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Water-based CI Flexo Flexible Package Printing
DIC COLORCLOUD Solution and “FINART” Gravure Lamination Inks
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Editor's Note

When it comes to food ingredients like sugars and fats, we are starting to learn that not only have we been mistaken about their impacts on heart disease, but also that we may have been intentionally misled by the sugar industry. Although similar to what we saw with the tobacco industry in the 1980s and 1990s, it is unlikely that we will see the same outrage from the public. After all, tobacco is the dominant cause of lung cancer, whereas there are a number of causes for heart disease, making it difficult to point to a single culprit. Moreover, fat has become so vilified among the public throughout the world that it will be extremely difficult for global consumers to suddenly change their beliefs and go back to a fat rich, sugar poor diet. Even so, this new understanding is likely to initiate slow changes in diet, especially if sugary snacks are pushed as a causal factor in both diabetes and heart disease.

Given that sugary snacks and candy account for a significant portion of flexible packaging demand, any major shift in diet away from these types of snacks present a potential challenge for both snack producers and converters. Even though these changes are unlikely to affect how much the public consumes, we may see people opting for larger meal portions to replace their intake of sugar calories from snacks and desserts. This could mean less demand for snack packaging and more demand for frozen food and other processed food packaging. It is impossible to tell which direction consumers will choose, but however they decide to change their diets will mean the foods coming down the packaging line will look different in the future.

For this reason, converters may find themselves faced with the need to convert materials with which they had not previously worked, and may end up in competition with experienced converters already well established in these new areas. Likewise, converters who already worked in areas that are positively affected by these potential changes may find themselves in competition with a greater number of companies. The converting industry, however, has faced countless changes over the decade, so we have no doubt that the industry will weather this storm as it has all others. That said, individual companies may still be thrown into turmoil if they ignore these potentially disruptive changes in the food industry. As such, it is essential that those in the converting industry, especially those involved in food packaging, continue to keep their antennas up for these issues.
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During TOKYO PACK 2016, THINK LABORATORY CO., LTD., a manufacturer of fully automated laser gravure cylinder making systems, will present its New FX3, the latest of its fully automated laser gravure cylinder making systems, along with a new VOC-free water-based inkjet printing system. The company will also provide samples and detailed data showing how the New FX3 reduces ink consumption up to 20%, supporting resource conservation and ecological gravure printing. The New FX3 also allows for better color image reproduction by using a 3,200 × 12,800 dpi high-resolution laser to produce consistent dot geometries in the highlight sections and improve ink transfer when printing on flexible packaging materials at speeds of 200–400 mpm. The company will also provide reverse OPP film printing demonstrations using a prototype water-based inkjet printer and the organic solvent-free water-based inkjet pigment ink announced by Kao Corporation this past spring. Although they previously released printing samples, this will be the first time in the world they will publicly demonstrate the machine in operations. Kao will also be presenting their water-based inkjet pigment ink at the THINK LABORATORY Booth (East Hall 6, No. 6-66).

A Rush of New FX3 Orders
Following drupa 2016, the New FX3 fully automated laser gravure cylinder making system has seen a steady increase in installments globally. According to Tatsuo Shigeta, president of THINK LABORATORY, converters, printers, and cylinder makers who already operate the New FX2 and New FX3 and print using the cylinders at 200–400 mpm, have realized good density and highlight stability even during high-speed printing. The honeycomb shaped CMYK cells are 12–15 μm deep, whereas the white cells are 15–16 μm deep. FX cylinders
made using the New FX series reduce ink usage by approximately 20%, and allow for 20% faster printing speeds.

According to Mr. Shigeta, cylinders with cell depths of just over 10 μm are also able to print solvent-based high-solid inks. Compared with electronic engraving, the shallower depths greatly decrease the use of both ink and solvent. Water-based inks can be printed with even shallower cell depths than solvent-based inks.

During TOKYO PACK, THINK LABORATORY will display samples of solvent gravure reverse printing (175 lines, CMY 14 μm, K 15 μm, W 16 μm), water-based gravure reverse printing (250 lines, CMY 5 μm, K 10 μm, W 12 μm), and solvent gravure surface printing (175 lines, CMY 14 μm, K 15 μm, W 16 μm). All of the samples will be printed using FX cylinders made on a New FX3 to promote the high level of quality to the visitors.

Several new installations of New FX3 include Shinwasangyo Corp. (Chiba, Japan), TOWA Process Co., Ltd. (Tokyo, Japan), and Gravure Japan, Inc. (Osaka, Japan). The New FX3 installed by Shinwasangyo in September is expected to go into full operation in October, which will allow the company to in-house and integrate all stages of the flexible packaging production process, including design, cylinder making, gravure printing, laminating, slitting, and bag making. Following its September installation, TOWA Process, a gravure cylinder making company, will install a second New FX3 in October. Gravure Japan, another flexible packaging converter, is expected to put their New FX3 into full operation in October. Globally, New FX3 systems are already in operation in Indonesia, Vietnam, and India, and are expected to be installed shortly in the Philippines, Taiwan, and Malaysia.

Inkjet at drupa 2016 and TOKYO PACK

Along with 15 employees, Mr. Shigeta attended drupa 2016 and comments that there were very few exhibitors from the gravure flexible packaging printing field, and that digital printing took the lead role, with most digital printing exhibitors focused on inkjet printing. In fitting with this trend, THINK LABORATORY displayed film samples printed with CMYK and W using Kao’s water-based inkjet pigment inks and the inkjet printer they are currently developing. They used two 75 inch 4K LCD monitors to present their water-based inkjet printer and the water-based inkjet pigment inks along with the New FX3 fully automated gravure cylinder making system and examples of the New FX in operation at Custom Gravure Co., Ltd. in Fukuoka, Japan, and SEIKOU CO., LTD. in Ibaraki, Japan. Kao also exhibited their inks across the aisle.

During TOKYO PACK 2016, THINK LABORATORY will provide the first public demonstration in the world of its FXIJ-1 AQUA inkjet printer designed specifically for Kao water-based
inkjet pigment inks. Currently, THINK LABORATORY is in the process of assembling and testing the second FXIJ-1 AQUA unit at their main plant. When Kao announced the development of its VOC-free water-based inkjet pigment ink in the spring, the white ink coverage property was insufficient and the inkjet printer still needed to be improved, but both of these problems have been resolved.

During the event, THINK LABORATORY plans to demonstrate reverse printing using Futamura Chemical Co., Ltd. OPP film for water-based printing, allowing visitors to check the coloration of the CYMK colors and the coverage of the white ink. They will also exhibit samples printed with solvent-based and water-based gravure ink as a comparison so that visitors can judge with their own eyes whether the inkjet printed flexible...
The Condition of New FX Systems Around the World Are Monitored From Japan to Prevent Problems and Send Out Alerts to Replace Consumables and for Maintenance

Based on the state-of-the-art print technology on show at drupa 2016, the latest analysis from Smithers Pira, a UK-based packaging, paper, and print industry marketing and consulting firm, has identified six key technology developments that will fuel new business models and revenue streams in global print markets 2016–2026.

- The arrival of more high-quality, high-performance, reliable industrial inkjet printers, capable of handling an increasingly diverse range of substrates.
- The evolution of highly autonomous litho print systems that enable higher throughput and lower labor costs.
- The refocus of many manufacturers on the development of print solutions for packaging, particularly value-adding toner and inkjet options. New consumables—inks, varnishes, paper, and other substrates—match this new emphasis on packaging.
- A new interest in a greater range of print embellishment products and processes, which add luxury appearance and better tactile effects to printed products.
- The evolution of more sophisticated workflow software to allow print service providers to accept and manage the more numerous and shorter run jobs that characterize modern print markets, with minimal operator input.
- The pending further commercialisation of functional print engines for additive manufacturing (3D print) and printing electronics.

The technology on show at drupa 2016 will invigorate new segments—led by packaging and digital printing—and help foster cross-industry annual growth of 4.6% over the next five years. This will create a global market valued at $812 billion in 2026. Smithers’ analysis shows that while in 2026 many print formats will be the same as in 2016, the routes to market will be different, with an emphasis on more efficient production methods and lower environmental impacts. Understanding the application and full future potential of new equipment is vital to staying competitive as the print market undergoes profound changes.

Smithers Pira: www.smitherspira.com

Drupa Shows Digital and Packaging Offer Routes to Rejuvenate Global Print Markets

This move by THINK LABORATORY begs the question, why is a gravure cylinder making system manufacturer interested in inkjet? Mr. Shigeta explains that although some may fear inkjet will take jobs away from gravure, in truth inkjet offers the opportunity to propose a new gravure printing business model. In Japan today, gravure printing machines are used to print short runs of 1,000 to 2,000 meters, which only take 10 to 20 minutes at 100 mpm. Moreover, when customers visit the printing plant in order to check the color, the printing machines must be stopped for 30 minutes to an hour. This means the operational efficiency of the gravure printing machines is decreased, which can put pressure on operations. Moreover, new jobs require the heavy printing cylinders to be changed, and Mr. Shigeta says that at least one converter has mentioned that the cylinders can only be changed three times per day. More frequent changes will drive away the operators.

As such, this is where VOC-free water-based inkjet printing comes into play. By using inkjet printing for the initial runs, additional short runs, and proofing when the customer is present, the gravure printing machines can be used for longer runs instead. This approach both improves the operational efficiency of the machines and allows water-based inkjet printers and gravure printing machines to be combined in the flexible packaging field because using the machines in this way means they must be able to reproduce the same colors.

Mr. Shigeta goes on to say that most people have the impression that gravure printing is time consuming, but the New FX series is able to produce a gravure printing cylinder in one hour, so printing can be started immediately. In this way, he feels that water-based printing and gravure printing will support each other, so the company aims to promote collaboration between the two at TOKYO PACK.

Combining Gravure and Water-based Inkjet

Packages can be used in practice. They also plan to hand out inkjet printed samples that have been laminated with the help of Shinwasangyo.
ADPLEX Co., Ltd., a Hiroshima, Japan, based commercial printer, recently entered the flexible packaging printing industry with the completion of its Seifu-Shinto packaging plant. Equipped with a solvent-free laminator and two water-based flexo printing machines, the plant eliminates almost all volatile organic compounds (VOC). This past April, the company held an open house for the new plant and a reception for some 200 attendees. During the event, Takahiro Ishihara, president of ADPLEX, stated that their entry into the field was made in hopes of contributing to a sustainable society and producing products that would be well received by both customers and consumers.

An Outlook for Business Growth
A member of The Chugoku Electric Power Co., Inc., ADPLEX (previously called Sanko) was founded in 1951 as a commercial printer of posters and pamphlets. More recently, however, the increasing digitalization of publications following the growth of the internet has had a significant impact on the company’s commercial printing business. In response, ADPLEX determined to print flexible packaging using water-based flexo printing and establish this as a new core business. More specifically, the company aims to capture a new market by providing highly ecological, water-based printed packaging. Mr. Ishihara stated that although he is relieved the plant is complete and grateful for everyone’s help, the company now faces the need to operate the plant at a profit despite their lack of experience.

At the start of the plant tour, Mr. Ishihara explained that they decided to establish the new water-based flexo business some three years earlier. After investigating the strength of the ground and the quality of access for the new plant, ADPLEX chose Seifu-shinto, a green, hilly region located 20 minutes by highway from the center of Hiroshima City. The land for the new plant was acquired in the fall of 2014, followed by the start of construction in April 2015 and completion in March 2016. The total site area is 20,835 m² and the two-story steel construction building has a total floor area of 6,528 m². The clean, white plant is located with plenty of space around it. Of the 30 workers employed at the plant, many of the operators are
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Japanese culture, particularly food culture, has traditionally been linked to the seasons. Snacks and sweets are no exception, and the spring is a time when many families and friends take easy to carry sweets with them when they go out for the day. This past spring, EZAKI GLICO CO., LTD. promoted a new campaign called “Haru wa Soto Po!” as a way of encouraging consumers to eat their popular Pocky snacks outdoors. As part of the campaign, the new packaging is printed in a color changing ink that reveals a hidden design when exposed to sunlight. This is also the first Pocky packaging offered by EZAKI GLICO to feature characters from the popular Peanuts comic strip. The new packages are produced by Dai Nippon Printing Co., Ltd.

Photochromic Inks

The Haru wa Soto Po! campaign was created for six flavors of Pocky, including a new seasonal soft serve ice cream flavor and the standard chocolate flavor. The campaign adopted a package design printed with characters from the Peanuts comic strip and a special color changing ink. When the backside of this package is exposed to sunlight, different types of playground equipment appear around the Peanuts characters. Takashi Miki of the EZAKI GLICO Marketing Department says this is the first package in Pocky’s history that encourages the consumer to take the snack outside. More specifically, the package concept aims to make friends and family smile when they see the images appear under the radiant sunlight.

Satoshi Okada of the Dai Nippon Printing Packaging Sales Department explains that there are various types of inks that change color when exposed to sunlight. Given the need to print high volumes with gravure printing, however, they chose a photochromic ink offered by THE PILOT INK CO., LTD. He goes on to explain that in the past they worked with another temperature sensitive ink from THE PILOT INK called METAMO COLOR. In this case, the snack packages printed for EZAKI GLICO would change color in the cold of a refrigerator. Given that the photochromic inks are formulated with the same characteristics—allowing them to use their know-how for printing the inks on their equipment—it made sense to use the same type of inks for this campaign.

Rapid Color Change

Photochromic inks are mixed with microcapsules that contain photochromic dyes, in other words dyes that change color when exposed to ultraviolet radiation. Before being exposed to ultraviolet radiation the photochromic dyes do not absorb visible light wavelengths (400–700 nm), and thus remain clear. After exposure, however, the absorption wavelength range of the dyes shifts to the visible light region, causing them to take on a color. More specifically, exposure to ultraviolet light shifts the colorless dyes from a low energy state to a high energy state, which is what changes the absorption spectrum and thus the color. As such, when the dyes are removed from exposure to ultraviolet radiation, the inks return to a color-
With a variety of exhibits from packaging materials and machinery to converting, packaging, distribution, and environmental protection equipment, Tokyo Pack will serve as a platform for business negotiations and international exchanges, and contribute to the development of society from an international perspective. TOKYO PACK 2016 will present state-of-the-art packaging, production, and processing solutions for food and beverage, confectionery and bakery products, pharmaceuticals and cosmetics, non-food consumer goods, and industrial products. Also on display will be a range of related services, packaging materials, printing, testing and inspection, logistics and distribution, and recycling and disposal. Over the four day event, 70,000 visitors from Japan and around the world are expected to attend the show, which includes several special events, including the Good Packaging Pavilion, Global Packaging Pavilion, and High-performance Packaging Pavilion.

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Model DT-3000
Suitable for sectional drive-type presses

Model SK-2090
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Inspection System and Web Hi-Vision System

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Inspects printing defects while high speed printing, by means of a pattern matching method

Web Hi-Vision System
Still image printing monitor

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Tokyo International Packaging Exhibition 2016
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Tokyo International Exhibition Center "Tokyo Big Sight"
Organizer: Japan Packaging Institute (JPI)
Exhibitors/Booths: 681/2,568 (as of July 15)
Admission: Free

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KEY COFFEE Eliminates the Need for an Espresso Machine, a First in the Industry

KEY COFFEE INC.  
www.keycoffee.co.jp

The increasing use of small single-serve capsule and pod type coffee packs has driven coffee consumption in Japan to new record highs for the past three years running. In line with this trend, KEY COFFEE INC. recently began selling PUSH PRESSO, a simple espresso percolator that eliminates the need for an espresso machine and a power source, a first in the industry. Targeted at coffee drinkers in their 30s and 40s and only requiring hot water to brew, KEY COFFEE expects to see increased demand for PUSH PRESSO from households.

Market for Pod Coffee Doubles Since 2014

The rich flavor of espresso relies on the steam and hot water that are simultaneously pressed through finely ground espresso coffee beans, so requires a special machine. In contrast, PUSH PRESSO offers a similar rich coffee flavor without requiring an espresso machine or a power source. All that is needed is hot water. Shigeki Omori, the individual in charge of developing PUSH PRESSO at KEY COFFEE, says that being easy to use is a given, but just as importantly, the appearance is good while the flavor is sweet with a soft touch of bitterness and a mellow aftertaste. He goes on to say that coffee-lovers who have tried it have all said it was delicious.

According to the All Japan Coffee Association (AJCA), 461,892 tons of coffee were consumed in Japan in 2015, making for three straight record breaking years. In addition to a growing number of regular coffee purchases at convenience stores, growth is also being driven by an increasing number of home-use coffee machines and popular simple percolation coffees. These trends have led Japan to become one of the highest coffee consuming countries in the world.

In particular, there is an increasing number of coffee-drinkers using capsules and pods to brew coffee at home. KEY COFFEE estimates that the market for pod coffee more than doubled in 2014 over 2013 to 25 million JPY. Meanwhile, given that coffee machines can be expensive and large, conventional easy-to-use drip coffee continues to be popular.

Mr. Omori says that despite the increased consumption of simple percolation coffee, espresso still requires a machine to brew. As such, the driver for developing PUSH PRESSO was finding a way to eliminate the need for a machine. The essential requirement was that the item be stress-free, in other words, convenient for everyone, has a structure that pours the coffee quickly, and is easy to use in all respects including washing. After repeated prototyping and five years of work, in March 2016 the company finally began marketing PUSH PRESSO.

Increasing the Flow of Coffee

PUSH PRESSO consists of a transparent holder and a white dome-shaped lid. A coffee ground pod with the same circular shape as that used for regular coffee is placed into this unit. The pod is 60 mm in diameter and is filled with seven grams of an original espresso blend. The pods are packaged in a modified atmosphere packaging made of aluminum metalized film with a high oxygen and light barrier.

The conical bottom of the holder, which also serves as the percolator, opens when a lever on the side is pressed. After placing the pod in the bottom, the bottom is closed tightly until the
Screw Cap Paper Carton
Demand Increasing in Japan
Among All Ages

Nihon Tetra Pak
www.tetrapak.com/jp

Easy-to-open, reclosable paper cartons from which the contents can be directly consumed are steadily increasing in demand among all age cohorts, from children to the elderly. In Japan, healthy beverages are further expanding the range of single-serve screw cap paper cartons, while dairy based drinks, in particular, are expanding the use of bottle-shaped screw cap paper cartons with a plastic top section. This past July, Nihon Tetra Pak K.K. spoke with us at Drink Japan in Tokyo about Sweden based Tetra Pak’s product trends in Japan.

The Convenience of Screw Caps
Over the past five years, screw cap paper cartons have found their way to the market in various forms. For example, the first product in Japan to use Tetra Gemina Aseptic (TGA) with a screw cap was a 500 mL soy milk carton in 2011, followed in 2013 by the first Tetra Prisma Aseptic 330 mL DreamCap for TBC drinks and Tetra Top for yogurt. The latter two were replacements for plastic bottles from which the contents can be directly consumed. The first time Tetra Top was used for milk was in 2014. According to Nihon Tetra Pak, the use of screw cap Tetra Pak packages in Japan (both refrigerated and room temperature types) grew 5% over the four years from 2012 to 2015.

The convenience of these cartons (ease of opening, pouring, and carrying, as well as reclosability) is one of the factors behind this growth in demand.

Globally, the Swedish Rheumatism Association (SRA), which uses internationally recognized testing methods to certify products considering the needs of those with reduced hand strength, such as the elderly and those suffering from rheumatism, has certified some types of screw cap Tetra Pak paper cartons.

For example, the design of the peak topped TGA carton used for 500 mL soy milk in Japan makes it both easy to pour and prevents dripping. Moreover, Tetra Pak HeliCap 27, the cap used on the carton, has teeth that break the aluminum foil seal when twisted, allowing the carton to be easily opened in one step. Other screw cap cartons offered by Tetra Pack include Tetra Brik Aseptic 1000 Slim with HeliCap23, Tetra Prisma Aseptic 330 mL Square with DreamCap, and Tetra Top chilled packages consisting of a paper body and a PE composite material for the top.

In particular, 2015 deliveries of HeliCap saw a 15% increase over 2014 in Japan. Growth in the soy milk market initially led to the adoption of larger cartons, which were later adopted for juice and coffee among other products in Japan.

From Japan
Stylish Mini-bottle Carton
In November 2015, Yakult Honsha Co., Ltd. began selling a new drink using a Tetra Top Micro package. The small 100 mL drink is easy to finish in one sitting and is intended for consumption at the point of sale. In early sales regions, Yakult Honsha saw a high rate of repeat purchases and good sales, leading them to expand sales nationally in Japan in May 2016.
New High-speed Textile Inkjet Printer Expands Inkjet Range to Medium Run Applications

MIMAKI ENGINEERING CO., LTD.
www.mimaki.co.jp

MIMAKI ENGINEERING CO., LTD., a Nagano, Japan based inkjet printer manufacturer, began selling its MM700-1800B high-speed (800 m²/h) direct inkjet textile printer to the textile and apparel industries this past May. Ahead of its release, the company exhibited the printer at JIAM2016 (Japan International Apparel Machinery & Textile Industry Trade Show) in Osaka in April, offering a demonstration of direct printing on cloth. Given the greater variety of designs and shorter fashion cycles (fast fashion) today, MIMAKI ENGINEERING foresees an accelerating shift to digital printing. In response, the company has been aiming to meet the expanding market for medium-volume production by offering a high-speed inkjet printer model.

High-growth Rate Textile/Apparel Business

Takahiro Hiraki, director of the JP Business Division, explains that greater design diversity and shorter fashion cycles have led to greater inventory risk. Meanwhile, digital printing offers a solution because it is able to print the exact number of items ordered without the use of a plate (on-demand printing). Inkjet is also more ecological because it deposits the ink directly onto the patterned sections, thus eliminating the wastewater generated during the washing of the plates used in conventional printing methods.

In addition, Mr. Hiraki explains that although inkjet printers were limited in use to very short runs ten years ago, such as for sample production, today the printing speeds are higher and in-house ink production has reduced ink costs. As such, the company feels that inkjet printers are suited to medium-volume production scenarios.

According to the company, the ratio of total dyed printing that has shifted to digital is only around 3% globally, but the company expects this ratio to grow to 10%. At 5.8 billion JPY in March 2016, the company’s textile/apparel business is the smallest of their three core businesses (sign graphics, industrial products, and textile/apparel), but this business has also seen the highest growth rate. In this light, Mr. Hiraki states that the company has seen a significant expansion of sales in textile/apparel, particularly since 2014. The growth in profits is also due in part to their introduction of a competitively priced ink, which has increased sales of genuine ink.

Domestically, as the 2020 Tokyo Olympics approaches, the company foresees increased demand for sportswear, as well as a shift of signage from conventional PVC sheets to soft signs. Mr. Hiraki says that roadside banners and flags is one area where this shift is occurring. These are temporary products and are required on short-notice, so there is a high chance these will be printed using inkjet.

Printing on Cotton, Polyester, and Leather

In response to these trends, the company released its MM700-1800B high-speed 1.8 m wide direct textile inkjet printer to the industry. By adopting a configuration in which 16 heads are arranged in 4 staggered rows, they achieved a maximum printing speed of 800 m²/h in 300 x 300 dpi draft mode. In the 600 x 600 dpi standard mode, the printer operates at a maximum of 560 m²/h. To handle these higher speeds, the printer

1 Print heads are aligned in a staggered formation to increase the area printed in a single pass and increase printing speeds.
2 Lower resolution allows for faster printing.
New Epson Water-based and Solvent-based Inkjet Printers Design to Accelerate the Shift to Digital Printing Across the Board

In its Epson 25 Corporate Vision & Mid-Range Business Plan (FY2016–2018), Seiko Epson Corporation (Epson) aims to add approximately 60 billion JPY in revenue to its printing business. Epson has also stated that it will focus inkjet innovation on the office and industrial sectors. The first step towards this goal was the May release of three wide-format, Eco-Solvent Ink inkjet models targeted at the sign and display industry and the June release of two high speed water-based pigment ink inkjet models targeted at a wider range of applications. In both cases, Epson has applied its vertically integrated design and manufacturing processes to upgrade every technology, from the inks to the web handling system and printing heads. Epson Sales Japan 2016 targets for the two machines are 200 units for the Eco-Solvent inkjet printers and 500 units for the water-based pigment inkjet printers.

Driving the Shift to Digital Printing

According to Epson, the total global value of the analog and digital printing industry (printers and inks) encompassing the photo/graphics, signage, textile, and label fields in 2014 was US $33 billion. Epson’s share by field for digital printing was 35% for photo/graphics, 30% for labels, 20% for textiles, and 5% for signage (outdoor advertising). Their estimates for the three years from 2016 to 2018 show that the shift to digital printing will first be seen in the photo/graphics field at a steady rate, followed by a shift in signage, textiles, and labels at a faster average annual growth rate of 9%.

In this light, Sunao Murata, COO of the Epson Professional Printing Operations Division, says that their aim is to strengthen the competitive position of their core hardware, primarily the PrecisionCore printing head; establish an organizational base for customer-oriented sales and services; and push for solid growth in new fields. In particular, they will offer the simple, flexible production process made possible by inkjet printing to growth markets, including signage, textiles, and labels, as they encourage the digitalization of the printing industry.

64 Inch Sign/Display Inkjet Printers

The three models of wide-format sign/display inkjet printers released in May are the SC-S40650 four-color entry model with one printing head, the SC-S60650 high-speed four-color model with two printing heads, and the SC-S80650 ten-color high-speed, high-resolution model with two printing heads. In all cases, the 64 inch wide machines handle substrate sizes ranging from 300 to 1,626 mm and use Eco-Solvent Inks (solvent reduced inks).

During development, Yuken Tanabe, director of the PS Planning and Design Department, Epson Professional Printing Operations Division, says that along with surveying their global customer base, they also worked at their customer’s offices for a month to determine what was actually needed. From the more than 1,000 requests obtained in this way, they focused development of the new machines on three areas:
PROPAK and the Thailand Food Packaging Industry Continue to See Strong Interest From Japan

Held from June 15 to 18 at the Bangkok International Trade & Exhibition Centre (BITEC) in Bangkok, Thailand, the 24th International Processing and Packaging Technology Event for Asia, PROPAK ASIA 2016, hosted 40,893 visitors from 68 countries. With 1,967 exhibitors from 48 countries and 50,000 m², the event showed significant growth over the previous year (45,000 m² and 1,692 exhibitors from 42 countries). As in previous years, attendees from Malaysia accounted for the largest group of international visitors (16%), followed by Singapore (10.3%), Japan (8.4%), the Philippines (8.1%), Myanmar (7.2%), and China (6.8%). Although Japan accounted for 12% of international visitors during the previous show, it still maintained a top three spot, showing the country’s strong interest in Thailand’s food packaging industry. In this report, we highlight some of the exhibitors from Japan and look at the state of packaging in Thailand.

ALTECH ASIA PACIFIC Booth
Co-exhibitors: DAC ENGINEERING CO., LTD., Toshin Co., Ltd., THINK LABORATORY CO., LTD., Nikka Ltd., etc.

DAC ENGINEERING captured the attention of visitors with a device equipped with register mark color difference and registration inspection functions. The Thai language touch screen display also received positive remarks.

Looking to prevent blocking during the slitting process, a visitor requests to use the Nikka anti-blocking powder/test system on display.

THINK LABORATORY exhibited an off-line gravure cylinder polishing unit. Given that the polishing condition has an impact on gravure printing quality, converters have requested that cylinder makers use this polishing unit.

Toshin exhibited an SNR-A model slitter equipped with a Toshin friction shaft (TAF). The rewinder has a wide tension range, and can rewind thin, thick, and elastic materials of up to 1,300 mm in width at speeds up to 350 m/min.
**Antistatic Applications and Integration With Envelopes Expand the Market for Bubble Sheets**

Kawakami Sangyo Co., Ltd.

www.putiputi.co.jp

Bubble sheets are used daily for everything from wrapping packages to protecting cookies sold in cans. Under the registered trademark PUTIPUTI, Kawakami Sangyo Co., Ltd. has developed a wide variety of functional bubble sheets for applications that go far beyond these. Moreover, the company’s ability to convert these sheets into easy-to-use bags and precut products has helped them grow steadily in an industry faced with severe cost competition. Recently, we spoke to Takeo Suzuki, head of the Tokyo Office, regarding the company’s development of functional PUTIPUTI sheets for food, electronic component, architectural material, electronic commerce, and disaster relief applications.

**Capturing 50% of the Market**

Bubble wrap is produced by heat sealing a film onto a second film covered in cylindrical bumps so that these bumps are sandwiched in between. The air entrapped inside these bumps allows the film to function as a cushioning material. US based Air Products and Chemicals, Inc. first developed bubble wrap in 1957, and in 1966 Ube Industries, Ltd. purchased a production machine from Air Products and Chemicals and began selling bubble wrap under the name Air Cap in Japan. In 1968, Kawakami Sangyo’s previous president developed a proprietary bubble wrap machine and began production. The company acquired the registered trademark name PUTIPUTI in 1994, since which time they have developed many different types of functional PUTIPUTI. Kawakami Sangyo is also able to convert PUTIPUTI sheets into easy-to-use bags, file folders, tubes for long items, circles, ovals, donut shapes, squares, rectangles, and box patterns, as well as perforate the sheets, all in-house. Recently, sales of converted sheets have been increasing, and today account for 50% of sales. Thanks to these functional and converted PUTIPUTI sheets, the company has been able to continuously open new areas within this highly competitive bubble wrap industry, and today holds a 50% share of the 20 billion JPY bubble wrap market.
Pack (a bleached kraft paper envelope) and Safety Light (an unbleached kraft paper envelope) have a high water-resistance that protects them from rain, while OTEGARU PUTI MAILER is laminated with stone paper that can be written on with a pencil or ball pen. Because the envelope and cushioning material is integrated, the envelope is easier to use than cardboard boxes and cushioning material, and can also reduce the cost. Mr. Suzuki says that packaging costs are extremely important for e-commerce businesses, so he believes using Safety Pack will benefit these businesses by greatly reducing both packaging and shipping costs. In some examples, this has led to cost reductions of several million JPY per year. As a result, sales have grown strongly the past few years.

Simple Sleeping Space

After the Kumamoto earthquake this past April, Kawakami Sangyo donated products made of PUTIPUTI and PP Plapearl to disaster areas and emergency shelters. PUTIPUTI applied to floors, walls, and ceilings acts as thermal insulation, and by wrapping it around faucets and handles in the winter, it prevents these from freezing. The sheets can also be wrapped around one's shoulders, ankles, and waist, to stay warm, or used as a sleeping bag. Naturally, one other specific benefit of PUTIPUTI is that the bubbles can be popped for fun.

Meanwhile, QUICK SPACE 72H, made of light-weight, high-rigidity Plapearl, can be used to create a private space within 72 hours of a disaster. In fact, QUICK SPACE 72H was even used as a medical space at the Ishinomaki Red Cross Hospital after the Great East Japan Earthquake in 2011. Mr. Suzuki says that although it is a temporary space, it is strong and thermally insulated, so can be used for shelter, as well as changing rooms and simple toilets, before moving into more permanent housing.

* PUTIPUTI, SEIBO PUTI, DODEN PUTI, ATO-LAYER, ATO-LIGHT, BOSEI PUTI, TACK PUTI, SHRINK PUTI, PIFO, ECO SOKO PUTI, ALUMI PUTI, ECO HARMONY, ECO HARMONY white, ECO HARMONY strong, LOOP PUTI, MEN-LOCK PUTI, SAFETY PACK, SAFETY LIGHT, OTEGARU PUTI MAILER, Plapearl, and QUICK SPACE 72H are trademarks or registered trademarks of Kawakami Sangyo Co., Ltd.
showcasing cutting-edge printing technologies, solutions, and manufacturing lines, the 24th South China International Exhibition on Printing Industry (Printing South China 2017) and the China International Exhibition on Label Printing Technology 2017 (Sino-Label 2017) will be held during 1–3 March 2017 at Area B, China Import and Export Fair Complex, Guangzhou, PR China.

Keys for Industry Transformation: Automation, Efficiency, Green & Innovation

The German concept of “Industry 4.0,” which promotes smart factories, has sparked a new tide of manufacturing automation and information communication technology around the globe. Meanwhile, China has initiated its “Internet Plus” model, which promotes the integration of mobile internet, cloud computing, big data, the Internet of Things, and modern manufacturing. Benefiting from the rapid and revolutionary development of internet technology, the printing industry can now pursue the in-depth integration of conventional production, internet technology, and automation, which in turn favors and facilitates greener production, improved productivity and efficiency, and the transformation and upgrading of companies.

Pioneers from South China, the heart of the country’s printing, labelling, and packaging industries, have realized several breakthroughs despite the market downturn. For example, Artron Art Group has transformed from a conventional printer to a leader of global art printing that promotes art and innovation. Another example is Hucais Group, which is not only at the forefront of high-end packaging, but is also a pioneer in digital printing and customized products. In keeping with the trends of industry transformation, Printing South China 2017 and Sino-Label 2017 will work with professionals to forge the ideal combination of events, provide in-depth analysis of market demand, and address the challenges encountered by enterprises. In short, we aim to help industry players make better use of resources throughout the industrial chain based on new business models and increased competitiveness.

Printing South China Highlights Post-Press Machinery and Green Flexo Printing

Eight theme zones will be included at Printing South China to facilitate visitors in finding what they need efficiently and effectively. The eight zone themes are “Pre-press,” “Digital Printing,” “Offset/Flexo/Gravure Printing Equipment,” “Screen Printing and Special Printing Equipment,” “Post-press and Paper Converting,” “Carton Packaging,” “Printing Materials,” and “Parts, Support, and Service.” Post-press machinery has always been the show’s focal point and in 2017 there will be an expanded scale for the post-press, packaging, and processing zones. There will also be special activity zones for the “Hong Kong Print Awards,” green flexo printing, and 3D printing, where topics of conventional printing, packing printing, and functional printing will be covered.

Sino-Label Focuses on In-mold Label Chain

Sino-Label will provide comprehensive coverage of label tech-
Providing Coating Services for Substrates as Thin as 1.5 µm and Mastering Thick-film Bar Coating of Low-viscosity Fluids

General Co., Ltd.
www.general.co.jp

General Co., Ltd., an Osaka based manufacturer of thermal ribbons, other printing related media, and office automation related products, is working to expand its contracted coating business from its manufacturing base in Shiga, Japan. The company’s Shiga Plant is equipped with converting facilities (coaters, slitters, etc.) specifically designed to produce multilayer coated products using substrates as thin as 10 µm. The company is also able to offer one-pass surface and underside coating and multilayer coating, as well as thick coating of low-viscosity fluids on thin substrates as part of its contracted services, all capabilities that set itself apart from other contracted coating converters. Using specialized equipment, the company also offers some rare options even for Japan, including coating and laminating of 1.5 µm thick substrates.

More than 100 Years of Carbon Paper

General was founded in 1914 as a producer and distributor of carbon paper, giving it more than 100 years of experience in coating. Takayuki Yonezawa, director of the Technology Development Department, explains that carbon paper is made by coating one side of paper with a carbon material. When a second sheet of paper is placed against the carbon coated side and an object used to write or draw on the paper side, the carbon transfers to the second sheet of paper. Although demand for this type of paper has decreased, there are still some fields where it continues to be used. Mr. Yonezawa goes on to say that their experience working with carbon paper has led directly to the company’s core technology of precision coating. More recently, however, an increasing number of customer requests to also produce the coating materials and inks has led General to acquire ink and coating production technology. They have also begun producing inks for industrial inkjet printers, which has gradually led them to increase the variety of materials with which they work today.

Mr. Yonezawa says that although their web site lists coated products such as thermal ribbons, dot matrix printer ribbons (printing media), carbon paper, and tapes, the company’s core business is producing semi-finished products for other manufacturers, which means they work with a broad range of products consisting of film and paper substrates. Although they have multiple plants, including several outside of Japan, their Shiga Plant contains all of the necessary converting related technologies (ink and coating formulation/production, coating, and slitting facilities, etc.). For example, the plant is equipped with 15 solvent, hot melt, and hybrid coaters, 5 laminator/coaters, and some 40 slitters. All of these machines are available for producing the company’s own products and for their contracted wet coating services.

According to Mr. Yonezawa, the company primarily works with thin substrates of less than 12 µm in thickness, so most of their equipment is designed to handle such thin materials. Moreover, the company’s converting facilities are slightly different from the equipment owned by converters of standard films and paper. For example, the company’s slitters only have a minimum slit width of 6 mm. Although this is not necessarily considered narrow as far as the converting industry is concerned, it is fairly narrow in terms of thermal ribbon production, an area in
Yamabun Electronics Has High Hopes for Its 7th Consecutive K

Yamabun Electronics Co., Ltd.
www.yamabun-ele.co.jp

Founded in 1971, we began developing on-line plastic film(sheet thickness meters and automated thickness control equipment in 1986. Under the motto “Business Continuity and Growth,” we have manufactured and delivered more than 1,200 such units to plastic film(sheet producers around the world. With 21 employees, our current capital valuation is 10 million JPY (Aug. 12, 2016).

Despite the growing demand for high-quality plastic film production from Japan, it has become more and more difficult for Japanese companies to attract new employees to whom they can pass on their film(sheet production technology. As such, these companies have increasingly looked to automation, a demand which we have worked to meet. We have also seen a greater need for maintenance than new installations or capacity expansion.

We have also recognized the importance of increasing recognition of our company and products globally. Our first international exhibition was K, an exhibition which has continued to see strong interest among many Japanese manufacturers because of the high number of participants involved in product development from around the world (Europe, Middle East, India, China, etc.). In fact, K 2016 will be our seventh consecutive K exhibition, and it is clear that our regular participation in K has strengthened our presence among both visitors and competitors. Our experience at K has shown us that we offer a greater variety of measuring equipment than our competitors.

We have also seen that our European competitors offer equipment with more refined designs, meaning that we still have much to learn. In terms of function, however, our products are designed with a specific target in mind.

When we first participated in K in 1998, Europe and the US were the sources of cutting-edge plastics, but since 2010 we have seen India and Taiwan become more competitive. Meanwhile, in 2013, most visitors to K were still focused on produc-

TOF-6R Details

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply</td>
<td>AC 100 V ±10%, 50/60 Hz</td>
</tr>
<tr>
<td>Temperature</td>
<td>5–40°C</td>
</tr>
<tr>
<td>Humidity</td>
<td>30–80% (no condensation)</td>
</tr>
<tr>
<td>Atmosphere</td>
<td>Environment without dust and corrosive gas</td>
</tr>
<tr>
<td>Vibration</td>
<td>Gauge sensor should not be subject to vibration</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>50 VA (excluding personal computer)</td>
</tr>
<tr>
<td>Applications</td>
<td>Thin plastic films (polyimide films, optical films, etc.)</td>
</tr>
<tr>
<td>Measurement Range</td>
<td>5–100 μm (depends on material)</td>
</tr>
<tr>
<td>Measurement Length</td>
<td>10–200,000 mm (depends on pitch)</td>
</tr>
<tr>
<td>Measurement Pitch</td>
<td>0.1 mm</td>
</tr>
<tr>
<td>Resolution</td>
<td>0.01 μm</td>
</tr>
<tr>
<td>Accuracy (at 20°C)</td>
<td>±0.2 μm</td>
</tr>
<tr>
<td>Measuring Force</td>
<td>0.19 N (0.12 N)</td>
</tr>
</tbody>
</table>

*Contact Points: 7R hemisphere
*Total precision is calculated by adding the machine error and the quantization error of the digital conversion error to the above values
*TOF-6R is supplied with 2 m communication cable and measured data processing software (PC not included)
tion, and we were just beginning to see an increasing need for inspection at this time.

During K 2016, we will display two types of desk-top thickness meters and a one-eighth scale on-line thickness meter. The highlight of our exhibition will be the TOF-6R high-resolution desk-top thickness meter.

**Expectations for K 2016**

1. We hope that K continues to be one of the largest, most attractive exhibitions in the world.
2. We hope to communicate with the many key players in the industry from different countries that will visit K.
3. We hope K offers the chance to create new business globally and discover new points of entry.
4. We hope K offers the chance to directly gather information on competitor trends.

We have also exhibited at other plastics related exhibitions in Europe and Southeast Asia, through which we have built connections with local companies. The response to our thickness control equipment has been positive given that many of the visitors to our booth at these different shows have been interested in the future importance of thickness control.

Despite this positive response, Southeast Asian companies, for example, have yet to fully recognize the need for thickness control. As such, we have found it necessary to promote why our equipment is important in the first place. Moreover, most regions also place more emphasis on simple operations and minimized operator control than Japan.

With their continued focus on cost and maintenance, many visitors are also influenced by the “Made-in-Japan” label. For example, although they recognize the consistently high quality and reliability of Japanese products, they also feel the cost is high. Moreover, many visitors only desire a level of precision and functionality that meets their needs, and are not interested in anything beyond. There is also a strong interest in our after-service policy.

Going forward, we feel that the precision of sheets and films produced in Southeast Asia and the Middle East will continue to improve. As such, these regions will increasingly require thickness meters and automated control, for which we will continue to promote our equipment at exhibitions like K.

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**Contact Type Desk-top Film-Sheet Thickness Measuring System**

<table>
<thead>
<tr>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement range</td>
</tr>
<tr>
<td>Measurement length</td>
</tr>
<tr>
<td>Measurement pitch</td>
</tr>
<tr>
<td>Power supply</td>
</tr>
<tr>
<td>Temperature/Humidity</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>Resolution</th>
<th>Accuracy (at 20°C)</th>
<th>Measuring force</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOF-4R05</td>
<td>0.5µm</td>
<td>2±2 µm</td>
<td>0.6±0.1 N</td>
</tr>
<tr>
<td>TOF-4R10</td>
<td>1.0µm</td>
<td>2±2µm</td>
<td>0.8 N or less</td>
</tr>
<tr>
<td>TOF-5R01</td>
<td>0.1µm</td>
<td>0.8±0.1 µm</td>
<td>0.3±0.01N</td>
</tr>
<tr>
<td>TOF-6R001</td>
<td>0.01µm</td>
<td>±0.2µm</td>
<td>0.19 N (0.12N)</td>
</tr>
</tbody>
</table>

* Export permission is necessary. (Japanese Govt.)

**Measurement Screen**

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**Precise Thickness Measurement and Control**

**YAMABUN Electronics Co., Ltd.**

2-13, Shityonishi, Higashi-osaka, Osaka 578-0964, Japan

TEL. +81-6-6745-3048  FAX. +81-6-6745-8482

http://www.yamabun-ele.co.jp  E-mail: yamabun@mxa.mesh.ne.jp

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**Exhibit**

**K2016 International Trade Fair for Plastics and Rubber**

Date: Oct.19~22, 2016  Venue: Duesseldorf, Germany

**Manufacturing Indonesia 2016**

Date: Nov.30-Dec.3, 2016  Venue: Jakarta International Expo Kemayoran
Using the Plastic Craze Defect to Functionalize Films and Fibers: cheaper battery separators and privacy films

Faculty of Engineering, Gifu University

www.eng.gifu-u.ac.jp

Purposefully using craze, a flaw found in plastic, two researchers at Gifu University have figured out a new way to provide films and fibers with functionality. The research of Associate Professor Akiyoshi Takeno and Assistant Professor Keishi Naito of the Faculty of Engineering, Gifu University, uses a sharp blade to bend the film, which generates fibrils and nano-voids (craze) that result in a (window) blind lighting control effect. In the case of fibers, the voids can be used to support enzymes or colorants that give the fibers functionality. Recently, their research has focused on the gas permeability of crazed film to produce lithium-ion battery separators. Given the simplicity of the process, the approach is aimed at reducing separator production cost.

Making the Distasteful an Ally

Bending plastic can cause the material to whiten and become cloudy. Called craze, this phenomenon is the initial failure stage of polymer materials. In general, craze occurs the moment a force is applied to plastic, and instantly evolves into cracks, after which the plastic breaks. Because craze immediately evolves into cracks, in practice it appears as though the plastic breaks instantly. Dr. Takeno explains, however, that the real difference between craze and cracks depends on whether the material fragments into two parts. In other words, during the craze mode the material remains intact, and because craze occurs without evolving into cracks, the crazed film has the same mechanical strength as film without craze.

Craze itself consists of fibrous sections called fibrils, which look like pulled yarn, and voids, which form the gaps between the fibrils (Fig. 1). The width of the fibrils ranges from 10 to 50 nm and the diameter of the voids ranges from 20 to a few hundred nm. Generally, craze is considered a defect and is avoided, but Dr. Takeno recognized that by purposefully generating craze he could produce polymer materials with a porous structure that offered new possibilities.

It was only a matter of chance, however, that Dr. Takeno realized the potential for craze. At the time, Dr. Takeno had been working with polyvinylidene fluoride (PVDF) film to produce a new material when he accidentally scratched the film with his fingernail. Upon taking a closer look at the scratched sections, he saw that light in these areas scattered in a different direction from the pristine sections. He immediately set to work verifying the conditions that would produce these results.

Dr. Takeno initially tried bending and stretching the film, which did not achieve the desired effect. It was only when he kept the film tension stable while bending the film in different locations using an edge that he was able to produce the desired results.

A Simple Process

After determining the generation mechanism, Dr. Takeno pressed a sharp blade against a moving film and succeeded in generating regularly occurring craze (crazing method, Fig. 2). The method works with films including PP and PVDF. In this approach, craze starts to form on the underside of the film and slowly grows vertically through the film towards the blade.

Dr. Takeno explains that stress concentrates at the blade edge when the film is bent strongly by the blade, which is what generates craze. Once craze occurs, however, the elastic modulus in this area drops, and stress no longer concentrates.

![Figure 1: Fibril and Void Structure (top) and Magnified Image of Craze (left)](image-url)
Ingenuity
For the satisfaction of our customers
Providing coating, labeling, and cutting technologies for increased value.

Coating
From thin to thick film coating

Laminating
Dry, non solvent, wet, extrusion, thermal, print, hot-melt, transfer

Printing
Gravure (film, aluminum foil)

Slitting
Film, aluminum foil, copper foil, paper

Technological Innovation
For the growth of our customers
Contributing to the future by “creating value, productivity, and a clean environmental” and by “reducing loss and costs.”

Meeting the needs of our customers with order-made functions
Available products: coating machines, laminators, gravure printing presses, paper tube manufacturing machines, slitters, and all manner of industrial machines.

To support our customers, we have permanent test machines at our factory. Contact our sales department for availability.

Okazaki Machine Industry Co., Ltd.

Head office / Factory : 2-22-6 Befu Settsu-Shi, Osaka 566-0046 Japan Tel: +81-6-6349-5566 Fax: +81-6-6340-7570
Tokyo Sales Office: 3-10 Nihonbashi Kodenmachi, Kawaosu Building, Chuo-ku, Tokyo 103-0001 Japan Tel: +81-3-3640-5566 Fax: +81-3-3640-1682
New CNF-resin Composite 3D Printing Filament Accelerates Prototyping of Composite Material Parts

STARLITE Co., Ltd.
2nd.starlite.co.jp

STARTLITE Co., Ltd., a manufacturer and distributor of plastic bearings and other industrial goods, has developed a CNF-resin composite material composed of cellulose nanofiber (CNF) and polylactic acid (PLA). Targeted for use with 3D printers, the composite of CNF and PLA can be formed into filaments that are printed with standard fused deposition modeling (FDM). The impetus behind the development was to use 3D printing as a means of reducing the time and cost of the repeated modeling, verification, and evaluations required to determine the viability of parts made of CNF-resin composites for practical use. STARLITE also sees expanding the potential compounding resins as a means of finding new applications for composite materials. During the Nanocellulose Symposium, held this past March, STARLITE used the prototype display area to exhibit its CNF-resin composite filaments for 3D printing. Yasumasa Kawabe, director of STARLITE and leader of the Innovation Promotion Unit, says that the CNF-resin composite attracted significant attention, with many attendees stating they had never seen anything like it before.

Machinery, Automobile, and Office Equipment Parts

STARLITE was established in 1936 and grew along with the development of sliding material made of phenol resin. From early on, the company worked to replace metal bearings with plastic bearings, and today applies tribology* to control the friction of bearings and gears for industrial machinery, automobiles, and ships, as well as sliding material for railways and parts for multifunction office equipment. Along with resin molding technologies, they are also skilled at compounding fillers and additives into resin. Some examples of their wide range of business operations include plastic helmets and emergency toilets designed for the safety and disaster management fields. Including their head offices in Osaka, the company has 9 locations throughout Japan. STARLITE also operates three group companies in Japan, as well as overseas companies in Thailand, China, and Mexico.

The company’s president and C.E.O., Takamitsu Saigo, and the previous president, are descendants of Takamori Saigo, one of the leaders of Japan’s Meiji Restoration. According to Mr. Kawabe, Mr. Saigo’s policy is that a product need not be profitable if it makes the world a better place. This venture mentality and passion for social contribution—something that seems to be in the blood of the Saigo family—has allowed the company to challenge new areas and produce unique products that other companies would never touch.

In fact, when Mr. Kawabe came to STARLITE from a major chemical producer a year and a half ago, he says he was surprised at the company’s aggressive stance. STARLITE moves quickly to work with universities even for technologies that are still in the developmental stage and for which prospects are difficult to judge.

Aiming For Major Cost Reductions

The company’s work into CNF began roughly 10 years earlier, at a fairly early stage in the development of CNF. One reason they looked into the material was that high-strength CNF is suited to tribology, one of the company’s core technologies. The company’s recognition that CNF would eventually reach the commercialization stage led it to further research and development. Using their skill in resin formulation, they recently succeeded in developing a CNF-resin compound filament for 3D printing.

Mr. Kawabe explains that before commercializing parts made of CNF-resin composites, each individual part must be repeatedly molded, tested, and evaluated. As such, the company realized that 3D printing could accelerate prototyping and evaluation of CNF-resin composite parts. Moreover, because 3D printing does not require an expensive die-mold, it provides the opportunity to significantly reduce costs. Mr. Kawabe says

* Tribology is the study and application of concepts of friction, wear, and lubrication between two surfaces in relative motion. Understanding and controlling these phenomena allows for low-friction, low-abrasion products.
Using Visible Light Lasers and Gold Nanoparticles to Replace Expensive Lithography Micro-machining Techniques

Ultrasound and electron beam lithography are two well-known nano-machining techniques used to produce integrated circuit patterns and other such structures. The short ultraviolet wavelengths and electron beams used in these techniques, however, have difficulty functioning in an atmosphere and the equipment is expensive. As such, Assistant Professor Kazushi Yamada of the Department of Advanced Fibro-Science, Kyoto Institute of Technology, has taken an entirely different approach to nano-machining based on visible light lasers and gold nanoparticles. Specifically, the approach uses a visible light laser to ablate nano-pores with diameters ranging from 10 to 100 nm into a film of gold nanoparticles coated to glass and PET substrates. In contrast to lithography, Dr. Yamada’s approach can be applied normally in an atmosphere, so is convenient and simple. Moreover, the diameters of the nanoparticles control the diameters of the pores, while the laser firing time is only a few microseconds.

Problems With Lithography

In the case of conventional photolithography, the focus of the beam is constrained by the diffraction limit of light, so micro-machining requires the use of short wavelength ultraviolet radiation. Electron beam lithography uses an even shorter wavelength, so the equipment is large and expensive.

Dr. Yamada explains that the minimum structure size of photolithography is generally limited to one-half to one-quarter the width of the light wavelength being used. In other words, to produce a structure width of 10 nm or 20 nm, the light wavelength must be less than 100 nm. In the vacuum-ultraviolet (VUV) light region, where wavelengths are less than 190 nm, oxygen in the air will absorb the light, meaning a vacuum is required to ensure the light reaches the material. Therefore, Dr. Yamada began his research with the question of whether it was possible to use a general-purpose, low-cost visible light laser in an atmosphere to realize a more convenient nano-machining process.

Laser Ablation of Nanoparticles

In Dr. Yamada’s approach, a glass substrate, for example, is first coated in a film of gold nanoparticles. Next, a 532 nm wavelength light laser is used to selectively ablate the gold nanoparticles to form nano-pores with a diameter and depth of 10–100 nm into the coated substrate (Fig. 1).

Here, the target substrate is produced by first immersing a washed glass substrate into an adhesive coating and drying. Next, the substrate is immersed again in a gold nanoparticle solution for 20 to 30 minutes, removed, and dried again. Finally, the substrate is spin coated in a polymer (polymethacrylate (PMA), etc.) to prevent thermal diffusion.

Dr. Yamada explains that when exposed to a laser, plasmon resonance causes the gold nanoparticles in the coating to absorb the light and instantly rise in temperature to several thousand degrees Celsius, far above the boiling point of gold. At such high temperatures, the gold nanoparticles simultaneously evaporate and instantly burn away part of the polymer and substrate surrounding the particle, which creates a porous geometry on the surface. Only a few microseconds are required to burn away the material, making it an extremely efficient process.

![Figure 1 Laser Ablation Nano-machining](image)
Reflection-type Sensor
PS-270

1. Detectable for gold and silver color materials
With a new optical system, the marked line on shiny materials like gold or silver materials can be detected.

2. Unaffected by ambient light
Since a new design circuit is equipped in a detector, it is not affected by sunlight and ambient light.

3. Detectable distance 30mm, Spot diameter $\phi 7.5$
With the adoption of large lens, the detectable distance is 30mm, and spot diameter is $\phi 7.5$. Therefore, the detection point is easily viewable and easy to position.
Films used in industry today can be as thin as one micrometer, but in the near future, it is likely that these will be as thin as a few tens of nanometers. As such, at least one research center is already using web handling theory and roll-to-roll equipment to develop and utilize such films. Established to bring together up-and-coming researchers from a myriad of fields, the interdisciplinary Micro/Nano Technology Center (MNTC) at Japan’s Tokai University is working to develop ultra-thin polymer films with thicknesses under 100 nm, as well as to search out potential applications. We spoke to Professor Rio Kita of the Department of Physics, School of Science; Associate Professor Yosuke Okamura of the Department of Applied Chemistry; and Tokai University Department of Mechanical Engineering Junior Associate Professor Yuta Sunami about their research in this field.

Targeting Medical Applications

Consisting of eight campuses throughout Japan, Tokai University is one of the largest educational systems in the country. MNTC was established at the Shonan campus, located in Kanagawa prefecture, in January 2015. A comprehensive subsidy was provided by the Ministry of Education, Culture, Sports, Science and Technology (MEXT)—the MEXT-supported Program for the Strategic Research Foundation at Private Universities, a subsidy for supporting various research projects at private universities. MNTC covers a total floor area of 403.57 m² and is equipped with all of the advanced research facilities, including a clean room, a cell culture lab, a chemistry lab, and a constant temperature/humidity room.

Eight young researchers from the engineering, physics, and medical schools have come together to work at MNTC with the common goal of developing next-generation medical technologies using ultra-thin polymer films, a theme that allows each member to apply his or her individual field of specialty. Professor Rio Kita, Department of Physics, is an expert in polymers and leads the MNTC research team.

Under the concepts of “Create,” “Test,” and “Know,” the members have divided themselves into three sub-groups. Associate Professor Okamura of the Department of Applied Physics and Junior Associate Professor Sunami of the Department of Mechanical Engineering belong to the “Create” group. Associate Professor Okamura is in charge of design and production, and Junior Associate Professor Sunami is in charge of developing the roll-to-roll production process with an eye on eventual mass-production. Ultra-thin polymer film, in short,
Mastering Coating to Meet Your Needs

Coating Technology
- Wide range of thickness
- All webs, from film to metal foil and paper
- Large variety of coating heads

Web Handling Technology
- Tension control specific to web conditions
- Low-inertia, specially processed rolls
- Multiple types of winders for different products

Drying Technology
- High-efficiency drying facility design
- Optimal drying methods
- Ventilation and maintenance-friendly drying furnace structure

Test Coater
Facilitates research and development

Variety of Coating Heads
(also for UV curable resin use)

"Choi Nuri-kun"
Table-top Test Coater

Kobayashi Engineering Works, Ltd.
Industrial Machinery Sales Department

Head Office: 2-1-1 Mitojima, Fuji-shi
Shizuoka-ken, Japan
Tel: +81-545-61-2400
Fax: +81-545-62-6466
http://kobayashieng.co.jp
The minimum lines/space (L/S) of mass-produced, screen printed electronics is assumed to be around 70/70 μm. This limitation has driven the development of new technologies, such as gravure offset, that can print finer L/S. As such, GUNZE LIMITED’s exhibition of a flatbed type screen printing machine that was able to print an L/S of 30/30 (60 μm circuit wiring pitch) during Printable Electronics 2016, held this past January, was highly unexpected. Moreover, a roll-to-roll version is already in operation for mass-producing touch screen modules. Although modifications to the screen printing technology itself contributed to these results, GUNZE’s success in this area was primarily based on their understanding of what is truly important to producing a quality product, a piece of wisdom garnered from their 30 years of experience in printing touch screens.

From Resistive to Capacitive Touch Screens

GUNZE began working with screen printing technology around 1985. The company had developed a transparent conductive film using ITO (indium tin oxide), which they felt could potentially be combined with printing to produce touch screens, a device that was still rare at the time.

When they began this business, the most common touch screens were either digital (X-Y matrix) type or analog type resistance touch screens. The company initially chose to work with digital types. In this case, the film (or glass) top substrate (X-axis) and bottom substrate (Y-axis) are patterned with striped transparent electrodes made of ITO. The substrates are then layered so that the electrodes are perpendicular to each other. When the upper electrode is pressed with a finger, the depressed area contacts the lower electrode, causing a current to flow. This current is what allows the touch screen to detect touch. Screen printing is used to print the spacer that creates the gap between the upper and lower electrodes, the leader wire, and the insulation layer required for the striped electrodes.

According to Takahiro Sonoda, director of GUNZE’s Electronic Component Business Division Technology Research Center (currently director of the Research and Development Division, No. 3 Research Laboratory), at the time touch screens were primarily used for commercial applications, such as train station ticket machines and bank ATMs. As such, there was plenty of space to print the electrode circuitry, so only required an L/S of 5/5 mm, and therefore did not require fine circuit wiring technology.

Later, however, projection type capacitive touch screens became more common. Compared with resistive touch screens, capacitive types allow for better device durability and environmental resistance. In fact, with the release of capacitive type smartphones in 2007, smartphones, tablet PCs, and laptops with touch functionality poured onto the market, causing the touch screen industry to explode. Even so, GUNZE continues to primarily produce commercial touch screens that require reliability, which it supplies to large-scale manufacturers globally in two versions. The first of these is a module in which the cover glass and touch screen are integrated, and the second is a module that includes a liquid-crystal display.
Membranes Offer the Chance to Mitigate Global Warming by Making CCS Economical

Center for Membrane and Film Technology, Graduate School of Engineering, Kobe University
www.research.kobe-u.ac.jp/eng-membrane/center/

One solution to global warming is carbon dioxide capture and storage (CCS), a method for separating and collecting CO₂ at the source of emissions and storing it on the sea floor. Although an effective method of reducing greenhouse gas emissions, the approach is expensive, with most of the cost being involved in separating and recovering the CO₂. As such, there is pressure to develop technologies that will reduce the cost burden of these steps. For this reason, Assistant Professor Eiji Kamio of the Membrane Engineering Group, Graduate School of Engineering, Kobe University, is working on ways of applying gas separation membranes as a CO₂ isolation technology. These membranes contain a highly CO₂ reactive substance that is able to selectively separate CO₂ using a chemical reaction, and thus reduce the cost of these steps. The new approach also offers the potential for developing new applications unique to membranes.

Start of CCS Testing in Japan

The Japanese government is aiming to reduce greenhouse gas emissions 80% by 2050.¹ One of the various methods it is promoting to meet this goal is CCS technology. Following in the wake of other large-scale CCS projects globally, in April 2016 Japan began testing CCS near the city of Tomakomai in Hokkaido. The goal is to store CO₂ on the ocean floor some 1,000–3,000 meters below the surface. This is the first test in Japan that integrates isolation, recovery, and storage, and is expected to launch the technology towards commercial use.

Factories, power plants, natural gas refineries, and hydrogen generation plants are all sources of CO₂, which must be isolated from gases such as nitrogen, methane, and hydrogen, also released from these sites, prior to storage. Several of the isolation technologies being considered include chemical absorption, physical absorption, and membrane separation.²

The chemical absorption method, which was chosen for the tests at Tomakomai and is close to commercialization, isolates CO₂ by chemically reacting a CO₂ absorbent liquid and the CO₂ found in the exhaust gas. One of the problems with this approach, however, is that heating is required to remove the CO₂ from the CO₂ absorbent liquid, which makes for extremely high energy costs.

Membrane Separation

The membrane separation method uses a polymer membrane that is able to separate CO₂ from other gases using only gas pressure. As such, this method does not require any added energy, and is thus expected to greatly reduce costs. In terms of performance, however, the membranes will allow gas molecules smaller than CO₂ to pass, so the approach’s poor selectivity has prevented it from being commercialized.

To overcome this problem, Dr. Kamio has been researching the use of a membrane separation method that utilizes a substance with high CO₂ reactivity as a carrier. This substance only reacts to CO₂, so has good selective absorbency (see Figure). Dr. Kamio explains that he chose to use amino groups in the form of amino acid³ as the membrane carrier because these are highly reactive to CO₂.

Although the resulting membrane (carrier membrane) is extremely good at absorbing CO₂, in dry environments it becomes nearly impermeable to CO₂. For example, when the hu-

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¹ Specified in the “Global Warming Prevention Plan (May, 2016 Cabinet Decision)“
² “2013 Feasibility Report on the Bilateral Shuttle Ship CCS Credit System” (Ministry of the Environment, March 2014)
³ The generic term for organic compounds consisting of an amino group and a carboxy group
New Screen Printing Inks Overcome the Issues of Screen Printing Complex Patterns

Teikoku Printing Inks Mfg. Co., Ltd.
www.teikokuink.com

Teikoku Printing Inks Mfg. Co., Ltd. recently developed a new type of high-quality, high-precision screen printing ink that can be used to print complex design patterns that combine solid, gradation, and fine line areas in one pass. The company completely revised the material design to improve ink anchorage on the substrate and ensured the inks can be used under existing drying conditions, which lowers the hurdle for adoption by printing companies. On July 1, 2016, Teikoku Printing Inks began selling four types for general-purpose, glass, and forming applications.

Screen printing is currently faced with several problems, including the difficulty of simultaneously printing solid areas and fine lines, the low printing speeds, and the need for experienced operators to deal with the many complexities. The new high definition inks were developed specifically to overcome these problems. Teikoku Printing Inks formulates the inks from the same materials as conventional inks, but completely revised the ink rheology control technology, the screen mesh, the screen mask/emulsion, and the printing machine, among others. The inks have the following characteristics:

1. Fine Line Printing: 100 μm lines
2. Area Printing: ability to consistently print combinations of solid and gradation areas
3. Sawtooth Edge: sawtooth edge (raster) is kept below 10 μm, allowing for smooth edged lines and circles
4. Continuous Printing: no change in lines and dots even after continuously printing 1,500 sheets
5. High-speed Printing: 800-1,500 sheets per hour with a rotary screen printing machine
6. Reproducibility: machine can be started even without cleaning inks left on the screen for one hour
7. Reduced Screen Mask Cleaning Frequency: decreased frequency from one cleaning per 300 sheets to one cleaning per 1,500 sheets.

An advanced version of their ERX ink for printing adhesive PET films, polycarbonate sheets, and home appliance name plates, XER is a general purpose one-component screen printing ink. XER has the same flexibility and heat resistance (characteristics required for post-printing processes) as ERX, but allows for higher resolution printing. For example, when ERX is used to print regular patterns of solid black squares at 30 μm intervals on PET film, the ink will bleed into the gaps (Photo 1 left). In contrast, XER will print crisp patterns, even when using the same screen mask and squeegee conditions (Photo 1 right).

According to Kenji Kinoshita, lead researcher at the company’s research center, conventional inks are not able to accurately reproduce fine patterns. Meanwhile, the physical properties and surface tension of XER are controlled so that the ink reproduces the exact screen mask pattern without bleed or splatter. Moreover, Teikoku Printing Inks modified the pigments and dispersions to allow for accurate reproduction of fine patterns on non-absorbent plastic substrates as well.

XIP-HF is a two-component screen printing ink for insert printing. This ink has the same heat resistance and good anchorage on adhesive PET film and polycarbonate as IPX, two factors required for insert molding, but it is better suited to high-precision printing. Teikoku Printing Inks already holds a dominant share of insert mold screen printing inks.

XGL-HF is an advanced version of GLS-HF two-component screen printing ink specialized for glass. The ink has good adhesion with the bezel of smartphones and tablet PCs, as well as inorganic materials such as glass bottles. It is also suited to fine printing that requires excellent linearity and circularity (Photo 2). In the future, the company plans to phase out their conventional inks, and expand sales of the new inks in Japan, China, Korea, Taiwan, Southeast Asia, the US, and Europe.
Asia Continues to Drive Growth in Petrochemical Derivatives

Chemicals Division, Manufacturing Industries Bureau, Ministry of Economy, Trade and Industry

Ethylene is one of the basic chemical components used to produce a broad range of products, including automobiles, home appliances, daily goods, clothing, drugs, and cosmetics. In this light, the Global Petrochemical Supply and Demand Trend Working Group (administered by the Ministry of Economy, Trade and Industry, Manufacturing Industries Bureau, Chemicals Division) recently released a report (July 2016) on global petrochemical demand, production capacity, and production volume trends through 2020. The report covers ethylene derivatives, propylene derivatives, and aromatics, among others.

Ethylene Derivatives

Global demand for ethylene derivatives in 2014 showed strong growth of 2.6% over 2013 to reach 131.4 million tons. This rate, however, is slightly lower than the 4.8% growth seen in 2013 (129.6 million tons). By the end of 2020, demand is expected to increase to 162.5 million tons, making for an average annual growth rate in demand from 2014 to 2020 of 3.6%.

Although demand for ethylene derivatives, such as polyethylene and ethylene glycol, has seen slower growth from East Asia, Asia as a whole is expected to continue to drive demand for these. Led by India and China, annual average growth from 2014 to 2020 in Asia is estimated at 4.7%, while Africa will see growth of 5.9% per year and the Middle East will see growth of 5.0% per year. Meanwhile, North, South, and Central America will see steady growth of 2.6% per year. The Commonwealth of Independent States (CIS) is expected to see average annual growth of 2.3%.

Increased shale gas production in North America and enhanced coal-to-chemical plant capacity in China are expected to increase the global ethylene derivative production capacity. Based on plans for new construction of plants that are likely to go into operation by 2020, the production capacity by the end of 2020 is estimated at 198.5 million tons, for an average annual increase of 3.2%. The estimated average growth rate by region is 2.9% for Asia, 4.0% for North, South, and Central America, 2.5% for the Middle East, and 0.1% for Europe. China (annual average growth of 3.8%) and India (annual average growth of 7.3%) are expected to see greater growth.

In 2011, the ethylene derivative supply/demand balance peaked at 7 million tons, and contracted thereafter before returning to peak levels in 2014. Since 2014, supply has continued to grow faster than demand, leading to an estimated supply surplus in 2017 of 10 million tons, or 7.6% of total global demand. In Japan, supply has remained steady since 2014, leading to an estimated supply of 5.9 million tons in 2020. Demand has also remained steady at 5 million tons since 2014, but is expected to decrease to 4.9 million tons in 2020.

Despite China’s increasing ethylene derivative production capacity resulting from expanded coal-to-chemical production, growth in demand is expected to outpace growth in production capacity. Supply is expected to grow from 18.6 million tons in 2014 to 27.2 million tons in 2020, whereas demand is expected to grow from 34.7 million tons to 49.1 million tons, for an increase of 14.4 million tons, in the same period. As such, excess demand will balloon from 16 million tons in 2014 to 22 million tons in 2020.

In the Middle East, Iran is planning the construction of new ethylene plants, which will create an estimated supply surplus of 22 million tons in 2020. As such, Iranian supply is expected to exceed the excess demand coming from Asia and Europe. Europe will see growth in excess demand from 100,000 tons in 2014 to 2.3 million tons in 2020. Meanwhile, North, South, and Central America will see supply surplus increase from 3.1 million tons to 6 million tons in the same period. Specifically, North America is expected to see its supply surplus expand from 6.7 million tons in 2014 to 8.1 million tons in 2020.

The report states that the significant drop in crude oil prices from the second half of 2014 through the beginning of 2016 may have had an influence on immediate supply and demand of ethylene derivatives, thus pointing out that it will be necessary to continue monitoring the trends in crude oil prices.
Expanding the Market for DIC COLORCLOUD Solution and "FINART" Gravure Lamination Inks

Toshio Watanabe
Dispersion Technical Group 1 Manager, DIC Corporation

Shinichiro Taniguchi
Color Support Center Manager, DIC Graphics Corporation

1. Development Background

The development of gravure ink for packaging closely follows the changing requirements in legal regulations, ecological measures, and the demand for higher functionality. Until now, DIC Corporation has worked to develop and commercialize inks that respond to the demands of the time, including solvent based Univure A, solvent based toluene free Univure NT, and MARINE PLUS G, a water-based ink. On the other hand, lamination inks are developed and released to the market on a five to ten year cycle, so it is necessary to consider issues from the mid- to long-term perspective when designing next-generation inks. In this respect, we see the following three points as specific issues for the future.

1. Safety for use on food packaging
2. Reducing the environmental impact of printing
3. Efficiency improvements throughout the packaging supply chain

Given the growing awareness of food safety, particularly in Europe, stricter regulations are being implemented regarding ink raw materials. In terms of printing ink, Japan has adopted a voluntary negative list (those that indicate prohibited substances), whereas other countries around the world have adopted positive lists (those that indicate sanctioned substances) as national law. As such, steps toward regulating food packaging under stricter safety standards have been accelerating. In Europe, the Swiss Ordinance, which regulates materials used in food packaging, including printing ink, has been enacted as law in Switzerland (a non-European Union nation). In this way, this ordinance has become one of the standards used by global brand owners and converters to select printing inks for food packaging. In addition, we are also seeing China move towards positive list regulations for food packaging materials, so future compliance with these regulations is desirable (Fig. 1).

Given this situation, DIC has developed and commercialized a gravure lamination ink called FINART based on the above mentioned legal and regulatory trends. In addition, these inks are designed to work with DIC COLORCLOUD Solution, a newly released color coordination and reproduction system that allows for brand image unification regardless of differences in packaging material (paper, film, metal, etc.), printing method (gravure, flexo, offset, etc.), and region (domestic, international). In this article, we will introduce the features of FINART and DIC COLORCLOUD Solution.

Food Packaging Regulations By Region
(ink and laminate adhesive fields)

<table>
<thead>
<tr>
<th>Region</th>
<th>Law</th>
<th>Voluntary Industry Regulation</th>
<th>Related Regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>Food Sanitation Law Notification 20, 370 of the Ministry of Health and Welfare</td>
<td>JPIMA</td>
<td>EU 2023/2006 GMP</td>
</tr>
<tr>
<td>EU</td>
<td>EC 1935/2004 EU 10/2011</td>
<td>JAIA</td>
<td>FSMA</td>
</tr>
<tr>
<td>USA</td>
<td>FDA 21 CFR</td>
<td>EuPIA FEICA</td>
<td>(NAPIM)</td>
</tr>
</tbody>
</table>

Figure 1 Food Packaging Regulations
COATER & LAMINATER
Ultra-clean, Ultra-precision World-class Technology

Headquarters (Plant)
101-1 Kawai, Kawai-cho, Kitakatsuragi-gun
Nara, Japan 636-0051
Tel: +81-745-57-0681 Fax: +81-745-57-1075

Tokyo Branch
Hutic Kanda Bldg. 3rd floor
1-16 KandaSudacho, Chiyoda-ku
101-0041 Tokyo, Japan
TEL: +81-3-5289-8834 FAX: +81-3-3251-7999

www.hirano-tec.co.jp
1. Film Decoration (continued)

1.3 Film Decoration Examples and Demand

Film decoration is the decoration technology seeing the most active developments today. As shown in Table 12, film decoration has been adopted for a wide range of applications, including communication devices, home appliances, various types of equipment, automobile exteriors and interiors, cosmetics, household goods, and architectural materials. In Chapter 3, we will introduce specific examples of how these have been adopted in each field. Table 13 shows which methods have been adopted in different countries and regions. Although Japanese manufacturers held a dominant share of in-mold decoration in the past, recently Taiwan and other countries have been increasing their share of the market. Over-lay methods such as TOM, which originated and were developed in Japan, have steadily expanded in use from Japan to the rest of Asia and on to the US and Europe.

1.3.1 In-mold Decoration Examples

Figure 33 shows several examples of in-mold decoration from Japan, and Figure 34 shows several examples from Europe.

In Japan, application primarily spread among mobile phones and laptop computers, but more recently applications for automobile interiors have been increasing.

Application in Europe is generally similar to that in Japan, but some differences include:

1. increasing adoption of Dry Paint Film (Formable Film) for automobile exteriors;
2. many combinations of forming methods with other technologies, including gas assisted injection molding (GAI) and MuCell foaming; and
3. combinations with other decoration technologies.

Investigation into paint-free automobile exteriors has a fairly long history in Europe, and in some cases was actually implemented, as shown in Figure 35, but whether its use has expanded or not is uncertain. In-mold decoration also allows for using two different types of films and partial decoration, something difficult to do with over-lay methods, so we expect to see further developments using these methods.

Figure 36 shows some examples of in-mold labeling, which is primarily used for decorating food containers.

About the Author

In 1965, Shohei Masui began working for Sumitomo Chemical Company, Limited. Engaged in research and development of plastic materials and molding technologies, Mr. Masui was involved in the development and commercialization of glass fiber composite materials, injection press molding technology, and skin material lamination/integration molding technologies, among others. After later working for LPM Co., Ltd., Mr. Masui established the MTO Technology Research Laboratory in 2005. Today, he speaks, writes, and provides technical support to individual companies, primarily in the fields of decoration technology and CFRTP molding technologies as a technical consultant. He has provided his services globally in countries such as Taiwan, Korea, and China. He has also authored many works focused on areas related to plastic decoration techniques.
5. Silicone Release Property

In this session, we will provide an overview of the fundamental research the author has conducted into the silicone release property. In addition, we will discuss the release property of polyolefin elastomers and low-density polyethylene, both non-silicone release agents discovered based on the knowledge acquired through this research.

5.1 How Easily Does Silicone Release?

First, let us take a look at how the silicone release property compares to that of several other polymers. Table 16 shows the results of tests (using the method shown in Figure 82) on the peel strength of PSA tapes bonded to various polymer adherends. Silicone has a much lower peel strength than the other polymers, indicating an excellent release property. As such, the question is why silicone releases so easily.

5.2 Fried Eggs Release Easily From Fluorine Coated Frying Pans

Looking at everyday frying pans gives us a hint when investigating the release property. For example, fried eggs release easily from frying pans that have been coated with fluorine resin (polytetrafluoroethylene, PTFE). In contrast, fried eggs will stick to normal frying pans unless oil is used.

If we drip water onto the frying pan, the water will repel from the surface of PTFE coated frying pans, whereas it will wet normal frying pans, as shown in Figure 83. From these examples, we can see that perhaps the release property is related to the ease with which water is repelled.

We can understand the phenomena of repelling and wetting as follows. In short, the attractive force between the water and PTFE is low, as is the interaction at the interface, so water repels. On the other hand, the attractive force between the water and metal is high, as is the interaction, so the water wets.

<table>
<thead>
<tr>
<th>Adherend Polymer</th>
<th>Peel Strength (g/20 mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silicone</td>
<td>3</td>
</tr>
<tr>
<td>Polytetrafluoroethylene (PTFE)</td>
<td>120</td>
</tr>
<tr>
<td>High-density Polyethylene (HDPE)</td>
<td>495</td>
</tr>
<tr>
<td>Biaxially Oriented Polypropylene (OPP)</td>
<td>520</td>
</tr>
<tr>
<td>HI Polystyrene (HIPS)</td>
<td>815</td>
</tr>
<tr>
<td>Unplasticized Polyvinyl Chloride (PVC)</td>
<td>1,260</td>
</tr>
<tr>
<td>Polychlorinated Vinylidene Fluoride</td>
<td>570</td>
</tr>
<tr>
<td>Polycarbonate (PC)</td>
<td>880</td>
</tr>
<tr>
<td>Acetate (AC)</td>
<td>860</td>
</tr>
</tbody>
</table>

Table 16 Peel Strength of Polymers Against PSA Tape

PSA Tape: Nitto Denko Corporation PET PSA tape No. 31B (main component: polyacrylate-butyl ester) Peel Speed: 0.5 m/min.
5. Water-based Ink Drying Property and Drying Solutions

Switching to water-based printing inks is likely to decrease printing speeds and increase drying costs. This situation, however, differs significantly with paper and film printing, and also differs with flexo and gravure printing. As such, drying solutions are the greatest problem in switching to water-based inks.

5.1 Printing Method Based Differences

Gravure printing of standard packaging films requires the use of low-viscosity water-based inks. High-viscosity gravure inks are one cause of cylinder fogging (smudging on the unlined sections). As such, we must add 50 or more parts diluent to 100 parts ink stock to achieve a printing viscosity of around 16 seconds using a #3 Zahn cup (RIGO CO., LTD.), for example. Naturally, decreasing viscosity increases the volume of volatile components, which in turn raises the drying energy.

Because water is the diluent here, we have no choice but to greatly reduce the printing speed, even if we increase the water-based gravure ink concentration and reduce the cell depths. In many cases, a mixture of water and alcohol (for example: 40% water/60% IPA, a hazardous substance under the Fire Services Act), is used as the diluent.

Meanwhile, regardless of whether the substrate is film or paper, flexo printing uses high viscosity inks with a viscosity similar to that of gravure ink stock. In addition, the inks are only diluted by a few percent. The printing viscosity in this case is 17 to 25 seconds with a #4 Zahn cup (RIGO). Although low-viscosity inks can be used, these inks will flow from the fine line patterned areas to the unlined areas and cause fouling. Process colors, often used today, can level out and cause fouling of the halftones, which leads to poorer image quality.

Therefore, flexo machines must be able to print thin films using inks having higher solid ratios and viscosities than gravure inks, so drying is easier than with gravure printing. The energy of vaporization for water is far greater than that for organic solvents, however, so water-based flexo printing also requires various drying solutions.

5.2 Water-based Ink Drying Morphology

Water-based ink drying methods are broadly divided into vaporization and penetration modes. Figure 5 shows the general relationship of these.

When we print a single-layer onto uncoated paper (kraft paper, wood-free paper, and liner paper), drying takes place through the process shown in Figure 5(a). In this case, tiny voids between the fibers of uncoated paper allow some of the water-based ink to penetrate into the paper, while the water component of the ink penetrates even deeper as it diffuses into the paper. As such, the printed surface dries and hardens instantly. Although the moisture content of the paper increases...
in the drying zone of each unit can be more than five times as long as the CI drum type. As such, drying solutions are fairly simple. It is necessary to increase the dryer capacity, however, to handle the increased drying energy as mentioned earlier.

CI drum flexo printing machines are also used in the liner paper preprint field. Recently, however, there has been a shift to using multiple colors and higher quality printing, for example with beer cartons, which account for the majority of the work. As such, printers must print a thick-film of non-slip varnish, which increases the drying load and limits the printing speed of the CI drum flexo machine to around 160 m/min.

An effective method of speeding up printing is to adopt a unit type printing machine in which the drying zones between each printing unit can be lengthened. In the preprint field, the adoption of unit type printing machines now allows for printing speeds of greater than 300 m/min. We can naturally expect the same results with water-based printing of packaging films, so unit type flexo printing machines equipped with high-performance dryers are one potential solution. It is possible these will become the future of printing systems.

References

In this part of the series, we have been introducing roll-to-roll production systems, and up until the previous session focused on explaining the technologies that are common to all roll-to-roll lines. From this session, we will introduce the way in which roll-to-roll systems are currently being applied to the major processes used to produce flexible electronics and the future potential of this approach. We will begin by looking at and providing some specific examples of the hole formation process, a typical mechanical converting process.

11. Adopting Roll-to-roll Systems for the Main Processes

Flexible device production requires that various processes be combined and used together, but we can separate these processes into several categories based on the applied roll-to-roll configuration. Of these categories, continuous processes, such as lamination, coating, and chemical etching, are initially designed and commercialized assuming the use of roll-to-roll systems, so the difficulty of switching these processes to roll-to-roll systems is not high. Meanwhile, step processes, such as hole formation, photolithography, vacuum treatment, electroplating, printing, inspection, component packaging, and trimming, face various technological hurdles when switching to roll-to-roll systems. In particular, it is important to solve problems dealing with dimensional precision control. Let us begin by taking a look at the hole formation process.

(1) Hole Formation

Although its importance varies, the hole formation process is unavoidable during the production of flexible devices. The most commonly used types of holes are guide holes and through-holes, but recently, partial shape trimming is increasingly being used.

Various technologies have been developed and commercialized to form holes in flexible sheets and circuits, and there has been a move to adopt roll-to-roll systems. Several typical hole formation approaches are die punching (die-cutting), NC drilling, and laser drilling. Each approach was developed and commercialized for different applications, so there is no one technology that is perfect in all respects, and each has strengths and weaknesses depending on the field of application. As such, roll-to-roll process engineers must consider the overall balance and choose the most suitable technique. In all cases, the roll-to-roll hole formation process is actually a step process. Although punching processes with a short cycle time may at first appear to be continuous processes, in practice the material is momentarily stopped while the material is punched.

Table 6 compares the features of each technique as a reference. Each technique, however, has several variations and the boundary regions overlap.

Let us take a more detailed look at how roll-to-roll systems are adopted for each technique.

(a) Punching (die-cutting)

Although punching is one of the oldest technologies used to form holes in flexible circuits, it continues to evolve today and has developed into a variety of types. There are also many examples of roll-to-roll versions. The basic principle is simple, and as shown in Figure 47, the shear force between male and female dies forms a hole in the thin film or sheet material. This type of die structure, however, results in a poor “cut”, meaning
We saw that even such a simple process as hole forming has seen the development of many technologies, and that adopting a roll-to-roll system for the process requires us to consider a broad range of aspects. In the next session, we will investigate adopting a roll-to-roll system for photolithography, the core process of the flexible electronics production process.

References
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19. Image Processing Technology in Web Control (cont.)

19.5 Plain Surface Defect Inspection Systems

19.5.1 Introduction

Plain surface defect inspection systems are used for inline surface inspection of plain webs during the production and processing of films, paper, metal foils, and nonwoven fabrics. They were first commercialized in the 1990s by image processing equipment manufacturers and film producers, but by the turn of the 21st century most companies that marketed print quality inspection systems also began selling plain film inspection systems because the ability to detect web defects prior to the printing process helped prevent defects before printing. There was an increasing awareness that print quality inspection after printing alone was insufficient and that it was no longer possible to ignore quality control of plain films before printing.

Plain surface defect inspection systems detect defects in the web, sound an alarm, and label the defective areas. In general, these systems also analyze, display, and store the data, as well as display defect maps and defects by type. Essentially, the principle and structure of plain surface defect inspection systems and print quality inspection systems are the same, but plain surface inspection systems are equipped with many image processing and analysis tools, and have far higher resolution, inspection speeds, and inspection precision. As such, they are able to detect even finer defects than printing inspection systems can.

19.5.2 System Structure

Figure 421 shows the structure of a plain surface defect inspection system. As with print quality inspection systems, the web...
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.

- Ultrasonic sensor UH01
- Web passage control
- Controller informed of degree of edge position change
- Liteguide Amplifier AE1000
- Web skew
- Guide Roll Mechanism LED-M
- Feedback information is used to correct the web’s movement.

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.
2. Macromolecular Aggregate

With polymer patterns smaller than 100 nm, as shown in Figure 3.13, we see that individual polymer macromolecular aggregates of 20–30 nm in size cause the surface to become uneven. From the perspective of micro-processing, such unevenness, called line-edge roughness (LEF), decreases the dimensional precision during processing. The agglomeration behavior of these aggregates also has a significant influence on mechanical properties such as anchorage.

Figure 3.14 shows an image of a macromolecular aggregate separated from the polymer pattern using an AFM probe. Here, (a) is an AFM image showing the part of the line pattern that has been separated and collapsed using the AFM probe. As shown in (b), we can see that the surface of the collapsed pattern consists of agglomerated macromolecular aggregates of approximately 30 nm in size. In addition, the probe is used to apply a load to the macromolecular aggregate in the direction shown by the arrows in the figure.

As a result, as shown in (c), we can separate part of the agglomerated macromolecular aggregate to analyze the agglomeration of the pattern as a whole. In Figure 3.15, a further load is applied as the AFM probe is used to separate two macromolecular aggregates separated from the pattern into 17 finer macromolecular aggregates. In this way we can see that the two original macromolecular aggregates are actually formed of an agglomeration of many smaller macromolecular aggregates. Figure 3.16 shows the load required to separate the macromolecular aggregates at this point. The load required to separate the macromolecular aggregates is extremely small at 3–8 nN, and we can see that the separation force decreases as the size of the macromolecular aggregates decreases. Therefore, the macromolecular aggregates have a limited cohesion force and can be handled as agglomerated particles. In short, manipulation using an AFM probe allows use to analyze the agglomeration of the polymer pattern at the nanoscale.
Coating force between the polymer film and the substrate, thus working to accelerate the penetration of the developing fluid into the interface. Figure 3.26 shows the undercut geometry when the above polymer films are used and the oxide film substrate is etched with an HF solution. We can see that as the residual solvent volume increases, the undercut size also tends to increase. Similarly, with the HF solution as well, internal stress inside the polymer film reduces the adhesion force.

In this session, we considered the penetration of an alkali developing fluid into the polymer film and the developing fluid’s effect on the adhesion strength in solution. We saw here that there are two phenomena that we must consider. The first is that a high residual solvent volume in the polymer will accelerate solution penetration. The second is that penetration of the solution increases the internal stress of the polymer film. As a new adhesion model, this approach looks at penetration of the developing fluid into the polymer film, increased internal stress in the film, and decreased adhesion force.

**Figure 3.24 Change in Polymer Film Stress Resulting From Developing Fluid Penetration**

![Change in Stress Graph](image1.png)

**Figure 3.25 In-solution Adhesion Defect model**

![Adhesion Defect Model](image2.png)

**Figure 3.26 Influence on Undercut Developing Fluid**

![Undercut Influence](image3.png)
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CONVERTING TECHNICAL INSTITUTE

Shigeo Araki
VORT Iwamotocho I, 3-4-6
Iwamotocho, Chiyoda-ku, Tokyo 101-0032, Japan
Tel: +81-3-3861-3858, Fax: +81-3-3861-3894
E-mail: econvertech@ctiweb.co.jp
URL: www.ctiweb.co.jp/eng/

Indonesia

PT Victory Blessings Indonesia
Franky M. Hutapea, President Director
Redwood Business Center Block A No. 5
Jl. Ganesha—Kota Deltamas,
Cikarang Pusat—Bekasi
Tel: +62-21-2909-3839, +62-21-37-1111-40
Fax: +62-21-2909-3840

KOREA

KOREA PACKAGING INSTITUTE

Yeoung Ho Kim
Lotte IT Castle 2-1313 #550-1
Gasan-Dong, Geumcheon-Gu
Seoul, 153-803, Korea
Tel: +82-2-2026-8166
Fax: +82-2-2026-8169

Taiwan

Worldwide Services Co., Ltd.
Robert Yu
11F-2, No. 540
Wen Hsin Road, Section 1
Taichung, 408, Taiwan
Tel: +886-4-2325-1784
Fax: +886-4-2325-2967
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