Nano Fiber and Japan’s Paper Industry
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In this issue we present several articles related to nano technology in the form of cellulose nano fibers, chitin nano fibers, and nano surfaces. When it comes to the converting field, in particular, nano technology is not an independent technology—something with its own dedicated engineers and scientists—but is part and parcel with all of the individual converting technologies. In fact, when we talk about nano technology in the converting field, we are often referring to coatings and materials that contain nano particles or talking about the nano structure of the surfaces on which coatings or films are applied. Of course, the analysis equipment is a big part of the topic, but such equipment is best left to the experts.

Instead, most of us in the converting field are most interested in nano particles or nano materials. These are what provide functionality to coatings and films. Because the nano world is strange and can change depending how you look at it, it offers nearly limitless potential. For example, most of our long time readers are familiar with a yogurt lid designed to mimic the surface of a lotus leaf in order to prevent yogurt from sticking to the top, but in this issue we present a short article that uses that exact same structure as a template to produce a near perfect light absorbing surface. In another example from the natural world, researchers are taking naturally existing resources, such as discarded crab shells and tangerine rinds, and producing nano fibers that are lighter and stronger than steel.

In this way, we must remember that the nano world is not something that is being created in a laboratory, but is something that exists all around us. It just requires better instruments to work with and a flexible mind to foresee the potential. As we come to better understand the nano world and how to utilize it, it will begin to penetrate every aspect of the industry. Already we are seeing nano fillers being used to improve the barrier properties of films, but we are also seeing nano particles being included in the foods and cosmetics contained within everyday packaging.

This greater understanding of the nano world makes this an exciting time for converters, but it also places higher demands in terms of equipment precision and work environment cleanliness. For this reason, we do not shy away from this difficult topic, and hope our readers are as excited as we are.
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MIZOBATA SHIKO Printing Co., Ltd.

Sputtering Lotus Leaves in Gold to Produce Materials With a Reflectivity of 1%
Tokyo Institute of Technology/ Shibaura Institute of Technology

Laminating Flexible Touch Screens to Curved Panels for Improved Interior Car Design
FUK Co., Ltd.

Orders for the New FX2 Pour In From Around the World
THINK LABORATORY CO., LTD.

New HDF-505-1300 Flexible Packaging Slitter Designed to Ease the Burden of the Operator
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Akira Hayashi
Founded in 1947 by Yasuo Mizobata, Wakayama, Japan based MIZOBATA SHIKO Printing Co., Ltd. (MIZOBATA) has been around for almost 70 years. Counting from the start of the Mizobata family printing business, however, this printer has more than 100 years of history. Today, their focus is on converting and printing paper products for the food and beverage industry, with a goal of holding the largest share of paper products supplied to restaurants. Aside from their three core products—chopsticks envelopes, wet paper towels, and napkins—they also produce many other products familiar to restaurants, including coasters, aprons, and cooking paper.

They have already held the largest share in Japan for converting chopsticks envelopes and wet paper towel bags. In addition to paper products, however, they have also become interested in flexible packaging. As their first step in entering this field, in November 2015 MIZOBATA installed a Miyakoshi Printing Machinery Co., Ltd. MHL18A Led-UV sleeve type offset press for short-run flexible packaging, the second such machine installed in Japan. Given that they hope to develop flexible package printing into a fourth core business by the end of 2016, the fact that they have already printed their first job shows they are off to a good start.

From 18-colors to 4-colors
In Japan, disposable wooden chopsticks are commonly used by restaurants and Japanese-style pubs in place of real chopsticks. Although most of the envelopes used to hold these are indistinct, in some cases the envelopes are printed in attractive designs. According to Tetsuo Saraya, managing director, a decade ago they needed 18 colors to print the different types of envelopes. At the time, however, they only had 4-color rotary offset presses, so they would print envelopes from different jobs together that used the same four colors as a single run (typically printing 14 or 16 envelopes per sheet). This was the start of what is today called gang-run printing, and naturally had an impact on delivery times. Mr. Saraya goes on to say that although they were able to quickly deliver envelopes printed in red or brown, commonly used colors, orders requiring unusual colors would delay putting together enough types of envelopes for one job, and thus delay delivery.

Proposals to switch to process colors (CMYK) had been made as far back as 15 years ago, but printing 16 envelopes per sheet placed severe precision requirements on the printing machines, while process colors limited the reproducible color range. Moreover, reproducing spot colors with process colors is difficult, so the idea was put on hold. When they updated their printing machines in 2010, however, they finally made the decision to switch to process colors. With this move, they were now able to deliver jobs within two days and handle minimum runs of 5,000 units.

Although it is obvious that the envelopes are made primarily through a standard roll-to-sheet converting process, the specifics of the chopsticks envelope converting lines are kept secret. In fact, their top share in the industry has even attracted the attention of television networks in Japan, but MIZOBATA has only shown certain areas of the plant during their
The ultra-water repellant effect of lotus leaves known as the lotus effect has been commercialized by aluminum foil makers as a non-stick yogurt container lid material in the past. More recently, Professor Kotaro Kajikawa and second year master’s student Yuusuke Ebihara of the Interdisciplinary Graduate School of Science and Engineering, Tokyo Institute of Technology (TIT) have focused on the nano-structure of the lotus leaf surface and collaborated with a research group at Shibaura Institute of Technology lead by Professor Masayuki Shimojo of the College of Engineering, Shibaura Institute of Technology to develop a light absorbing material.

In fact, the black material produced by dry coating (sputtering) the surface of the leaf with gold has a visible light reflectivity of less than 1%. Typically, the micrometer size geometries of these types of metamaterials are made using electron beam lithography. In contrast, Dr. Kajikawa used a lotus leaf as the template and succeeded in creating a high efficiency, large area, ultra thin-film light absorbing nano-structure metamaterial.

According to Dr. Kajikawa of TIT, the team began its research in 2014 after considering whether the uneven surface of lotus leaves could be used for surface enhanced Raman scattering.* Surface enhanced Raman scattering (SERS) uses an uneven surface to enhance the Raman scatter signal by several million to several hundred million times. Because the research required sputtering, Dr. Kajikawa, who’s expertise is in light, says that Professor Shimojo’s expertise in sputtering and microscopes helped to accelerate the research.

It is known that the surface of lotus leaves is covered in countless 10 μm micro-bumps, each of which is covered in wax crystals. This structure is the source of the lotus effect. Using a high-resolution scanning electron microscope, the research team then discovered that this surface is actually covered in a random distribution of countless macaroni-like nano-structures (See Figure 1) with an external diameter of 100 nm.

The team then used sputtering, which results in smaller grain boundaries than vacuum deposition and applies little damage to the lotus leaf surface structure, to form a chemically stable gold thin-film on the lotus leaves. During sputtering the lotus leaves were affixed to a glass plate with tape. The resulting thin-film 10–30 nm thick optical metamaterial structure traps 99% of incidental light.

As shown in Photo 1, the area at the center of the glass (the area where the lotus leaf is affixed as a template) absorbs light, so appears black, whereas the tape used to lock down the leaf reflects light, so has a gold color. Despite both surfaces being coated in gold, the difference in reflectivity is clear. It is assumed that the countless macaroni-like nano-structures on the lotus leaf, which are what actually trap light, are the reason such gold coated materials appear black. Evaluations show that the light absorbing structure of this metamaterial reflects less than 1% of all light in the visible light spectrum.

For purposes of comparison, when the group sputtered a gold film in the same manner onto several other types of leaves

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**Note: Surface Enhanced Raman Scattering**

Typically, the wavelengths of incidental light and scattered light are the same, but the vibrational energy of molecules can increase and decrease photon energy so that the scattered light wavelengths elongate and shorten, thus causing the scattered light wavelengths to differ in length from the incidental light wavelengths. This is called Raman scattering. Because Raman scattered light is very weak, surface plasmons (free electron waves in structures such as metal surfaces and metal nanoparticles) can be used to enhance the Raman scattered signal. This is called surface enhanced Raman scattering.
collected on the TIT campus, they found that these did not turn black, but turned gold (Photo 2). These results helped them to conclude that the lotus leaf nano-structure plays an important role in trapping light.

Optical metamaterials are substances that exhibit a unique optical nature using artificial nano-structures. As such, these hold the potential for use in negative refraction, turning substances invisible (cloaking), and as high-efficiency light absorbing structures, so have garnered the attention of many researchers. Many such optical metamaterials are produced using micro-machining technologies, however, so it has been difficult to produce these at low-cost and over large-areas.

In contrast, as shown by this research, naturally existing materials, such as lotus leaves, can be used as a template to form extremely thin gold films of 10–30 nm the result in a light absorbing structure. As such, the team expects these to be used in improving the conversion efficiency of solar cells and as high-efficiency photothermal conversion materials. Their research also hints at the possibility of realizing a variety of other large area optical metamaterials made using these types of natural nano-structures.
Based on the number of units delivered by manufacturers, the car navigation system market is anticipated to grow globally at a significant rate, with the 17 million units shipped in 2013 expected to reach 20 million units in 2016. When looked at from the perspective of the user, however, existing car navigation systems are not always convenient, because they tend to rely on after-market installation, while most require specialized controllers and use resistive touch screens. Even built-in car navigation systems use flat monitors, so the design of these does not harmonize well with the curved interior designs often used in automobiles. Moreover, there is an expectation that large center information display screens, used to display various information in an integrated manner, will be installed in center consoles, which also hints at an increasing demand for curved touch screens that suit curved interior designs. For this reason, FUK Co., Ltd. has developed a new technology for laminating flexible devices directly onto instrument panel covers with complex curved designs. Although the market for curved monitors and three dimensional flexible devices lies in the future, this market is an ideal challenge for Mitsuo Uemura, president of FUK, given the company’s motto of “Creative Design. Innovative Process.”

Improving Smartphone Production Processes

FUK’s development of their three-dimensional curved surface lamination system began when a touch screen manufacturer came to them for advice on improving their production process for a smartphone equipped with a curved OLED display. Specifically, the yield was poor and the loss was high when they laminated the curved cover plastic and touch screen together.

Mr. Uemura explains that the company was laminating the smartphone units in a conventional vacuum chamber (“vacuum lamination”), after which the chamber was deaerated to remove the entrapped air. One problem was that it was difficult to expel the air from the curled cover plastic and that, unlike glass, the cover plastic, which was primarily polycarbonate, is not uniform. As such, the polycarbonate does not conform well to the one type of die-mold they were using, which often caused the yield to decrease. In the worst cases, half of the units were defective, and even after making improvements 10% were still defective, which was a major problem for production. For this reason, Mr. Uemura explains that the smartphone manufacturer was interested in FUK’s “Glass Bend Lamination System,” which uses a roller to efficiently remove the air by controlling the contact surface instead of using a vacuum chamber.

During conventional “vacuum lamination,” the flexible device (touch screen, touch sensor, etc.) and cover plastic anchored to the die-mold using an OCR (optically clear resin: liquid adhesive) are simultaneously pressed and laminated over the entire surface. As such, the air gap between the die-mold and the cover plastic becomes a problem. The Glass Bend Lamination System uses a roller to laminate the flexible device without the need for a vacuum chamber and is able to control the contact point (tangential contact) between the
Orders for the New FX2 Pour In From Around the World

THINK LABORATORY CO., LTD.
www.think-lab.com

THINK LABORATORY CO., LTD.’s New FX2 has been installed by large-scale converters and gravure cylinder makers around the world, including those in China, Taiwan, Korea, Indonesia, India, and many other countries, and the pace of orders has only been increasing. Although hard to believe, one Japanese large-scale converter has even realized yields of nearly 100% with the New FX2. Tatsuo Shigeta, President of THINK LABORATORY, is unable to hide his surprise at these results, saying this is proof of the machine’s excellent control. In this way, users of the New FX2 cylinder making system are also driving its further evolution.

Thus far, THINK LABORATORY has shipped some 40 to 50 units globally, making for one to two units a month. In fact, four New FX2 systems were simultaneously installed at the Kyushu Plant of Custom Gravure Co., Ltd., a Japanese gravure cylinder making company, all of which began operations in January 2016. Each machine is aligned in series so that one operator can handle two lines at once in a highly rationalized approach to operations. Using the four lines, the company produces a wide variety of printing cylinders, ranging in length from 200 to 1,400 mm. All printing cylinders are made automatically.

Given the range of users, the New FX2 has been employed to make a surprisingly wide variety of gravure printing cylinders. One such example provided by Mr. Shigeta was the gravure cylinders used to produce 0.4 × 0.2 mm multi-layer ceramic capacitors. Mr. Shigeta explains that a single smartphone will contain several hundred of these units, which look like grains of sand. Despite their appearance, each unit is actually composed of several hundred layers of alternating dielectric and conductive layers. The conductive layer is printed with precision gravure cylinders made using their laser gravure cylinder making technology.

Addition of new technologies to the New FX2 is also opening new territory. For example, THINK LABORATORY is expanding the use of dot codes, a two-dimensional code composed of microscopic dots developed by Gridmark Inc. of Japan. Until recently, the microscopic dots were gravure printed using carbon ink, but a newly developed transparent infrared absorbing gravure ink allows these dot codes to be printed on areas of cyan, magenta, and yellow. Moreover, because the ink is invisible dot codes can also be used for security and product recognition applications, as well as universal design that can provide voice and video data. The dots are read with a specialized pen in which an infrared camera has been integrated, or with devices such as iPhones or iPads. Dot codes can also contain a URL link to a voice recording. After touching the dots with the pen, the pen can be rotated to select one of five different languages to replay the voice data. Naturally, the printing cylinder is made with a New FX2.

THINK LABORATORY exhibited at Printable Electronics 2016, held in Tokyo this past January. During the exhibition, some of the applied examples of gravure printing technology that gathered the attention of visitors included a touch screen electrode printing cylinder and a cylinder for transferring micro-lens arrays and holographic patterns onto film.
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Number of Cylinders Made by Laser Per Day Globally
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New FX 2
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For the first time in nearly 20 years, Hagihara Industries Inc., a Japanese slitting equipment manufacturer, updated its flagship flexible packaging slitter model. With a focus on operability, the new flagship HDF-505-1300 duplex center drive slitter was designed specifically to reduce both the physical and mental burden of the operators in every way.

Focusing Development on the Operator

In the past, slitting equipment manufacturers would independently design new models and only allow users to determine their value after release, but today development is more often based on the requests of their customers.

Tatsuhiko Iiyama, managing executive officer of Hagihara Industries, says that over the past 20 years since they began manufacturing and selling slitters, they have received many such requests from their customers, and have recently been shipping 100 units per year. In fact, he goes on to say, they have taken this 20 year mark as an opportunity to release a new flexible packaging slitter model ahead of their competitors.

Masatomo Kushiro, director of the development department, explains that the focus of development did not prioritize the latest technologies, but instead prioritized easing the use for the operator. Mr. Iiyama adds that the specific goal was to reduce the burden placed on the operator during operations and to eliminate as many of the frustrating tasks as possible. In other words, the model was developed as a machine that an operator would choose.

(1) Easing Unwinding Roll Loading

By adopting a dual-sided press cone method and swing arm lift mechanism, the roll only needs to be carried to the indicated position, after which a button is pressed to lower the swing arm to the roll position. The dual-sided cone system then securely grips the unwinding roll core and raises it for loading.

The conventional model uses a one-sided press cone system and uses a lift that is independent of the main machine. As such, the lift itself is an obstacle that forces the operators to...
Designing a New Flexo Printing Machine to Rival European Performance and Meet Japanese Quality Demands

SOBU Machinery Co., Ltd.
www.sobukikai.co.jp

SOBU Machinery Co., Ltd. has been developing a new CI flexo printing machine, the SFCI-0813, designed specifically for flexible packaging printing. Ultimately, the machine is planned to handle eight or ten colors, but to uncover the needs of the industry and verify the mechanical functionality of the machine, they plan to install a four color pilot line at their plant in 2016. Promoting the machine under the name “water green,” SOBU Machinery’s goals are to rival or exceed the functionality of European made CI flexo printing machines and to meet the demands of Japan’s flexible packaging printing industry. In order to meet these goals, SOBU Machinery is focused on several points, including improving short-run operational efficiency, improving print quality, decreasing print loss, and improving high-speed stability.

SOBU Machinery originally exhibited the “water green” printing concept at JAPAN PACK 2015 in October. During the event, they found that there was more interest in a Japanese made water-based CI flexo printing machine than they had expected.

Currently, they are moving forward with the development of a pilot line to install in their plant sometime during 2016. The planned specifications for the pilot line include four color (CMYK) printing, a printing speed of 400 m/min., a maximum printing width of 900 mm, and a printing repeat length of 370 to 900 mm. The specs for the production model will be 8 or 10 colors, printing widths of 820, 1,100, 1,300, and 1,700, a printing speed of 400 m/min. and a repeat length of 370 to 900 mm.

Shigeyoshi Ohtake, president of SOBU Machinery, comments that their ultimate target for print quality is that of gravure printing, so the challenge is quite difficult. At the same time, realizing performance and convenience that suit the needs of Japan’s flexible packaging printing industry is also an important issue. In order to reach these goals, they began designing the machine with four major development themes in mind: improved short-run operational efficiency, improved print quality, reduced print loss, and improved high-speed stability.

In terms of improving the short-run operational efficiency, sleeve type plates and anilox rollers allow for automatic sleeve change out. In addition, they plan to install an ink circulation system with an automatic cleaning system made by TRESU, a Denmark based international supplier of printing related equipment, to reduce the time and effort required to wash the plates and chamber when job changes are frequent.

Mr. Ohtake explains that they also plan to install a warm water circulation type temperature control system in the CI drum to improve print quality beyond that of what is currently realized by Japanese flexo printing machines used for conventional applications. They expect that this will reduce ink blurring and drying defects that occur during film printing. In addition, they intend to control the CI drum and printing drive motors together using the same virtual master to achieve direct line control.

Good register position will lead to less printing loss, so “water green” is designed to use an automated registration function consisting of a high-precision servo motor length registration system and an automated plate register device. The machine also includes a ball screw for applying pre-load, a heavy-load bearing, and a high damping coupling to improve the dynamic rigidity and precision under printing pressure.

Another issue they needed to deal with was the radiant
heat from the drying equipment between colors and the motors, which raise the internal temperature of the machine during high-speed operations. The higher temperatures can change the printing pressure, and in some cases affect the resulting print quality. As a solution, SOBU Machinery is considering using a laser displacement meter with a precision of 2 μm to measure the dimensional variation between the plates and the anilox rollers as well as between the CI drum and the plates, where control would be based on these measurements. In addition, to stabilize the doctor blade pressure, they adopted a design where the supporting shaft is located at the center of the blade, which increases the blade's durability under high-speed printing. For users that print household goods, such as toilet paper or paper towels, they are also considering including a TRESU device that removes the paper dust generated during high-speed printing.

SOBU Machinery has also been sending its younger design staff to undergo training at a printing company to learn how to operate printing machines. They hope that their experience will work its way back into the design.

Contact Type Desk-top Film-Sheet Thickness Measuring System

**Specifications**

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<th>Accuracy (at 20°C)</th>
<th>Measuring force</th>
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<td>0.19 N (0.12N)</td>
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ORIENT SOGYO Dedicates Its New Headquarters and Plant, Improving Efficiency and Opening the Way to the Future

With a total investment of 1.37 billion JPY, the Japanese converting equipment manufacturer ORIENT SOGYO CO., LTD. finished completion of its new head offices and plant on November 25, 2015, and began full operations shortly thereafter on December 1. Located in nearby Komaki in Aichi Prefecture, Japan, equipment assembly at their original head offices and plant was spread out over four locations, including rented warehouses, making for poor efficiency. As such, the move was aimed at increasing efficiency through integrating the design, machining, and assembly workflows. Purchase of a plot of land in neighboring Kasugai City, however, could only be made once they had first settled on a time line to pass the reigns of leadership to the next generation.

In November, ORIENT SOGYO held a dedication ceremony with the converters FUJI TOKUSHU SHIGYO co., ltd. and Chukyokagaku in attendance. Following the ceremony, the company offered a tour of its new plant and a reception, which were attended by 80 customers and persons involved in building the new facility. Hidenori Harada, managing director, closed the event by expressing his passion for the future as he looks forward to leading the company into the next generation.

The new plant, covering 5,900 m² of the 11,000 m² site, is located in the heart of Aichi Prefecture, Japan, just north of Nagoya. The first floor of the building contains the plant (assembly, machining, painting areas) and production office, the second floor contains the warehouse and development space, and the third floor houses the offices for design, management, sales, development, the server room, and meeting rooms.

The machining area is equipped with 10 machine tools. Along with the move, they also installed a new JTEKT CORPORATION FH800SX-i horizontal spindle machining center. This machining center is equipped with 120 different tools, and has a two pallet changer. ORIENT SOGYO states that the new piece of equipment will be used to machine components involved with quality as a means of raising the standard of the assembled units. In this way, they see shifting to in-house production of parts as a way of providing better machines.

The machining room also has a YAMAZAKI MAZAK CORPORATION vertical machine center with a six pallet changer, an Okuma Corporation double-column machining center, a two ton crane, and a 2.8 ton crane. The neighboring room is equipped with a roll machining space.

The assembly plant is 25 meters wide, 70 meters long, and 13 meters high. The floor is covered in two locations over a length of 66 meters and 46 meters with 22 mm thick steel plates. This allows them to assemble four gravure printing...
Barrier Packaging Reduces Food Loss and Packaging Material Volume

Japan Food Packaging Association
shokuhou.jp

With the increased awareness of food safety, the demand for longer shelf-life, and the need to reduce food loss, sales of high barrier films have been gradually increasing. In light of these industry trends, the Japan Food Packaging Association held its Food Packaging Technology seminar in November, 2015. During the seminar, representatives from UNITIKA LTD., Dai Nippon Printing Co., Ltd., and DIC Corporation each spoke on advanced gas barrier materials.

High Gas Barrier Remains After Boil/Retort

Ai Kobayashi of UNITIKA Market Development Group, Packaging Films Sales Department, states that despite the slight drop in flexible packaging film sales from 2011 to 2013 in Japan, a closer look shows that barrier films saw steady growth during the same period. This growth is based on the desire of the food industry to extend food shelf-life and decrease food loss, a trend that is being seen around the world. As such, UNITIKA expects the barrier film market to continue growing into the future.

In regard to the status of barrier films in 2013, Ms. Kobayashi introduced some data provided by Fuji Chimera Research Institute, Inc., a Japanese market research company. The data show that the total sales volume of barrier films was 67,500 tons, the majority of which was accounted for by aluminum metalized film (38%). Transparent deposition film accounted for 22%, PVDC coated and nylon coextruded film for 14% each, PVA coated film for 8%, EVOH coextruded OPP film for 2%, and nano-composite and organic-inorganic hybrid film for 1% each. Although the barrier film market primarily consisted of aluminum metalized film for conventional retort foods in the past, there has been a recent and rapid increase in microwavable retort foods and an increase in transparent deposition film. In addition, there has been a rising number of examples of non-retort foods adopting barrier films to extend shelf-life and examples of cans and bottles being replaced with more convenient barrier film pouches.

In targeting these barrier film markets, UNITIKA developed its Emblem HG high gas barrier nylon film specialized for boil/retort applications in January 2015. The film consists of a 15 μm thick nylon film with a 1 μm thick organic barrier layer wet coated to one side. Even after boil/retort, the film maintains a barrier property with an oxygen transmission rate (OTR) of less than 5 ml/m² · day · MPA and maintains the strength of the nylon film. In retort tests after the packaging was flexed 50 times, the OTR of transparent deposition PET and transparent deposition nylon films increases to more than 25 ml/m² · day · MPA, whereas Emblem HG maintains its OTR of under 5 ml/m² · day · MPA. In addition, UNITIKA visually evaluated the barrier property based on the degree of color change by filling the packaging with a liquid that reacts with oxygen and turns blue (dyeing method). After retort treatment, vacuum packaging, and flexing the package 10 times, the film remained free of cracks (in both the seal and flexed sections) and thus maintained its barrier property. Corn on the cob packaged in Emblem HG did not undergo any discoloration after one month at room temperature and jelly did not undergo any discoloration even after nine months. Thus far, the film has been used for pudding, cut vegetables, and pickles, among other foods.

IB-Film Transparent Vacuum Deposition Film Bends Without Sacrificing Barrier Property

Shigeki Matsui of DNP introduced their IB-Film transparent vacuum deposition film created using the company’s plasma-enhanced chemical vacuum deposition (PE-CVD) method originally developed by DNP in 1988. Mr. Matsui explains that the PE-CVD method differs in three ways from physical vapor deposition (PVD) methods used to produce silica deposition films. The first is that the film forming process is conducted...
Various types of medical packaging have been used to prevent accidental administration and ingestion, as well as keep counterfeit pharmaceuticals from reaching the market. Despite this, there is still a question over what the best approach to protecting the safety of pharmaceuticals is and the role packaging should play. For this reason, during the 68th Symposium held by the Society of Packaging Science & Technology, Japan, specialists from a hospital pharmacy, packaging and printing companies, and a pharmaceutical company discussed the latest concepts in the field.

Safe Medical Packaging Design

Hiroshi Kanno, director of the pharmacy unit at a major hospital in Yokohama, Japan, spoke on medical packaging safety from the perspective of pharmacists. The hospital at which Mr. Kanno works handles roughly 1,000 outpatients and 500 inpatients per day. Despite the fact that the hospital pharmacy employs 39 pharmacists and 9 temporary staff (as of September 1, 2015) to handle this volume on a two-shift rotation, 30% of all accidents, including minor incidents, for the entire hospital are related to medications.

The wrong medication can be ingested because names such as Alotec, Atelec, and Allelock are very similar, but also because the design of the blister sheets cause confusion. When individual doses are removed from such blister sheets, even pharmacists find it difficult to tell the difference.

During the development stage, the container design is given the same level of priority as the medication effectiveness and side effects, but in some cases just before a design is adopted, it is found that the label design closely resembles that of an existing medication, so the design is quickly rejected. In the case of automatic ampule dispensers for injection preparations, containers can be rejected because they do not roll well. Mr. Kanno says that automatic ampule dispensers eliminate human error, so will probably be increasingly used at hospitals. To improve the convenience, however, he says that sufficient care must be placed on the design of the container.

Mr. Kanno also spoke about the recent increase in accidental ingestion of medications by children. In Japan, there is little child resistant senior friendly packaging (CRSF), so he proposed the mandatory use of CRSF packaging for pediatric medications and including CRSF packaging into payment for medical services. At Mr. Kanno’s hospital, as well, accidents have occurred where an adult accidentally gave the desiccant (used to protect the medication from moisture) packaged together with the powdered medication to a child. In this case, because the dosage packaging of the powdered medication and the individual packaging for desiccants have a similar shape, the pharmaceutical company changed the desiccant to a sheet type, which reduced the risk of accidental ingestion.

Barcodes Used to Prevent Counterfeiting

Yoshitaka Shimada, president of SIGMA P.I. CO., Ltd., talked about the increasing use of barcodes as a global anti-counterfeiting measure. In this approach, the medical information for each pharmaceutical is recorded in a database center, and a barcode is printed on the outer packaging of each sale unit. In this way, the barcode can be read to immediately authenticate the product. Countries such as Turkey and Brazil have already begun to implement the system, and Mr. Shimada says that Turkey has already seen a sharp drop in false claims for insurance reimbursement. Moreover, China and Korea adopted the system in January 2016, and the US and the EU plan to begin the system in 2017. Taiwan, Saudi Arabia, and the Philippines have entered the consideration stage. Given the severity of the situation in China, the government has taken charge of managing the entire system, and provides pharmaceutical companies with the 20 digit bar code, which consists of the product number, the
The seamless capsule technology developed by Morishita Jintan Co., Ltd., well-known in Japan for its little silver Jintan pills, has recently been used to encapsulate liquids (water, oil), powders, and even microbes in several new areas of application. Using the “Dropping Method,” their proprietary interfacial tension production method, Morishita Jintan is able to produce capsules of 0.5–8 mm in diameter with a seamless shell. Moreover, functionalizing the shell allows them to control the release of the substances contained therein. In addition to their foods with functional claims, such as Bifina, a capsule containing lactobacillus bifidus (a beneficial microbe that aids in digestion) that passes safely through the stomach to be dissolved in the intestines, Morishita Jintan has also produced more than 1,000 types of seamless capsules as an OEM/ODM. More recently, however, their seamless capsules are increasingly being used for industrial applications.

We spoke to Daisuke Tagawa, Capsule Business Department Assistant Manager and Capsule Development Department Manager, on these new application fields and the future potential of seamless capsules.

**Interfacial Tension Based Dropping Method**

Morishita Jintan first swept Japan by storm with its silver Jintan Pills years ago, but in the 1980s, Morishita Jintan found itself with stagnant sales, leading it to begin diversifying into businesses such as processed foods. One of these new business fields was seamless capsules, which applied their Jintan Pill production technology.

Mr. Tagawa explains that the company’s Dropping Method used to produce the capsules relies on the principle of interfacial tension. Interfacial tension is the force that causes a water droplet on a leaf or a water droplet in oil to contract into as small a sphere as possible. Specifically, the Dropping Method immerses a multi-layered concentric nozzle into a congealed liquid, and extrudes the substance to be encapsulated from the center of the nozzle at the same time the liquid shell material is extruded from the edges. As such, the shell material uniformly encapsulates the substance and forms a nearly spherical capsule with no seam. The weight variance in the capsules is extremely small, and the capsule geometries are uniform.
In 2007, the Center for Membrane and Film Technology (MaFTech Center) of the Graduate School of Engineering, Kobe University was established as the first faculty-driven membrane research unit in Japan. One of its recent focuses is the development of water treatment and power generation systems using special semipermeable forward osmosis (FO) membranes. Osmotic pressure power generation applies FO membranes in a way that uses the difference in osmotic pressure between seawater and river water to generate electricity. Another application for FO membranes is seawater desalination, for which their high potential to solve global water shortages has drawn attention. In April 2015, the center completed and opened its new research building, bringing the MaFTech Center to a new level of comprehensive membrane research. Considering that the global water business market is expected to reach a scale of 100 trillion JPY by 2025, we are very pleased to have an opportunity to interview Prof. Hideto Matsuyama, director of the MaFTech Center, on recent trends as well as future developments in FO membrane research.

Developing a Forward Osmosis Membrane For Use In Osmotic Power Generation and Lower Energy Desalinization

Professionals Dedicated to Membrane Research at New 6 Floor Building

The newly completed 6 floor, 6,120 m² building for the MaFTech Center is located at Rokkodai Campus of Kobe University. Within this new building, 23 faculty and more than 100 students are currently engaged in multi-perspective membrane research. This professional team is divided into five research groups: ① water treatment membranes, ② gas separation membranes, ③ organic thin-films, ④ coating films, and ⑤ membrane bioprocesses.

According to Prof. Matsuyama, the MaFTech Center research aims to apply membrane technology to purifying air and water, with an ultimate goal of realizing a sustainable society. Since this research theme is very large and unable to be covered by only one group, membrane professionals from different fields have assembled at this new research building for more integrated research.

There is a high potential for integrated membrane research. According to data provided by the Japan Research Institute, Limited,* the scale of the global water business is estimated to have reached 50–60 trillion JPY by 2013 (water supply related sectors: 28.3 trillion JPY, sewage related sectors: 22.1 trillion JPY, and industrial water sectors: 5.3 trillion JPY). By 2025, the combined scale of all sectors is expected to exceed 100 trillion JPY.

In December 2015, SEIKO EPSON CORPORATION announced the start of a smart cycle business aimed at making it possible for offices to recycle their own used paper. Their first step in this endeavor was to unveil their compact PaperLab office paper making system at Eco-Products 2015 held in Tokyo this past December. PaperLab is capable of making recycled paper from the used copier paper (A4, A3 size) discarded from offices right on site. During the show they held a demonstration showing how this is all possible. For now, SEIKO EPSON envisions the system being used in the back offices of companies and local governments, but in the mid-term are working to miniaturize the system to design a machine that can be used in standard offices as if it were an office printer. Although the price is yet to be settled, they are aiming to finalize a commercial model by the end of 2016. They will also begin testing the viability of the system at several large corporations and local governments in Japan soon.

PaperLab is equipped with Dry Fiber Technology, a new technology developed by SEIKO EPSON. This new technology allows the system to produce recycled paper without even using one cup of water, the amount generally required to produce a single A4 size sheet of paper. The fact that the system does not use water means it does not require any water supply or wastewater treatment facilities, so it can easily be installed in an office. The existing machine is 2.6 m long, 1.2 wide, and 1.8 m high (excluding protruding parts).

Dry Fiber Technology consists of three steps—fiberizing, binding, and pressure forming. During the fiberizing process a proprietary mechanism applies a mechanical shock to shred the paper into fibers, at which time the paper is converted into long, thin threads that appear like cotton. At the same time, any colorants, such as ink or toner, are separated so that the printed information is completely erased. The deinked colorants are released separately as waste. The volume of waste
Establishing a Graduate Program to Educate the Next Generation of Paper Industry Leaders

New Paper Industry Program Center, Faculty of Agriculture, Ehime University
web.agr.ehime-u.ac.jp/~kami_sangyou/

Ehime Prefecture in Japan is home to a cluster of small, medium, and large paper and pulp related companies. In particular, Shikokuchuo City, Ehime Prefecture, accounts for the largest share of product delivery by value in Japan’s pulp, paper, and paper goods industry. Given the region’s strong connection to paper, in 2010 Ehime University established the New Paper Industry Program Center, a graduate program specialized in the paper industry. Accepting professionals into the program, the graduate school allows for research on all aspects of paper, including cellulose nano-fiber (CNF) and technology for utilizing paper sludge. Professor Hiromi Uchimura, director of the graduate program, also has a background in the research and development of paper money at the Printing Bureau of the Ministry of Finance (today called the National Printing Bureau), which has helped shape the Center's aims. Specifically, Dr. Uchimura states that the program’s focus is on practical skill with a goal of educating human resources to support the paper industry.

Japan’s Top in Pulp, Paper, and Paper Goods Delivery Value

Atop a gently sloping hill overlooking the Setouchi inland sea, the New Paper Industry Program Center, Faculty of Agriculture, Ehime University, is located 15 minutes by car from Shikokuchuo City. The school occupies part of the Ehime Institute of Industrial Technology Paper Technology Center in a wooden building made from local timber. The natural wood gives it a sense of warmth, unlike that seen on a typical college campus.

Ehime Prefecture is a mecca of the paper industry and according to the Ministry of Economy, Trade and Industry (METI) 2013 Census of Manufacturers, Report by Item, Ehime Prefecture is second only to Shizuoka Prefecture in terms of delivery value for pulp, paper, and paper goods. Looking more closely, Shikokuchuo City has maintained the number one position in Japan for 10 years running (since 2004) in terms of pulp, paper, and paper goods delivery value.*

Meanwhile, the spread of electronic media, fewer young people reading printed materials, and globalization, have increasingly placed pressure on the environment encompassing the paper industry. Several local companies recognized the risk this posed and felt the urgency of educating young people

*These data are according to the 2013 Census of Manufacturers, Report by Cities, Wards, Towns, and Villages, compiled by the City of Shikokuchu.
LPC Web Guide System
Compact Family

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New Compact family in the LPC series
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- PW-800 Controller Size approx. 1/4 (as compared with our conventional product PW-1000)

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The Growing Role of Cellulose Nano-fiber

Paper Industry Innovation Center of Ehime-university 2nd Symposium
piice.ccr.ehime-u.ac.jp

Cellulose nano-fiber (CNF) is believed to be five times as strong as steel at only one-fifth the weight. This past October in the City of Shikokuchuo, Ehime Prefecture, Japan, the Paper Industry Innovation Center of Ehime-university held a symposium to promote the technological development of the paper industry and the potential for CNF. Ehime Prefecture is home to a cluster of industries that support CNF, including agriculture, forestry, fibers, chemicals, and paper, so the Center foresees CNF as a new industry that will utilize these regional resources. During the symposium, Hidenori Nomura, an assistant director at the Ministry of Economy, Trade and Industry (METI), spoke about the future outlook of CNF. Professor Hiromi Uchimura, director of the Center, spoke on the development of a paper biochip for blood testing, and Akihiro Hideno, a lecturer at the Center, spoke on formulating CNF using regional biomass resources as a raw material.

1 Trillion JPY Market in 2030

The symposium began with a talk by Mr. Nomura, assistant director of the METI Manufacturing Industries Bureau, Paper Industry, Consumer and Recreational Goods Division, on the future outlook of CNF. According to Mr. Nomura, the market for CNF related materials is targeted to reach one trillion JPY in 2030, with a particular focus on automobile components, electronic information materials, packaging materials, and advanced filters, for example. Mr. Nomura says that although many have pointed to the high production costs of CNF, in reality, the cost of raw materials and energy are decreasing, so today the majority of the production cost is accounted for by personnel and equipment. As such, increasing production scale will result in sufficient economies of scale, which are expected to further reduce costs. By 2020 CNF should cost 1,000 JPY per kilogram and by 2030 CNF should drop below 500 JPY per kilogram.

Currently, METI is planning a budget to support the development of an integrated production process for lignin sheathed CNF (ligno CNF) and for the processes to form these into components as part of an approach to commercialization. For example, Mr. Nomura says that one potential future technology is the nano-dispersion of ligno CNF in plastic to make high-quality, high-strength materials.

Finally, Mr. Nomura says that such CNF projects can maximize the regional forestry resources, technology, and personnel. Through broadcasting such information, Mr. Nomura says they intend to increase the opportunities to communicate with local small and medium size businesses.

Using Paper’s Ability to Absorb Water

Dr. Uchimura spoke on his research into producing a simple biochip from paper that detects sugar and protein levels in the blood. Recently, there has been a greater focus on preventive medicine, which aims to extend healthy life expectancies and has led to increased interest in the development of diagnostic devices that can conduct simple tests and diagnosis at hospitals and homes.

Dr. Uchimura says that according to the government, by 2020 preventive medicine and nursing care related industries will reach 10 trillion JPY in value, while medical related industries, including pharmaceuticals, medical equipment, and regenerative medicine, will reach 16 trillion JPY in value. Dr. Uchimura states that if the paper industry is able to enter this market by developing new products with previously unseen capabilities, the industry would be able to capture an extremely large part of these markets.

Standard biochips are made by forming micro-structure flow channels on a glass substrate, which detect the components in specimens of blood, for example, that are injected into the chip. Conventionally, however, a pump is required to feed the specimen into the chip. Therefore, Dr. Uchimura focused on the absorbency of paper to eliminate the pump. Here, the paper in the biochip naturally draws up the blood, which eliminates the need for a pump and allows the biochips to be produced in high quantities at low cost. In addition, they are disposable and can be incinerated to ensure safety in terms
Improving the Competitiveness of Cellulose Nano-fiber and Developing New Applications

Shikoku Applied CNF Seminar in Tokushima

With five times the strength of steel at one-fifth the weight, increasing focus is being placed on cellulose nano-fibers (CNF); the promotion of its use as a material was even specified in Japan’s “JAPAN is BACK” national recovery strategy. In hopes of further promoting CNF and strengthening cooperation between private businesses, the Shikoku Bureau of Economy, Trade and Industry, Tokushima Prefecture, Shikoku Industry & Technology Promotion Center, held the Shikoku Applied CNF Seminar at the Tokushima Prefectural Industrial Technology Center in November 2015. During the seminar, Professor Hiroyuki Yano of Kyoto University and Eiichi Mikami of Oji Holdings spoke on the latest trends in CNF R&D.

**Cellulose Nano-fibers**

During the keynote speech at the start of the event, Dr. Yano of the Research Institute for Sustainable Humanosphere, Kyoto University, announced his research results on CNF and talked about some structural material applications on which he is working. As chairman of the Nanocellulose Forum, a national-level consortium, Dr. Yano is a leading figure in CNF research. In fact, his research covers a broad range of fields that encompass CNF production methods, chemical surface modification, resin compounding, integrated production processes to form resin composites from pulp, and the use of CNF to produce transparent materials.

Although CNF are composed of nanofibers having widths of 10–20 nm and lengths of more than 1 μm, they have five times the strength of steel at one-fifth the weight. The linear thermal expansion coefficient is small and the elastic modulus does not change over a wide temperature range of -200 to 200°C. Dr. Yano explains that the cellulose molecular chains that form CNF are linear, and thus form fine crystals when stretched to their fullest extent. This characteristic is what gives CNF their high strength and low thermal expansion.

CNF exist along with lignin and hemicellulose in the cellular walls of plants. Using reinforced-concrete as an example, Dr. Yano says that the CNF aligned as longitudinal fibers function as the reinforcing bars and the surrounding lignin and hemicellulose function as the concrete. Although the CNF in cellular walls has a width of 10–20 nm, the TEMPO-mediated oxidation treatment developed by Professor Akira Isogai of the University of Tokyo can be used to reduce the CNF in width to just 4 nm.

Before using CNF in resin reinforcing applications, it is first necessary to compare other reinforcing materials to determine if CNF are suitable. For example, according to Dr. Yano, the CNF tensile modulus of elasticity is 140 GPa. Although this is not as high as that of carbon fiber (230 GPa), it exceeds that of aramid fiber (112 GPa) and glass fiber (74 GPa). In addition, the density of CNF is 1.6 g/cm³, which makes it lighter than both carbon fiber (1.82 g/cm³) and glass fiber (2.55 g/cm³).

Dr. Yano’s research is centered on the development of CNF into resin reinforcing materials. In particular, his research is focused on chemically modifying the CNF surface, which is necessary to improve the compatibility of highly hydrophilic CNF with hydrophobic resins, and perfecting an integrated production process that produces the resin reinforcing material from pulp. Both of these aspects are necessary for commercialization. In terms of CNF resin reinforcing material potential, Dr. Yano points out that replacing just 5% of the 265 million tons of plastic produced globally each year with CNF would create a 13 trillion JPY market at a CNF price of 1,000 JPY per kilogram.

Phosphorylation Method Reduces Miniaturization Energy

Eiichi Mikami, senior researcher at Oji Holdings Corporation (Oji), Pulp and Paper Innovation Center, Innovation Promotion Division, spoke on their development of CNF.

Oji began research into the use of CNF in the 1990s. At the time, they were investigating its use as a paper additive (paper strengthening agent), so CNF research was seen as an extension of paper research. As the result of a 2007 NEDO project, however, they began developing a CNF reinforced
Marine Nano-fiber: A Novel Fiber Made From Crab Shell Waste

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1. Introduction

Many biopolymers produced by living organisms, including crabs, are fibrous, several of which are nano-fibers that develop into self-organized superstructures. Therefore, grinding these organized structural materials can convert them back into nano-fibers. Sakaiminato, a port in Tottori Prefecture, Japan, is famous as a crab fishery that is estimated to bring in 4,000 tons of red snow crab per year. In addition, the surrounding area is home to many seafood related companies that process the crab catch. Because large amounts of crab shells are left over after processing, the port provides a stable, high-volume supply of crab shells that are uncontaminated with other food residue. Therefore, the author began working to produce chitin nano-fiber and applications for the material as a way to effectively use these crab shells.

2. Producing a New Chitin Nano-fiber Material From Crab¹

Chitin is classified as a polysaccharide, which are composed of linked long-chain monosaccharides called N-acetyl glucosamine. Chitin is the main component of crustaceans, such as crab and shrimp, the exoskeletons of insects, and the cell walls of fungi, such as mushrooms. In other words, these organisms use chitin as a structural material to form their skeletons. In fact, crab shells are composed of roughly 20–30% chitin.

Chitin nano-fiber is produced by first using hydrochloric acid and sodium hydroxide, for example, to remove the ash and proteins contained in the crab shells. Tropomyosin, a protein found in crab and shrimp shells, is considered to be an allergen, so by repeatedly applying a deproteinization treatment, these proteins can be removed to the detection threshold. In addition, astaxanthin, a red pigment, can be separated out using alcohol. Next, the refined chitin is fed through a wet-type grinder and ground into nano-fibers of only 10 nm in width (Fig. 1). Crab shells are composed of a composite of these chitin nano-fibers and proteins that self-organize into void structures that are filled with calcium carbonate (Fig. 2). Calcium is a filler that gives the chitin nano-fibers elasticity, while the proteins play the role of controlling calcium separation and dissolution. Therefore, removing the calcium and proteins causes the chitin assembly to lose its structural support so that grinding easily disentangles the chitin and converts it into nano-fibers.

One characteristic of chitin nano-fibers is their excellent dispersibility in water. Even though chitin nano-fiber that has been ground in a wet process typically achieves a concentration of around 1%, the transparent appearance of the high-viscosity slurry actually stems from the high dispersibility and the fact that the geometry is narrower than visible light. As such, it

Figure 1 Geometry of the New Chitin Nano-fiber Made From Crab Shells
Applying Photoresponsive Photochromic Materials to Light-Starting Thermosensors

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1. Background

The phenomenon showing a chromatic change when exposed to light is called photochromism, where substances that express this nature are called photochromic compounds. Photochromic compounds can be classified into two types, T-types, in which the colorant changes through exposure to light and returns to its original state when heated, and P-types, in which the colorant is thermally stable and returns to its original state only when exposed to light (Fig. 1). T-type compounds include azobenzene, spiropyran, and spirooxazine, which are primarily used as light-controllable materials in automatic light-controllable sunglasses. A typical P-type compound is diarylethene, for which anticipated applications include optical recording media, optical switching elements, and display materials.1

As shown in Figure 2, diarylethene has an aryl group that is primarily composed of thiophene, benzothiophene, thiazole, furan, and benzofuran. The structure at the left side of the arrow is called an open-ring isomer and the structure at the right side is called a closed-ring isomer. When the colorless open-ring isomer is exposed to ultraviolet light, a photoreaction causes it to photoisomerize into a colored closed-ring isomer. When the closed-ring isomer is exposed to visible light, a photoreaction causes it to return to the open-ring isomer. The diarylethene shown in Figure 2 is a P-type photochromic compound in which both isomers are thermally stable. Meanwhile, diarylethene containing an aryl group, such as pyrrole, indole, or phenyl, has a colored form that is thermally unstable, so if the temperature rises slightly, it will return to the original isomer. In this way, even P-type diarylethene will change in terms of thermally stability depending on the type of substituent.

Figure 3 is an overview of thermal stability of the diarylethene closed-ring isomers. The diarylethene shown in Figure 3(a), as mentioned previously, is an example in which the thermal stability differs significantly as a result of the aromatic stability of the aryl group. In other words, diarylethene with aryl groups consisting of high aromatic stability will have low thermal stability and diarylethene with aryl groups consisting of low aromatic stability will have high thermal stability.
New econano Technology Reduces CO₂ Emissions During Incineration

Hiromi Yamamuro
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1. Developing econano

Looking at a newspaper one day we came across an article introducing a new technology developed to reduce CO₂ emissions during incineration that had been developed by Active, a venture company established by the Tokyo University of Science (TUS). By applying this technology, we felt it might be possible to reduce the environmental impact of our own seal and label products, and visited Active, located on the TUS Noda campus to find out more details.

Active had already received inquiries from several companies after announcing the new technology, so we felt it was necessary for them to understand our products to attract their interest in cooperating with us on our product development proposal. Upon listening to our explanation, Active agreed to work with us on developing a product under the theme of applying their technology to seals and labels.

Seals and labels come in many different combinations of pressure sensitive adhesives (PSA) and face stocks depending on the adherend. As such, we felt the most efficient way of converting all of our products to econano in order to reduce CO₂ emissions during incineration was to add nano vesicle capsules (NVC) to the PSA. With this, we began researching NVC additives for the PSA.

PSA can be broadly divided into aqueous and solvent types, where the NVC has a different structure for each. Our first step was to develop water-dispersion NVC for aqueous PSAs, which are used in large volumes. Working with water-based PSAs required us to overcome several problems before commercialization in November 2011, including freezing during transport in the winter and the stability of the dispersion.

When we introduced the resulting seals and labels to our customers, the CO₂ greenhouse gas reducing effect was well received, which led to rapid sales growth from

–What is econano?

“econano” applies the “Nano Vesicle Capsule (NVC)” technology developed by Professor Masahiko Abe of the Research Institute for Science and Technology, Tokyo University of Science, as a new technology for reducing CO₂ generated during incineration. NVC technology was originally developed for application to drug deliver systems (DDS).

Together with Active, a TUS venture company, SATO HOLDINGS added NVC to the PSA used in seals and labels to commercialize a product in November 2011 that reduces CO₂ emissions by 20% during incineration.
Development and Growth of Moisture Absorbent Film Active Packaging

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1. Introduction

One of the functions required of flexible packaging is the ability to obstruct the water content inside the package from degrading the product in order to extend shelf-lives and deliver a safe product to the consumer. This function is realized by coating or laminating gas barrier materials onto the packaging film, which slows the permeation of water vapor through the outside of the package into the product during the product’s storage period.

Meanwhile, to further reduce deterioration beyond simply preventing external water vapor permeation, we must ask ourselves how to eliminate the moisture trapped inside the package during the packaging process. In other words, the packaging must actively absorb moisture from inside the package to maintain a low-moisture environment. Packaging that has this type of function is called active packaging, and is defined as packaging material that can detect and respond to changes in the internal package environment to maintain the quality, safety, shelf-life, and consumability of the contents.1

Conventional active packaging includes desiccants, which are placed inside the package along with the contents. Recently, however, food and pharmaceutical producers have indicated the need to reduce the risk of accidental consumption of desiccants by consumers. In response to such demands, we have developed a moisture absorbent film that integrates the packaging film and desiccants.

In this article, we will introduce the technological details of our Moisture Absorbent Film.

2. Moisture Absorbent Film

2.1 Absorption Mechanism

Moisture Absorbent Film is a laminated packaging film that contains a moisture absorbing layer that has been formulated with desiccants. As such, the film absorbs the moisture in the package head space and reduces deterioration caused by moisture and water content released from the contents (Fig. 1).

The typical material structure of Moisture Absorbent Film is PET/Al foil/polyethylene/moisture absorbent layer/polyethylene (Fig. 2). Permeation of external moisture is blocked by the aluminum foil.

The moisture and water content trapped in the head space during packaging pass through the innermost polyethylene layer to be absorbed by the moisture absorbent layer, which is what keeps the inside of the package dry. The desiccants inside the moisture absorbent layer chemically adsorbs the moisture so that the moisture does not separate and release back into the package again when exposed to heat. Therefore, storage and transport of the packaged item is reliable, even in high temperature environments.

2.2 Characteristics of the Moisture Absorption Process

Our Moisture Absorbent Films can be broadly divided into two types, those that function to ensure a 0% (bone dry) relative humidity (RH) inside the package and those that function to maintain an RH of 20 to 30% (humidity control). When the contents are pills and capsules, humidity control types that do not...
Slide-Ring Material Characteristics and Its Application—Commercializing Polyrotaxane

1. Introduction

Recently, supramolecules composed of several different types of smaller molecules have been attracting attention. One of these is the supramolecule polyrotaxane, which as shown in Figure 1 consists of a linear polymer with bulky end groups that prevent the cyclic molecules around the linear polymer from sliding off. Polyrotaxane supramolecules are synthesized through self-organization of clathrate from α-cyclodextrin and polyethylene glycol, which was first reported by Harada et al. around 1990. Ito et al. reported a completely new type of cross-linked polymer material that uses this polyrotaxane structure. Slide-Ring Material relies on polyrotaxane as the cross-linking points, so has a cross-linked structure based on the cyclic molecules. Because the cross-linking points can freely slide along the polymer chain, the material has a polymer structure with unique characteristics that differ from those of cross-linked polymer materials locked together by conventional cross-linking points. In other words, the cross-linking points can move freely at the nano-scale, which gives the material limber yet tough physical properties, mechanical characteristics similar to those of living organisms, durability, unique damping properties, and soundproofing properties, for example. For this reason, the material is garnering attention for a wide range of applications, including new elastomers and coating materials.

2. Slide-Ring Material Overview and Grades

Elastomers produced through standard chemical cross-linking have polymer chains that are directly cross-linked together, so stress concentrates in certain areas when the material is deformed. In contrast, the cross-linking points in Slide-Ring Material using polyrotaxane for cross-linking, as shown in Figure 2, act as pulleys, so the material forms elastomers with unique stress relaxation, high elasticity, and toughness. Slide-Ring Material, as shown in Figure 3, has both cross-linked cyclic molecules (figure-eight type cross-linking points) and cyclic molecules that do not contribute to cross-linking. Before deformation, the cyclic molecules that do not contribute to cross-linking are dispersed evenly. Deformation, however, causes the cyclic molecule distribution to become uneven so that distribution entropy decreases. As such, a new entropy elasticity (sliding elasticity) that does not exist in conventional polymer materials emerges. This elasticity gives Slide-Ring Material a high restoring force.

Given these characteristics, Slide-Ring Material allows for the production of elastomers with extremely small compression setting and hysteresis loss properties. The mobile cross-linking points also meant that the inside of the material has a high uniformity and the material is highly transparent. As shown in Figure 4, we sell Slide-Ring Material polyrotaxane compounds under the name SeRM, as well as one-component curing elastomers.
19. Image Processing Technology in Web Control

19.1 History of Image Processing Technology

Image processing can be defined as the digital (signal) processing of an image to change the image electrically and to extract some kind of information from it. In other words, image processing converts the original image into a digital image, processes the image using digital (signal) technology, and extracts the required information.

In the printing industry, color scanners are used to convert color originals into color separated images. Color scanners, originally patented in the US by A. Murray and R. Morse in 1937, separate the original color image into R (red), G (green), and B (blue) images. In the 1970s this technology underwent significant technological advancements. Today, color scanners are essential equipment in the printing plate making process.

In 1968, an in-line steel strip defect inspection device was marketed as part of a quality control system for the steel industry. The device was able to detect, display, and record defects, but it did not have an image processing function (Fig. 388). Sometime after 1995, various companies began providing print quality inspection devices that applied image processing technology for use in web printing defect inspection. The area in which these devices are being used is expanding, and now ranges from printed film to functional plain film quality control.

In 1973, the analysis industry saw the development of image processing technology into a tool to analyze images taken of specimens under a microscope and display them on a monitor (LUZEX 100, Fig. 389). Following this development, image processing technology came to be used for observation and analysis of microscopic substances.

Recently, printed electronics are often mentioned as a potential field for the web processing industry, but this area requires high-precision sensors. This will make it necessary to combine image processing technology with conventional measurement technology. For this reason, engineers involved in web handling must become familiar with image processing technology.
Nireco Web Guide Control System

A web guide control system designed for use with small-sized machinery. The system comprises an edge sensor, amplifier, motor-operated actuator and centering sensor.

High performance items supporting the system

- **Ultrasonic Sensor UH01**: Objects that were conventionally difficult to detect, such as the edges of transparent film and photosensitive materials, can now be detected with high accuracy.

- **Liteguide Amplifier AE1000**: Light load ECP controller with high precision edge control function.

- **Guide Roll Mechanism LED-M**: This end pivot guide roll mechanism provides a high level of response to control commands.

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As part of our discussion on roll-to-roll systems, in the previous session we introduced the basic thinking behind these systems, their strengths, and their shortcomings. Given the content of the topic, much of the discussion was somewhat abstract, so might have been difficult to understand. In addition, if our emphasis on the problems with roll-to-roll systems gave the impression that these are nothing but useless junk, this was not our intention. In fact, if the machines are designed and operated properly, the user can expect great results from roll-to-roll systems. Unfortunately, despite such high expectations, there are countless examples of roll-to-roll lines that have been designed without sufficient consideration of certain aspects that must be established first, which has led to such projects failing as a result. In this session, we will introduce the design and operational methods that draw out the maximum potential of these lines in consideration of building an actual roll-to-roll production line.

Specifically, this session will detail those aspects that must be considered first when designing a practical roll-to-roll line.

6. Preconditions

As explained previously, producing a single flexible device requires multiple production steps, but handling all of these on a single continuous roll-to-roll line is not very practical. If the final product is some kind of functional device, the device must be cut from the web at the end of the line to produce the individual products, so a fully roll-to-roll production line is not possible (Fig. 6). Instead, a more practical production system would have a configuration that organically combines several individual roll-to-roll processes. Of these, at least one of the lines would be fed from one side with a roll of material and cut the web into individual products that would be ultimately inspected, packed, and shipped at the other side (Fig. 7).

With practical roll-to-roll processes, the raw materials are supplied in roll form, and at least the earliest processes are handled in roll-to-roll systems. At some point, however, the web is cut into standard sizes, after which all of the processes are handled as sheets.
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5. Drying Defects

5.1 Introduction

The drying process evaporates the residual solvents remaining in the film formed by uniformly applying a coating fluid. At this point, Laplace forces will act on the tiny amount of solvent and increase the cohesion of the coating film. Volumetric change resulting from the increased cohesion will generate stress, however, which will cause various problems.

The drying system can also cause drying variation within the coating film. Specifically, drying results in a cured layer at the surface of the coating film, which causes film strain. In addition, high volumes of solvent can result in problems caused by fluid flows, such as water marks and drying irregularities.

In these two sessions we will introduce several problems and defects caused by the drying process, explain the mechanisms behind these problems, and provide some countermeasures. In particular, we will focus on coating film cracking, local peeling (popping), polymer film cured surface layers, environmental stress cracking caused by contact with a solution (crazing), water marks, drying variation, and drying strain in the fluid meniscus. In this session we will look at cracking, popping, polymer film cured surface layers, environmental stress cracking, and water marks.

5.2 Cracking

Layering coating films is one method that is sometimes effective for stress matching and viscoelastic control. When drying control of the residual solvents in each layer is insufficient, however, strain, such as cracks, can occur. Here, we will explain the annealing (thermal treatment) conditions as well as causes and countermeasures for cracking in an inorganic laminated film.

Figure 2.76 shows a stepped substrate that has been coated with a thick-film layer of novolac resin (undercoat) and coated with a glass film (middle layer) using the sol-gel method called spin-on-glass (SOG). During the actual production process, a polymer resin layer (top layer) used for micro-processing is coated over the middle layer.

This is the basic structure of 3-layer polymer resin films used in the large-scale integration (LSI) micro-machining process field. In this structure, the undercoat smooths the stepped substrate so that the substrate does not have a negative affect when the top coat is patterned. Because all three layers contain a solvent, however, the drying conditions are important.

Figure 2.77 shows the appearance of a cracking pattern that occurs when a thermal treatment is applied after coating the SOG middle layer onto the undercoat. This cracking can be observed using a light scattering type surface geometry measuring device (profilometer). The substrate is a 6 inch silicon wafer. As we increase the thermal treatment temperature for
Release Paper
Part 4: Release Paper History

4. Release Paper History (cont.)

4.4 Japanese Silicone Release Paper History Begins With Emulsion Silicone

Now let us take a look at the history of release paper in Japan (Table 11). The first silicone release paper in Japan was made by FUJIMORI KOGYO Co., LTD. about 1953. The application was for asphalt paper bags (Fig. 70), in which the release paper was used as the inside layer that came into contact with the sticky asphalt. Before this development, asphalt was sold in metal drums or wooden barrels, but metal cans were problematic in that they were expensive and it was difficult to take out the asphalt during the winter. Moreover, wooden barrels were problematic in that the asphalt would leak out.

The US, however, took a different approach to storing asphalt. When FUJIMORI KOGYO looked at the US, they saw that the US used paper bags in which the innermost layer was made of a paper coated with silicone. When they saw this, they began working on a similar development that resulted in two types of release paper for asphalt packaging. One type was made of kraft paper with silicone coated on a gelatine and red iron oxide barrier layer and the other was made of kraft paper with silicone coated on a PVA barrier layer.

Through the development of these release papers, FUJIMORI KOGYO was able to replace metal drums and wooden barrels, which greatly reduce the cost of the container. This development is said to have had major repercussions on the asphalt industry.

The silicone release agent used at the time was an emulsion condensation reaction type, which was imported. The silicone main components were PDMS (polydimethylsiloxane) and PMHS (polymethylhydrogensiloxane). Compared with later silicone release agents, the ratio of PMHS was extremely high and accounted for about half the agent (for this reason, the release paper was suited to asphalt paper bags, but the release was too tight for PSA labels). The silicone was coated using the air knife method.

Two years after FUJIMORI KOGYO’s development, Shizuoka Kakoshi Kogyo Co., Ltd. (the predecessor of Sun A. Kaken Co., Ltd.) also began producing a release paper for asphalt paper bags. FUJIMORI KOGYO and Shizuoka Kakoshi Kogyo were both producers of tarpaulin paper, a moisture and water proofing paper used to package asphalt at the time.

4.5 Japanese Production of PSA Labels and Subsequent Growth of Release Paper

The first PSA labels produced in Japan were made by Takeuchi Kagaku Kogyo in 1959. These early Japanese made PSA labels did not use silicone release paper, but used PVC film as the liner. This was because a silicone release paper suited to PSA labels had not yet been developed. Using PVC film as the liner, however, limited the types of PSA that could be used for the PSA labels, and had various problems with the PSA property. The emergence of silicone release paper for PSA labels and the start of full-scale production did not begin until the

Figure 70 Inside Surface of Asphalt Bags Are Coated in Silicone

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8 Tarpaulin paper, made by adhering two sheets of paper together with asphalt, is a moisture and water proof packaging paper that blocks the passage of moisture.
Preface
In addition to its excellent physical properties, plastic is easy to mold and is light. Even so, molded plastic items appear cheap and cold (lacking in texture) after conventional primary molding. This is a problem in that manufacturers desperately want to take advantage of the characteristics of plastic, but need to improve the appearance to create products that satisfy the sensibilities of the consumer. The process of applying some form of ornamentation to molded products to satisfy these sensibilities is called decoration.

For this reason, decoration has become an important concept for the plastics field today. In this series, we will provide a range of information collected over the years, and explain such in as much detail as possible. Given limitations on space, however, this series will only be able to provide a general overview. We have also provided a list of reference materials, primarily websites, that detail the individual technologies. For those interested in reading further, please see these references.

We hope that this series will be useful to as many readers as possible and will contribute in some small way to their endeavors.

1. Kansei (sensibility) Engineering, Product Quality, and Decoration

Before we delve into an explanation of the individual plastic decoration technologies, we must first touch upon the concept of kansei engineering and product quality that lie behind these technologies. Kansei is a Japanese term that is difficult to directly translate into English, but in this case refers to a concept similar in meaning to emotion or sensibility. Here we will use the term sensibility.

Sensibility Engineering is an academic field that focuses on how monozukuri (craftsmanship/manufacturing) can use emotion and craftsmanship to speak to the consumer’s sensibilities. This topic is primarily being researched by Professor Nagasawa of Waseda University and others in Japan.

Figure 1 shows the product qualities that we will discuss as seen from the stance of Sensibility Engineering. These qualities can be classified as primary qualities (function, performance), which can be measured using physical and chemical tests; secondary qualities (sophistication, appearance), which can be evaluated using the senses; and tertiary qualities (brand,
Akira Hayashi

1. Introduction

As part of our work, we had the opportunity to put together materials detailing the Ion Cluster Beam Film Vacuum Deposition System¹ (ICB Web Coater²), so in this session, as an extra edition and the closing of this serial, we will excerpt and summarize the goals and problems presented in these materials in regard to commercializing this vacuum deposition system.

The ion cluster beam film vacuum deposition system (Fig. 1) was developed based on the ion cluster beam vacuum deposition system, for which the basic patent was filed in 2007. Although our company did not have any previous experience in this area, we expect our know-how on silicon (Si) substrates for solar cells accumulated in meeting the performance requirements of silicon in conventional solar cell applications, coupled with sales of thin-film silicon substrates made using the newly developed ICB Web Coater, will allow us to both target a greater share of the solar cell silicon substrate supply business and aim for mass production of thin-film solar cells in the future. Practical development focused on application of the Ion Cluster Beam Vacuum Deposition System patent (patent publication No. 2008-291339) filed on May 28, 2007.

2. Goal and Details of Practical Technological Development

The fundamental theories behind the ICB thin-film production method established by Kyoto University were developed based on a significant amount of fundamental research. Despite this, there is no industrial ICB mass production machine because the unique ICB method, which jets high-temperature metal vapor from a sealed crucible and turns this vapor into clusters that are then ionized and accelerated, makes the design of an actual production machine difficult. We received instruction on the key points of the ICB method from Professor Takagi of Kyoto University during the research and development phase, through which we succeeded in designing a novel ICB ion source that would allow for mass production. The completed ICB Web Coater, which is expected to be used as a production machine in fields that require mass production of advanced metal thin-films, particularly production of thin-film solar cell Si thin-film substrates, is intended to realize advanced, low-cost thin-film solar cells aimed at supplying low-cost, high volume clean energy that is competitive with thermal and nuclear power. In this way we are aiming to mass produce advanced silicon vacuum deposition thin-film substrates for thin-film solar cells at a production speed of several hundred meters per minute and at a product width of two to three meters. As part of this approach, we have produced a prototype ICB Web Coater (product width 20 cm, production speed 5–100 m/min) as a

¹ Vacuum Web Coater: a device consisting of a vacuum deposition chamber and vacuum film handling device for continuously coating a metal thin-film on a plastic film substrate. In other words, the production technology forms a metal thin-film (a few hundred to a few thousand Å) by cooling a metal vapor heated to high temperature (a few hundred to a few thousand °C) in layers onto a plastic film substrate traveling at high speed (10–500 m/min) in a vacuum. When necessary, the system applies ion energy to the metal vapor, which contributes to the formation of a thin-film structure.

² ICB Web Coater: a film deposition system for industrial purposes that adopts the ion cluster beam ion source from the Ionized Cluster Beam Web Coater.
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