper pulp. Cellulose nanofiber and the related products are also one category of these biomass based products.

TEMPO oxidized pulp, which is one of the intermediate products of CNF, has several unique features such as high reactivity to metal iron and ammonium ion, excellent handling character like wood pulp, and possibility of wide variety of utilization.

In this paper, 3 types of utilization patterns will be introduced, ① Hydrophobic modified cellulose, ② Metal ion doped cellulose which adsorb highly (8～20% higher than normal pulp) metal ion on the surface of pulp, ③ Microfibril cellulose (MFC) which control fibrillation degree for the appropriate physical properties.

Paragon winding
- Our revolutionary patent-pending winding technology-

Taihei Kashibe
Paper Converting Machine Company Far East Inc. Japan Branch

PCMC's New Surface Rewinder “Paragon”provides unmatched simplicity, productivity, and product quality for premium tissue products. It is designed based on our Forte Rewinder what has an unique winding technology.

Some of technologies and contents introduced in this paper include patent information, so we are sorry that we cannot disclose all of them, but we hope that you will be interested in these innovative and epoch-making technologies.

Some familiar technologies that has been followed from the conventional model are included in these newness designs, and each parts are rigorously designed to reduce concerns from operators and maintenance personnel due to complexity.

We would like to thank you for this opportunity to introduce us to a wonderful technology to meet the demands of the market.

Introduction on how KAWANOE realizes “together with our customers” utilizing our pilot plants and the tissue machine for hygienic paper

Masaya Onishi
Kawanoe Zoki Co., Ltd.

Due to recent heightened awareness of sanitation generated from COVID-19 outbreak, we as a machine supplier have responded to the customer’s needs such as capital investment in increased production of hygienic paper products including towel paper.

In the paper making industry, paper as information media such as newspaper continues to decline, while production facilities are shifting toward the increasing use of corrugated board and hygienic paper.

We offer a variety of paper machines, primarily for hygienic paper (household tissue paper) equipment, to the converting machines. Under these circumstances, we have received orders and manufactured hygienic paper production facilities that reflect the needs of the market, such as the BestFormer Yankee paper machine for household tissue paper, IF-200 towel paper Inter Folder machine, and TR-8 toilet winder.

In addition, in order to reflect customer demands on actual machines, we are preparing for a pilot facility for a non-stop winder that can verify operation data assuming the production and actual operation of prototypes that could not be handled until now, and is scheduled to begin its operation in October of this year.

We are also researching and developing cellulose nanofiber, which is expected to be a next-generation material, focusing mainly on its dewatering technology.

A pilot machine is produced together with Ehime University, etc., which we are collaborating, and further technology development is carried out based on the patents already obtained.

Andritz Tissue Pilot Machine

Satoshi Konishi
Andritz K.K.

Despite the global spread of the COVID 19 and the economic damage due to the virus, the global market of tissue paper and hygiene products tends to grow. The growing demand will be met by existing tissue paper suppliers and the newcomers, but they must require the advantages of the types of products and product quality to survive. And in recent years, the introduction of digital transformation and AI technology in plants has made remarkable progress, becoming the key to factory efficiency.

This report introduces "*Prime*Line TIAC" the most modern tissue pilot plant in the world. The plant is running in Graz, Austria since March 2018 to engage in our future theme. This machine can provide as many as eight configurations in one machine, the customer will be able to do trials that match their future vision. It can handle multiple requirements and purposes not only for tissue suppliers but also for pulp suppliers, chemical suppliers, and clothing and filter fabric suppliers.

And, this pilot machine is controlled by *Prime*Control E which is Andritz digital solutions. It can operate as many as eight configurations in one control system, and save time, cost, and energy by the optimization of monitoring with mobile devices and the predicting that equipment failure or malfunction. As a result, the plant efficiency can increase. The OPP service optimizes the process performance by collecting data continually, analyzing and proposing the improvement. It already has more than fifty contract achievements in more than eleven countries.

We hope you will be useful this pilot machine for changing the products and developing the new products.

Revolutions in the history of civilization induced by paper
The summary of the series：Part 1

Kiyoaki Iida

Until the paper was invented, letters were written on clay tablets and papyrus rolls for more than 3000 years and on bamboo slips for over 1000 years. Those media and letters on them, at their beginning, helped dynasties to administer territories, then gave birth to literature and philosophy in about 500 years and further contributed to development of physical and medical sciences by keeping various records. The result accomplished by help of clay tablets and papyrus in 3000 years was Greek civilization which prospered in Ancient Orient and Mediterranean coast, and the outcome by bamboo slips was civilization of Han dynasty in China.

In around 100 A.D., a revolutionary process of making paper was invented in China. One of its technical advantages was to use, as raw material, several kinds of bast fiber as well as usual rags. The process spread around, East Asia and South-east Asia using bast fiber which grew naturally there, and Central Asia being dependent on rags. In about 500 years since the invention, tribes in those regions, having paper in hands, created their own letters, and developed their own civilizations which were modified from that of china. Buddhism took great part in the spread of paper and reformation of civilizations. Japan was typical among them.

In the 8th century, Greek and Roman civilization was recorded on papyrus and parchment in Middle East and Mediterranean coast. Tribes in Central Asia, and East and South-East Asia made record of their own civilizations on paper they newly obtained.

Trends in Nanocellulose Related Standards

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Specific discussions on the standardization of nanocellulose began in 2005, when the new TC (TC 229: Nanotechnologies) started its activities within ISO. In particular, the role of the American Technical Association for Pulp and Paper (TAPPI) has been significant, and after holding a series of related workshops to discuss the types of standards that may be needed and the schedule for their publication, the basic policy was summarized in the form of Roadmap for the Development of International Standards for Nanocellulose (TAPPI-roadmap) published in 2011. After that, taking into account the policy of TAPPI-roadmap, the development of standards has been promoted in two systems, ISO/TC229 and ISO/TC6 (Paper, Board and Pulps).

In this paper, the overall picture and each theory of the standards discussed in the TC229 and TC6 is explained. In addition, ISO information necessary for a better understanding of nanocellulose relevant standards is summarized. Lastly, the outline of the development process of ISO/TS 21346, which has been developed by Japan's initiative, is presented in the hope that it will be useful for future standard development activities in this field.