Sample Issue
Partial Articles Only

Functional Materials Special
Shipping Address
Name: ________________________
Company: _____________________
Address (line 1): __________________
Address (line 2): __________________
City/Town: ____________________
State: ____________________ Zip Code: _________
Country: ____________________
Phone: _____________________
Fax: ________________________
Email: ______________________

Billing Information:  □ Print + Electronic  □ Electronic Only
□ Bank Transfer (please send account information by □ Fax or □ Email)
□ Visa Card
□ Other (Please contact us for other options)
Card Number: __ __ __ __ - __ __ __ __ - __ __ __ __ - __ __ __ __
Expiration Date (month/year): __ __ / __ __
Amount Paid (US$): __________________
Card Holder Name: __________________
Card Holder Signature: __________________

* An invoice will be issued upon confirmation of payment

Billing Address (if different):
Name: ________________________
Company: _____________________
Address (line 1): __________________
Address (line 2): __________________
City/Town: ____________________
State: ____________________ Zip Code: _________
Country: ____________________

E-magazine Advantages
• Instant Viewing
  The magazine reaches the reader as soon as it is ready for publishing.
• Ubiquitous Access
  The electronic version can be viewed on PCs, tablet PCs, smart phones, and any device that has internet access and can load a PDF file.
• Portability
  Because the format is portable, readers and advertisers can use their handheld devices to show articles to those without internet access at the moment for use on the spot.

Online Ordering
Order online with your credit card or PayPal account. With no need to open an online billing account, checkout is even easier than before.

For more information, access our site and visit us at:

www.ctiweb.co.jp/eng/

Media Summary
Magazine: Convertech & e-Print
Issuance: 6/year (odd months)
Readership: 8,000
Size: A4
Color: Full Color
Subscription Fee:
  • Year Subscription (6 issues)
    Print + Electronic: US$160
    (US$45 Shipping)
    Electronic Only: US $80
  • Single Issue
    Print + Electronic: US$30
    (US$8 Shipping)
    Electronic Only: US$15
Issue Date:
  Print (15th of issue month)
  Electronic (5th of issue month)

Please return this form to:
Converting Technical Institute
Iwamotocho-Takahashi Bldg, 3-4-6 Iwamoto-cho, Chiyoda-ku, Tokyo 101-0032 Japan
Phone: +81-3-3861-3858  Fax: +81-3-3861-3894  Email: econvertech@ctiweb.co.jp  Website: www.ctiweb.co.jp
Editor's Note

We are now entering our sixth year in print, and there is one trend that underlies many of the articles we have published over the last few years—the environment. Despite the global community only having come to a unanimous, yet tentative, agreement this past December at COP21 on how to approach global warming, our articles have shown that the Japanese converting industry has been making great strides on all environmental fronts for much longer.

When we look at the drivers for this, we see two basic factors. The first is increased consumer environmental awareness, which means consumers are willing to pay a premium for products that are not only safe for daily use, but also have a lower environmental impact. The second is that ecological products and production processes can, in many cases, also be economical. Despite the apparent higher costs of treating wastewater, volatile organic compounds, and dealing with scrap and defective products, many Japanese companies have found that the savings in terms of energy costs, reduced input costs (fewer solvents), and higher yields make up part of the difference.

Although better plant management and employee education can also reduce the environmental impact of the converting industry, there is a limit to such measures. Materials, however, offer nearly limitless potential for making converting more green. As such, we have collected several material related articles that look at ways to directly clean up the environment, in terms of removing radioactive particles from soil and cleaning surfaces using metal-less indoor light photocatalysts, ways to realize clean energy through photovoltaic textiles, and approaches to reducing virgin plastic usage by effectively returning the properties of used plastic to virgin properties.

One reason Japan is replete with such ecological concepts is its lack of resources. Resource conservation has a long history in Japan, and Japan's historical experience has made it acutely aware of resource dependency. In this way, particularly in terms of energy, food, and plastic, Japan has been making great strides in material developments that will offer benefits to nations around the world. Because each region is economically and socially diverse, however, we do not expect our readers to simply copy what we present here, but to take these materials into new fields, and apply them to local needs to produce products unseen anywhere else.
<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Author(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>SOMAFORM EP Advanced Epoxy Adhesive Sheet</td>
<td>Ayumi Ueki, SOMAR Corp. Technical Division, R&amp;D Department</td>
</tr>
<tr>
<td>44</td>
<td>J-cat: A Metal-less, Full Visible Light Spectrum Responsive Photocatalyst</td>
<td>Keiji Nagai, Tokyo Institute of Technology, Chemical Resources Laboratory</td>
</tr>
<tr>
<td>48</td>
<td>Developing a Photovoltaic Textile and Evaluating Resin Lamination Durability</td>
<td>Atsuji Masuda, Senior Researcher; Chihiro Kiyama, Researcher; Takahiro Tsuji, Director, Industrial Technology Center of Fukui Prefecture</td>
</tr>
<tr>
<td>52</td>
<td>Novel Recycling Technology Increases the Value of Discarded Plastic Container and Packaging Resins</td>
<td>Aya Tominaga, Shigeru Yao, Fukuoka University</td>
</tr>
<tr>
<td>68</td>
<td>Film Sensor Designed to Realize Three-Dimensional Electronics</td>
<td>Masanori Shimura, TOYO LABEL</td>
</tr>
<tr>
<td>70</td>
<td>Soft Blanket Gravure (SBG) Printing Technology for Fine Electronic Interconnect Layers for Three-Dimensional Curved Surfaces</td>
<td>Konami Izumi, Yasunori Yoshida, Shizuo Tokito, Research Center for Organic Electronics, Yamagata University</td>
</tr>
<tr>
<td>75</td>
<td>Development of Omnidirectional Inkjet (OIJ) Printing Technology Using a Vertically Articulated Robot</td>
<td>Yasunori Yoshida, Konami Izumi, Shizuo Tokito, Research Center for Organic Electronics (ROEL), Yamagata University</td>
</tr>
<tr>
<td>98</td>
<td>Fully Automatic Coater and Applicator Properties As Seen From Test Results</td>
<td>President Tsuneo Tate, COTEC</td>
</tr>
<tr>
<td>109</td>
<td>Improved Operability and Quality of the D Chamber Coating System</td>
<td>Ryo Morikawa, Toru Isozaki, FUJI KIKAI KOGYO Co., Ltd.</td>
</tr>
<tr>
<td>4</td>
<td>An Interview With Hidenori Fujiyoshi: New President of Toshin Speaks on the Future of Slitting</td>
<td>Toshin Co., Ltd.</td>
</tr>
<tr>
<td>7</td>
<td>New Inkjet Print Head Designed for High Volume, High-viscosity Ink Ceramic Tile Print Applications</td>
<td>KYOCERA Corporation</td>
</tr>
<tr>
<td>8</td>
<td>Gravure Technology for More Than Just Printing: Micro-embossing and Micro-geometry Powders</td>
<td>THINK LABORATORY CO., LTD.</td>
</tr>
<tr>
<td>10</td>
<td>An Interview With Yoshitaka Hikami: Providing Image Inspection Equipment Globally to Support Lifestyles Locally</td>
<td>DAC ENGINEERING CO., LTD.</td>
</tr>
<tr>
<td>14</td>
<td>New Die Cutter for Cutting Rounded Corners on Flexible Packaging and Reducing Waste</td>
<td>DAIISO CO., LTD.</td>
</tr>
<tr>
<td>18</td>
<td>Stand-up Pouch Prevents Oxidation With a Double Bag Structure and Non-return Valve Film</td>
<td>Okura Industrial Co., Ltd.</td>
</tr>
<tr>
<td>Page</td>
<td>Title</td>
<td>Author(s)</td>
</tr>
<tr>
<td>------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>19</td>
<td>Launching Flexo Printing Zone to the Show Brings a Sustainable Packaging Printing Solution</td>
<td>Printing South China 2016</td>
</tr>
<tr>
<td>22</td>
<td>Developing a Flexible Hard Coat With a Crystal Appearance and Scratch Resistance</td>
<td>Nakai Industrial Co., Ltd.</td>
</tr>
<tr>
<td>26</td>
<td>Expand Your Printing Businesses in China</td>
<td>The 6th All in Print China</td>
</tr>
<tr>
<td>30</td>
<td>Reducing FCV Hydrogen Fuel Transport/Storage Costs</td>
<td>Sakai City Industrial Promotion Center 56th Growth Industry Business Seminar</td>
</tr>
<tr>
<td>31</td>
<td>New Flexible Film to Be Used in Clothing Measures Heart Rate and Other Physiological-data</td>
<td>Toyobo Co., Ltd.</td>
</tr>
<tr>
<td>34</td>
<td>Using Polyurethane Beads for Molding Automobile Interiors</td>
<td>Society of Polymer Science, Japan</td>
</tr>
<tr>
<td>36</td>
<td>New Absorbents Remove Cesium From Water Faster and Cheaper Than Zeolite</td>
<td>University of Hyogo, Graduate School of Engineering</td>
</tr>
<tr>
<td>58</td>
<td>Adhesive Pattern Coating Technology Used to Develop a Tab-leadless LIB</td>
<td>Showa Denko Packaging Co., Ltd.</td>
</tr>
<tr>
<td>62</td>
<td>Screen Printed Glucose Powered Sensor Designed to Aid Incontinence Care</td>
<td>Tokyo University of Science, Faculty of Science and Technology, Department of Pure and Applied Chemistry, Itagaki/Shitanda Laboratory</td>
</tr>
<tr>
<td>66</td>
<td>Applying Flexo Printing to the Production of Multilayer Thin-film Electronic Components</td>
<td>TAIYO KIKAI LTD.</td>
</tr>
</tbody>
</table>

80 Introduction to Flexible & Printable Electronics, Session 27
Roll-to-roll Productions Methods: 1
Dominique K. Numakura, DKN Research LLC

86 Basic Course on Instrumentation and Control in the Converting Process, Session 29
Yoshihiko Ohta, NIRECO CORPORATION

92 Packaging Film Production and Functionalizing Technology
Part 15: Research and Development (9)
Akira Hayashi

104 Coating Theory and Phenomenon for the Plant, Chapter 2, Session 4
Drying Equipment
Professor Akira Kawai, Nagaoka University of Technology

114 Release Paper
Part 4: Release Paper History, Session 7
Tomishi Shibano

118 Dry/Solventless Lamination Technology Characteristics: Today and Tomorrow (2)
Koichi Matsumoto, Professional Engineer (Industrial Management)

Copyright Information: Unauthorized copies of this magazine, except when permitted by copyright laws, are prohibited by law. For information on copying the material herein, please contact the Japan Publishers Copyright Organization in advance for permission.
(Phone: +81-3-3513-6969, Fax: +81-3-3513-6979, e-mail: info@jcopy.or.jp)
With 65 years of history, Toshin Co., Ltd. is one of Japan’s oldest slitter and rewinder manufacturers. One of their latest developments was the 2014 release of a new TAF differential shaft from their TAF Drive Series. Given that the new shaft balances tension control with air friction roll core gripping force, Toshin is already seeing strong sales. More recently, in June 2015, Hidenori Fujiyoshi became the company’s fourth president at the age of 45. With his youth and flexibility, Mr. Fujiyoshi is taking this venerable company to new heights.

Origins in Imitation Pearls
Toshin was founded by Mr. Fujiyoshi’s grandfather in 1950 as a manufacturer of imitation pearl production equipment. In 1955 the company began remodeling, repairing, and customizing cellophane production equipment produced by Futamura Chemical Industries Co., Ltd. (now called Futamura Chemical Co., Ltd.). It was only in 1957, however, that the company began producing slitters, their primary type of equipment today, and developed a hydraulic lift and air friction mechanism, among others. After this point, the company expanded its business with a focus on slitter and rewinder manufacturing.

Having first gained experience in an unrelated field, Mr. Fujiyoshi entered Toshin in 2010. As the company’s managing director, he placed particular focus on human resources. Mr. Fujiyoshi says that because of his young age, his focus was on caring for young and new employees. Specifically, he spoke regularly with them, and joined them for meals in order to increase his opportunity to speak with his younger employees. In fact, the more he spoke with them, the more open they became, which led them to talk about various topics. As a result, Mr. Fujiyoshi says that the company’s employee retention rate has increased. In other words, for Mr. Fujiyoshi, nurturing employees comes before manufacturing.

When he is asked if this stance has changed since becoming president, he replies that he has not changed himself. He has just taken a natural approach to his position.

40 Years of High SNR Sales
Although their customers are spread throughout Japan, the majority are located in the Tokyo and Osaka regions. Until recently, roughly half of their equipment has been sold in the flexible packaging industry, with the remainder sold to industries producing advanced films, such as optical, battery, and medical product films. Today, however, their equipment is increasingly being used to produce such advanced films, which now account for 60% of equipment sales.
Gravure Technology for More Than Just Printing: Micro-embossing and Micro-geometry Powders

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

This past October at CEATEC JAPAN 2015, THINK LABORATORY CO., LTD. exhibited metal micro-geometry powders made using their Diamond-like Carbon (DLC) technology; seamless micro-embossed sheets and resin micro channel sheets made using their special patterned cylinders; and a new functional cylinder with surface layers of copper and nickel. THINK LABORATORY makes a wide range of the special cylinders essential for coatings, conductive inks, and micro embossing using a 25,600 dpi (max) resolution laser to pattern the surfaces of steel and aluminum cylinders of all different diameters and lengths. DLC coating, however, requires a special chamber, of which THINK LABORATORY has one of the largest in the world. Using this chamber, they can even make cylinders of 1 meter in diameter and 3.5 m in length. This DLC surfacing technology goes far beyond being a very hard, thin-film. It also provides the cylinder with a variety of characteristics, including improved wear resistance, a lower coefficient of friction, and a better ink transfer and release property. Moreover, the wetting property can be controlled from hydrophilic (contact angel 25°) to hydrophobic (contact angel 90°).

THINK LABORATORY exhibited samples of metal powders with micro-geometries made using this same DLC technology, metal foil micro-patterning technology, and 25,600 dpi high resolution laser patterning technology. They envision using these powders as functional pastes. The metal powders, which can be generated in high volumes, can contain combinations of different geometries with grain sizes ranging form 30 to 100 μm. Copper metal examples on display included star, currency (yen, dollar, euro), and alphabet letter geometries.

Gravure cylinders are superior to screen (excepting rotary screen), flexo (excepting sleeve type), and offset printing plates in that they can reproduce continuous patterns with no seams at high volumes. They can also be used for embossing. Although such examples are rarely made public, THINK LABORATORY exhibited a seamless UV cured micro-embossed sheet supplied by YURI ROLL MACHINE Co., Ltd., which gave a peek into the embossing market.

Unlike conventional gravure printing and coating cylinders made by plating the surface of an aluminum or steel core in copper and chrome, THINK LABORATORY introduce a new type in which the etched copper plating is then plated in nickel to make a functional cylinder. By changing the metal of the cylinder surface in this way, they are able to provide new characteristics.
Environmentally Friendly Laser Cylinder
Making Being Recognized Globally

Number of Cylinders Made by Laser Per Day Globally
Our laser gravure cylinder making systems are used by 250 companies in 35 countries, with a total of 5,000 cylinders made per day. All of the 1,500 item packages for which these cylinders are used reduce ink usage by up to 25%.

An Environmentally Friendly Laser Gravure Cylinder Making System

New FX2
Eco Gravure Cylinder Making System

Compared to the original model, the latest “New FX2” fully automated cylinder making system reduces power consumption and installation space by 50%, and ink usage by 25%. More than 20 New FX series machines are already in operation throughout the world. To visit our demonstration lines or for cylinder making for ink reduction tests, feel free to contact us directly.

THINK LABORATORY Co., Ltd.
URL http://www.think-lab.com/  e-mail think@think-lab.co.jp

Head office 1201-11 Takada, Kashiwa, Chiba 277-8525, Japan  
☎ +81-4-7143-6700  Fax +81-4-7146-0566
An Interview With Yoshitaka Hikami: Providing Image Inspection Equipment Globally to Support Lifestyles Locally

A designer and developer of image processing technology based quality inspection equipment, DAC ENGINEERING CO., LTD. has been aggressively driving its international expansion around its Crossover gravure printing inspection system. Although international sales only account for about 20% of the company’s business today, they have already sold systems in countries such as China, Korea, and throughout Southeast Asia. Yoshitaka Hikami, president of DAC ENGINEERING, has traveled the world, each time visiting convenience stores and experiencing local life to help determine whether or not to begin sales in that country. In this way, by promoting their inspection equipment internationally, Mr. Hikami has gained a unique perspective on the global converting industry. Stating that he wants to contribute to the prosperity of the industry, Mr. Hikami hints at his broad point of view.

From a Development Engineer to a Walk-on

The first president of DAC ENGINEERING established the company in 1974 after having worked for Shimadzu Corporation, a leader of Japan's analytical and measuring instruments technology development. Since its earliest days, DAC ENGINEERING had worked with advanced image processing technology, and thus challenged ways to add new value under the concept of automated image recognition. Although he originally was involved in technology development at a water heater manufacturer after graduating from college, Mr. Hikami decided that he wanted to work for DAC ENGINEERING because his research at college was related to image processing. He was 28 at the time.

Mr. Hikami explains that conventional image processing places importance on visualization, in other words making images easier to see, but DAC ENGINEERING had gone one step further and worked with image recognition, finding success in the field of replacing humans with machines for image recognition tasks. At the time, he says he was moved when he discovered this new world.

Despite his interest, the company was popular at the time, and the competition to get hired was stiff. Even after being accepted, however, he was not taken on as a regular employee, but as a kind of walk-on. Given that he had just had a child in January of that year, his family was resistant when he decided to change jobs in April. Thinking back on it now, he says the move was a major life risk.

Kyoto Head Office
DAISO CO., LTD., a manufacturer of paper carton and cardboard box die cutters, recently developed a new die cutter designed for laminated flexible packaging materials used for food packages. The new die cutter, called ECCM (Epoch Corner Cut Machine), has rounded corners and can be installed inline. Since their founding, the company has made die cutters for paper cartons and cardboard boxes, but it was only at the request of a large converter in Japan that they began developing the ECCM for flexible packaging. The machine, which rewinds the cut edges and curved corners together as they are die cut, has been highly accepted as an effective means of preventing contamination. Masakazu Otsuka, president of DAISO, and Shonosuke Otsuka, director of the Marketing Promotion Department, spoke to us about their goals and outlook in expanding from paper cartons to flexible packaging.

Roots in Paper Carton Production

After working for a paper carton and cardboard box producer, Joji Otsuka, the current chairman and father of Masakazu Otsuka, founded DAISO in 1971. The die cutters the company produces today are made by inserting a Thompson die blade and rules, which cut and crease the work, into a plywood base. Customers use a press at their plant to drive the die cutter into the work resting on a face plate. In this way, the die cutter simultaneously cuts the work into the desired shape and applies folding creases.

The company has also invested in developing and manufacturing related items that facilitate die cutting, such as G-Tape, which improves the fold precision and prevents ruled line tearing, the Supo Series, which prevents the work from slipping during die cutting, and DAISO MAT, which ensures uniform die cutting pressure.

Ruled line tearing occurs when the liner on the outer surface of the paper carton tears as the carton is folded along the creases. By applying G-Tape, one of their core products sold widely throughout the world, on the face plate of the die cutter, the rules in the die cutter stick to the tape, which prevents tearing along with creases.
Launching Flexo Printing Zone to the Show Brings a Sustainable Packaging Printing Solution

The China Foreign Trade Centre (Group) and Adsale Exhibition Services Limited are collaborating to hold the The 23rd South China International Exhibition on Printing Technology (Printing South China 2016), which will run from March 2–4, 2016 at Area B, China Import and Export Fair Complex in Guangzhou, PR China. Over 1,000 exhibitors and suppliers will showcase their innovative printing machines and latest technologies at this 3-day event.

**Flexo Printing Makes Printing Eco-friendly**

Printing South China 2016 not only continues the popular Post-press Converting & Packaging Printing Zone and various special theme zones, but it also launches the brand-new Flexo Printing Zone to enhance the competitiveness of the show.

Compared to traditional printing, flexo printing allows for the use of solvent-free inks on the widest possible range of substrates, including all kinds of paper and even plastic packaging products, which results in a reduction of volatile organic chemical (VOC) emissions. Decreasing the amount of harmful chemicals released to the environment is a unique feature of this new technology. With its high efficiency, flexo printing is an emerging product in the printing industry.

**Comprehensive, One-stop Access to Printing, Packaging, and End-user Industry Chains**

Printing South China 2016 provides a trading platform for suppliers and buyers in printing and packaging industries, where new-explosers of industry are invited to the show, such as Shenzhen YUTO, Astros, Jinjia, RR Donnelley, Lukka and 999Ninestar. In order to enhance trading links between different industries, “Sino-Label 2016,” “Sino-Pack 2016,” and “PACKINNO 2016” are co-organised to cover food, pharmaceutical, cosmetic, other industries, and end-use packaging. Meanwhile, the show also includes P&G, Unilever, Johnson & Johnson, Amway, Infinitus, Heinz, and other International end-user companies from various end-user segments. It provides a direct platform to enable suppliers and end-users to communicate and understand more about the trends and actual needs between each other. The four shows collaborate to create China’s only international event consisting entirely of printing, packaging, and end-product industry chains.

**Global Exhibitors Gather to Show Support**

Despite the impact of national policies, high labor costs, and other factors causing the decline of printing markets, the show is still widely recognized and fully supported by new and existing customers. More then 80 percent of booths are sold. Confirmed worldwide supporters include GUOWANG, JINBAO, FANGBANG, ZHONGKE, HONGMING, CHENGMING, KEO-IANG, GUANGMING, RUIDA, OUNUO, RUIAN JINGGONG, THINKING, SINI, CRON, RISO, ASIA SYMBOL, XINDA, XIN-WEI, RUIGUANG, HUIBO, DAQIAO, XCS, LITONG, LIXIN, ZONO, LONGHUA, JIGUO, KUADA, WENZHOU YONGSHUN, FENGMING, LISHUNYUAN, SIEGWERK, and ZHONGYI.

**Printing South China 2016 Exhibit Highlights**

Jiangsu Fangbang Machinery Co., Ltd.
Booth no.: 10.2G522

Fangbang will demonstrate flexo printing machines using flexible photosensitive resin and rubber plates, and anilox rollers for transferring liquid ink for printing. The machine is controlled by a PLC system and consists of unwinding, tension control, infeed traction, printing, drying, outfeed traction, rewinding,
and control units. This machine is ideal for printing paper cups, cartons, paper bags, and the like.

They will also present a fully automated sheet-fed square bottom paper bag machine. This machine is designed to manufacture square bottom paper bags with handles from sheet paper, paper patch roll, and paper rope. It is ideal for producing mid-to-high-end paper handbags. Equipped with an advanced pre-heap paper feeder, it can provide non-stop feeding to improve production capacity. It can also produce high-quality paper handbags in many different forms that are especially suitable for food, clothing, and luxury industries.

**ASIA SYMBOL (GUANGDONG) PAPER CO., LTD.**

**Booth no. 11.2H303**

ASIA SYMBOL will showcase its PaperOne Offset paper at Printing South China 2016. The paper is an uncoated wood-free paper with excellent printability suited to printing high brightness and blue white shades. PaperOne Offset paper is certified by PEFC and graded with five stars by PREPS. PaperOne Offset paper is especially suited for printing final products such as manuals, brochures, inserts, maps, catalogues, books, annual reports, envelopes, and commercial forms.

The company is the world’s leading pulp and paper producer. Their production includes 2 million tons of pulp per year, cultural paper (including office copy paper), 450,000 tons of packaging board, food cards, cigarette cards, and 500,000 tons of paper products exported to over 20 countries and regions in the world.

**RISO TECHNOLOGY CHINA CO., LTD.**

**Booth no. 11.2H503**

RISO will present Comcolor, an energy-saving and eco-friendly printing machine that greatly increases efficiency in color printing with a wide variety of fixtures that can also raise the reliability and the printing speed. Its extremely low cost, functionality, power response capacity, low energy consumption, and low operating cost make it far more superior to other digital printing presses, making it an ideal choice for green-printing!

**Promote Globally to Recruit Quality Buyers**

Domestic printing industry associations and well-known enterprises have been invited to organize a professional buyers group to visit Printing South China. More than thirty overseas printing and packaging associations are planning to organise overseas tours, including Southeast Asia, Pakistan, Russia, South America, the United States, Europe, and other countries. In this way, Printing South China will be a precious chance for worldwide experts to have broad ranging discussions with each other about the dynamic global printing market.

---

**About the organizer:**

Adsale possesses over 35 years of experience in staging international exhibitions in China and has become one of the leading companies in this field. Adsale is also the organizer of the Chinaplas exhibition, Asia’s number one plastics and rubber trade fair. Adsale’s Sino-Pack, Printing South China, and Sino-Label exhibitions also have a track record of more than over 20.

**For more information, please visit:**

www.PrintingSouthChina.com

**Connect us, join the conversation at:**

Facebook: @PrintingSouthChina
Twitter: @PrintingSCchina
LinkedIn: @PrintingSouthChina

**Contact for the press and show enquiry:**

Adsale Exhibition Services Ltd. (Adsale)
Ms. Winnie Fung / Ms. Mavis Ng
Email: printpack.hkpr@adsale.com.hk
Phone: (852) 2516 3340 / 2516 3389
Fax: (852) 2516 5024
Address: 6th Floor, 321 Java Road, North Point, Hong Kong
The 23rd South China International Exhibition on Printing Industry

Professional Theme Zones

- Post-press Converting & Packaging Printing Zone
- Flexo Printing Zone (For Paper Packaging Printing)
- Digital Printing Zone

2016 - 3 - 2 - 4

Area B, China Import & Export Fair Complex, Guangzhou, P.R China

SINO LABEL 2016

Special Zones

- Flexo Printing Zone (For Label Printing)
- In-Mold Labeling Zone

The China International Exhibition on Label Printing Technology 2016

Pre-register Now!

www.PrintingSouthChina.com
www.SinoLabelExpo.com

Organizers

CFTC

Enquiries

Tel
(852) 2811 8897
(86 755) 8232 8251
(86 20) 8912 8268 / 8912 8319

E-mail
pfp@adsale.com.hk
pfp@fairwindow.com.cn
printpack.hkpr@adsale.com.hk
Nakai Industrial Co., Ltd., a Japanese metallizing and coating company, recently developed a new highly flexible hard coat film with a hardness of 9H called HARDFLEX. Despite the hard coat being applied to only one side of the substrate to ensure flexibility, the company succeeded in reducing curl. Moreover, the use of commercially available PET films with an improved adhesiveness as the substrate eases printing, pressure-sensitive adhesive (PSA) coating, and other secondary processing. Combining this new hard coat with their conventional LAYHIPAR functional coated film has also accelerated their expansion into display applications. Nakai Industrial is composed of several group companies, including their sales division, Kyoto Nakai Shoji Co., Ltd. (Kyoto, Japan), and two manufacturing divisions, Nakai Techno Co., Ltd. (Shiga Japan) and Shimane Nakai Industrial Co., Ltd. (Shimane, Japan). Recently, we visited Nakai Techno, the manufacturing division in charge of HARDFLEX.

Developing a Flexible Hard Coat With a Crystal Appearance and Scratch Resistance

Rollable Film

Today, after-market protective films for smartphones made using hard coats with a hardness equal to glass are gaining importance. As such, different companies have been developing film properties such as safety (crack-resistant and shatter-proof) and excellent secondary processing.

In contrast, Kiyoshi Taniguchi, representative manager of Kyoto Nakai Shoji’s Tokyo branch effortlessly rolls up a HARDFLEX coated film as if it were a poster, saying that their film is contradictory in that it is both hard and flexible. He goes on to say that this surprises most people because hard coats are believed to be rigid. In fact, he says, when they exhibited the film at shows this past January and April, visitors to their booth were impressed by demonstrations showing how samples could be cut with a pair of scissors.

Less Demand for Conventional Materials

Nakai Industrial began developing hard coat films 30 years ago as a means of preventing architectural materials and
During October 18–22, 2016, The 6th All in Print China will be held at the Shanghai New International Expo Centre. All in Print China is being held under the theme of "Discover the Future of Printing" and has always been dedicated to providing an exhibition platform with the most advanced productivity, the ability to promote exhibition and exchange of products, facilitate information and technologies in the printing industry, and discover and guide development trends in the industry. Currently, more than 400 domestic and overseas manufacturers have applied to attend the exhibition, and the registered area has reached the planned exhibition area of 82,000 square meters. Log on to the website and apply for your booth at www.allinprint.com.

Why Be an Exhibitor?

Strong organizers and facilitators provide you with a high-quality trading platform
Organized by:

- Messe Düsseldorf (Shanghai) Co., Ltd.—a wholly foreign investment subsidiary of Messe Düsseldorf GmbH, the organizer of drupa
- Printing Technology Association of China—The initiator of Forum of Asian Graphic Arts Technology (FAGAT)
- China Academy of Printing Technology—China’s largest comprehensive printing technology research institute
- Keyin Media—A professional media agency in China’s printing industry
More Reasons to Exhibit:

Six theme pavilions, highlighting cutting-edge technologies and leading the printing industry to explore its future: "All in Digital," "All in Press," "All in Packaging," "All in Label," "3D printing and All in Creativity," and "All in E-business"

- Synchronous promotion across a global network, helping you to stabilize your international position and expand within the Chinese market
- 100,000+ accurate buyer database entries, 30+ EDMs; joint exposure by 200+ professional and mainstream mass media organizations; support from 20+ domestic and international industry associations/chambers of commerce; 40+ offline promotion activities; platform promotion by domestic and international mainstream social media
- More than 30 concurrent conferences, giving you opportunities to speak with industry authorities and obtain information on industry trends
- A decade of development, brand exhibition, and high-quality buyer groups
- Industry associations/chambers of commerce from many countries around the world, covering Asia, the Middle East, Europe, and America, will organize high-quality buyer groups to bring together professional users and buyers of printing technologies and printing equipment and machines

Go to the "exhibitor service info" center on the website www.allinprint.com to download the full version post show report.

Latest Promotion Activities:

Promotion in Bangkok Thailand

The talkfest in Xi'an China

Presentation in Tokyo Japan

For more information about the exhibition, please view the official website: www.allinprint.com.

Quick review on last show in numbers:

- 82,000 sqm
- 680 exhibitors from 20 countries
- 61,820 trade visitors, with 58,602 from mainland China
- 150+ Chinese & 40+ overseas visitor groups
- 20+ concurrent seminars and conferences

Media Contact

Messe Düsseldorf (Shanghai) Co. Ltd.
Ms. Tracy Cui
Tel: +86-21-6169 8342
Fax:+86-21-6169 8301
Email: tracy.cui@mds.cn
THE 6th
ALL IN PRINT CHINA
China International Exhibition All about Printing Technology & Equipment
2016.10.18-22
SNIEC - Shanghai China

Discover the Future of Printing

website
www.allinprint.com

Organized by
The Printing Technology Association of China
China Academy of Printing Technology
Messe Düsseldorf (Shanghai) Co., Ltd.

Undertaken by
The Printing Technology Association of China
Keyin Media
Messe Düsseldorf (Shanghai) Co., Ltd.

Co-organized by
Shanghai Printing Trade Association

International Supporter
Messe Düsseldorf GmbH - organizer of drupa
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

DM (Direct Metering) Coater  Chamber Gravure Coater

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

Two-axle turret winder (also for clean room use)

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
More free, more comfortable. That is the theme under which Toyobo Co., Ltd. developed a new stretchable conductive film for electrodes and wiring to be used in measuring physiological-data, such as heart rate. The new material is also only 0.3 mm thick. Given their focus on ensuring comfort when wearing the film, they designed a flexible material that conforms to the movement of the body by using a conductive paste with a unique elasticity for the electrodes and wiring. The film material can be applied almost anywhere, while thermal compression bonding allows for a high level of processing and design freedom. With an initial target of sportswear, they plan on commercializing the material sometime in 2017. With a sales target of 300 million JPY for the first year, they aim to reach 600 million JPY a few years later. Mitsuhiro Sakuda, director of the Textile Production Technology and Development Department, and Sonoko Ishimaru, manager of the Comfort Engineering Center at Toyobo, spoke to us about the background to the development of this smart sensing wear.

Conductive Paste Electrodes

In general, electrodes attached to the body designed to read physiological-data are made using conductive paste. In this light, Ms. Ishimaru says that the development of their stretchable conductive film for electrodes and wiring relied on the use of Toyobo’s highly elastic, highly conductive silver paste, which led them to consider application to the sportswear market first. Another driver behind their choice of sportswear is the fact that the movement to extend healthy life expectancy—an indicator of the time one’s lifestyle is uninhibited by health issues—has raised consumer interest in sports. As such, sportswear manufacturers are now selling sportswear with high design and functional aspects, bringing about changes in the market that create demand for such materials. In fact, many companies in the industry are researching and developing new materials for smart sensing wear.

Toyobo assumes that such clothing will be worn for long periods of time, so focused on minimizing discomfort and increasing the natural feel of the items. Because the new material is a film, it can be processed into various shapes and thermally compression bonded to clothing, making it unique in that it does not interfere with clothing design.

Measuring Heart Rate and Mental State

The new functional film material, which is only about 0.3 mm thick, is made by sandwiching electrodes and wiring formed of conductive paste between elastic polyurethane resin layers. The miniaturization and light-weighting of computers and sensors also lies behind the spread of wearable devices. Meanwhile, the emergence of smartphones has made it possible to manage physiological-data using mobile devices, which has only accelerated the development of wearable devices.
alarm, it could be used to prevent drivers from falling asleep at the wheel.

In regard to the development of smart sensing wear, the company is participating in the COI STREAM Program (Revolutionary Innovation Creation Program) administered by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), through which it is working with Ritsumeikan University on further research. Currently, the new material is used to measure electrocardiograms, but through COI STREAM, they are continuing to develop the material so that it can measure breathing rate, skin temperature, and elbow bend, as well as detect sweat.

Sensor Miniaturization

Mr. Sakuda explains that they are working with clothing and device manufacturers in developing new applications for the material, and hope to have a product ready by the end of 2017. Their sales target for the first year is 300 million JPY, with a goal of 600 million JPY within a few years. In addition to sportswear, they are also considering fields including work clothing aimed at health management of employees, and medical clothing, including that for health care.

In the immediate future, they will divide the sportswear applications they are working to commercialize now into personal and professional sports. Mr. Sakuda explains that for professional athletes, they also need to consider the convenience of the coaches and trainers, and that the data be displayed in a way that will allow it to be easily reflected in training programs. Ms. Ishimaru says that it is also necessary to miniaturize the sensors so that the athletes can move more freely. There is also a need to improve the performance of the battery.

Mr. Sakuda says that the increase in health awareness is not only limited to Japan, and that their concept of comfort and attractiveness should register with people around the world. In this light, they also expect sports market to expand significantly with the holding of the 2016 Olympics in Rio De Janeiro and the 2020 Olympics in Tokyo. Ms. Ishimaru says that although they see particular potential for smart sensing wear in sports, she says that they also want to aid in providing accurate information that will prevent automobile accidents for the elderly and extend the active life of elderly without the need for care.
COATER & LAMINATER

Ultra-clean, Ultra-precision World-class Technology
New Absorbents Remove Cesium From Water Faster and Cheaper Than Zeolite

Following the accident at Japan’s Fukushima Daiichi Nuclear Power Station operated by Tokyo Electric Power Company, Incorporated (TEPCO), various absorbents designed to remove radioactive cesium from contaminated soil and water have been developed in Japan. Although most examples are made using zeolite and Prussian blue, Hiroshi Nishioka, associate professor at the University of Hyogo, School of Engineering & Graduate School of Engineering (Environmental Material Chemistry) has successfully synthesized an absorbent from tobermorite, a type of calcium silicate. This absorbent not only has a higher cesium absorption rate than zeolite and other such materials, tobermorite is also the main component of autoclaved lightweight concrete (ALC). As such, using ALC waste to synthesize the absorbents is expected to greatly reduce costs. We visited the Nishioka Research Office in Himeji City, Hyogo, Japan, to speak with Dr. Nishioka about the potential of these new absorbents.

From Environmental Analysis to Cleanup

Following the Great East Japan Earthquake and Fukushima Daiichi Nuclear Power Station accident, Japan became increasingly concerned with risk of radioactive cesium and strontium contaminating the environment. In particular, cesium readily ionizes and dissolves in water, so there is a fear that cesium is diffusing widely in river water, ocean water, and soil, for example. The half-life (the time required for the radioactivity to drop by half) of Cesium (Cs) 137 is 30 years, so decontamination work must continue for some time.

Specialized in analytical chemistry, Dr. Nishioka previously focused on toxic substances (cadmium, lead) contained in water, but says he wanted to go beyond analysis to begin researching environmental cleanup. As such, he began looking into absorbents that remove toxic substances.

Specifically, after the nuclear accident he wondered if there was a way to stop radioactive cesium from proliferating, so decided to focus on researching cesium absorbents. Despite zeolite and Prussian blue being known to absorb cesium, Dr. Nishioka decided to work with the mineral tobermorite.
1. Introduction

SOMAR Corp. manufactures and distributes functional epoxy resins, including Epiform liquid/powdered epoxy resins for electronic components, motors, and rust prevention/binder applications; SOMAKOTE adhesives for surface packaging of printed circuits; and SOMATECT resins for underfill and sealing applications, among others. Although many epoxy resins are commercially available in powdered, liquid, and sheet form, until recently we had not produced sheet type epoxy resins.

In this way, SOMAFORM EP is our first functional epoxy resin adhesive sheet. SOMAFORM EP is designed to be easy to handle when uncured, but to be adhesive and have heat resistance when cured (Photo 1).

2. Development Concept

Epoxy resin is conventionally formed into sheets by dissolving a solid epoxy resin in a solvent, which is then coated onto a substrate and dried. Epoxy resin sheets formed in this way will easily crack when subject to even small stresses, which makes handling a problem in many cases. Although attempts have been made to provide uncured sheets with flexibility by adding high-molecular weight resins or forming sheets during the A-Stage where high amounts of liquid epoxy resin are added, the former results in adhesion defects because of the lower flow capability during extrusion, whereas the latter has problems with tack and dimensional stability.

Methods of providing dimensional stability include partially curing the epoxy resin during sheet formation (B-Stage). The sheet in the B-Stage, however, has a lower flow capability given the higher molecular weight of the epoxy resin. For this reason, a higher pressure is required to adhere B-Stage sheets to the adherend than is required for A-Stage sheets, so B-Stage sheets are limited to use with adherends that can withstand a high press pressure.

Therefore, we began developing an epoxy adhesive sheet with both good handling and adhesive properties to resolve these problems. Specifically, we use A-Stage sheets for the adhesive layer, which ensures good handling in an uncured state. Next, we applied a coating layer that blocks the fluid components from leaking out from the sheet surface to solve the problems of dimensional stability and tack, the weaknesses of A-Stage sheets (Fig. 1). The coating material used in this layer has excellent compatibility with the epoxy resin, and was selected so that it would mix with the adhesive layer through

![Photo 1 Uncured SOMAFORM EP Flexibility](image_url)

![Figure 1 SOMAFORM EP SERIES Basic Layer Structure](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 environment” 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, Kawaatsu Building, Chuo-ku, Tokyo 103-0001 Japan Tel: +81-3-5640-5566 Fax: +81-3-5640-1682
1. Introduction

Expected to play the role of artificial photosynthesis in transforming solar energy into fuel and food, photocatalysts have been the subject of research for many years. Meanwhile, so-called environmental cleanup photocatalysts are already used for decomposing dirt, deodorizing, sterilizing, and removing toxic substances at a practical level. Even so, there is a need for photocatalysts that respond to visible light, unlike titanium oxide (TiO₂) catalysts, which only respond to ultraviolet light. The majority of visible light responsive catalysts, however, contain various types of transition elements. Meanwhile, the author and collaborators have discovered a method of using the active layer from organic thin-film solar cells as a photocatalyst for decomposing organic material in their gas and liquid phases. Specifically,

- fully organic system that does not contain any metal,
- responds with a photon quantum yield under visible light,
- layering polymer films separates the oxidation and reduction reactions onto the front and back sides of the film,
- and layering multiple films allows for the construction of high-efficiency response systems.

Moreover,

- micro flow device allows for mass-production at low cost,
- and using co-catalysts (promoters) allows for water splitting to generate hydrogen and oxygen.

These characteristics are highly reliant on the same type of p-n junction found in solar cells. For this reason, the Tokyo Institute of Technology has trademarked the name J-cat to reflect the concept of a junction catalyst. In this article, we will explain the J-cat principle, provide performance evaluation examples, show a highly effective application method, and explain a low-cost production method.

2. Principle Behind and Differences Between Organic Thin-film Solar Cells and J-cat

The organic thin-film solar cell mechanism proceeds through a series of continuous steps, including light collection by an n-type and p-type semiconductor, exciton diffusion at the p-n junction surface, load separation at the p-n junction surface (=carrier generation), travel of the carrier to the electrode, and acceptance of the carrier by the electrode (Fig. 1 a). The open circuit voltage (Voc) is the difference in energy between the upper end of the p-type semiconductor valence band and the lower end of the n-type semiconductor conduction band. The only difference in this process between photocatalysts and thin-film solar cells is that the final carrier recovery process relies on a redox reaction (Fig. 1 b). In principle, the upper end of the p-type semiconductor valence band indicates the oxidation strength and the lower end of the n-type semiconductor conduction band indicates the reduction strength. In the same way that the carrier consumption at both electrodes is equal in solar cells, the number of electrons consumed per unit time must be the same at the site of oxidation and reduction with photocatalyst reactions. Moreover, fullerenes (C₆₀) and derivatives of these, as well as perylene derivatives (PTCBI, etc.) can be used as the organic semiconductors in both organic thin-film solar cells and J-cat (Fig. 2). Although phthalocyanine (H₂Pc, etc.) can be used for the J-cat p-type semiconductor,
1. Introduction

To achieve a low-carbon society and diversify the use of energy resources, it will be necessary to shift to distributed power generation using natural energy, including solar light. Although solar powered electrical generation systems are advantageous in that the installation criteria are few and energy loss is low, there are limitations on the solar panel weights and installation surface geometries. As such, there is a need for lightweight, flexible solar power generation systems that can be installed in locations where it is difficult to use existing general-purpose solar panel systems. Given this situation, development has been focused on film-type solar cell modules and organic solar cells, such as organic thin-film and dye-sensitized solar cells, which are lighter and more flexible than conventional silicon solar cell modules.

In this light, we have developed a solar power (photovoltaic) textile woven from photovoltaic threads produced by connecting multiple spherical solar cells between pairs of conductive fibers in series. This photovoltaic textile is obviously lightweight and flexible, but it also has the unique textile properties of stretchiness and bendability, allowing it to be easily handled. In addition, we have also laminated the photovoltaic textile in a resin film to water-proof the unit and improve durability, which are necessary for outdoor use. In this article, we will provide data on the performance and durability of the photovoltaic textile after resin film lamination.

2. Photovoltaic Textile Development

Photovoltaic textiles are made from photovoltaic threads. These photovoltaic threads are made using Sphelar, spherical solar cells (1.2 mm diameter) produced by Sphelar Power Corporation, as the photovoltaic element. These cells are aligned and connected in series between pairs of conductive threads. Photo 1 shows an enlarged image of the spherical solar cells and Figure 1 shows a schematic of a photovoltaic thread. The spherical solar cells are composed of an anode on the curved surface and a cathode on the flat surface, where the electrode units are soldered to conductive fibers to link the solar cells in series as a single photovoltaic thread. The core of the conductive fibers is made of VECTRAN (KURARAY CO., LTD.), around which two tin-plated copper wires (60 μm diameter) are wound to produce an encased thread (Fig. 2). This structure gives the conductive thread the same electrical resistivity as metallic...
Novel Recycling Technology Increases the Value of Discarded Plastic Container and Packaging Resins

Aya Tominaga,* Shigeru Yao**
Fukuoka University

1. Research Background

Figure 1 shows the change over time in plastic production volumes for Japan. As made clear by the figure, production volumes fell following the global financial crisis of 2009, since which time they recovered slightly. Over all, however, production has not returned to 2000 levels, and has even declined slightly. Meanwhile, we can also see that container and packaging production only fell slightly in 2009, and has since continued to grow. In this way, the ratio of container and packaging applications of all plastic applications continues to rise. Therefore, a major aspect of plastic recycling is the ability to recover and reuse plastics suited to container and packaging applications. Given this situation, Japan established laws to implement container and packaging material recycling around 2000. In general, these laws aim to collect and reuse material from used containers and packaging primarily through material recycling methods.

Meanwhile, Figure 2 shows the application ratio of different recycling methods used for discarded plastic since 2000. From the figure, we can see that despite the implementation of these recycling laws, material recycling has remained little used for more than 10 years.

The reason for this is that the physical properties of plastic made from discarded container and packaging resins obtained via material recycling are clearly poorer than those of virgin plastics. Moreover, toughness, a major characteristic of plastic, is completely absent. As such, current applications for recycled container and packaging resins are limited to imitation wood and pallets, for example.

Until now, the reason for the poor physical properties has been assumed to be irreversible chemical degradation. Chemical degradation is a phenomenon by which the molecular chains of the plastic are broken under the influence of heat during molding, as well as rainwater and ultraviolet light during use. These phenomena generate radicals and reduce the molecular weight. Moreover, polar group (hydroxyl group, carboxyl group, etc.) replacement is also believed to be a problem. Chemical degradation is a chemical phenomenon that cannot be reversed. In addition, plastic made through material recycling consists of material recovered from a variety of applications, and because sorting is not thorough we find contamination by various components like inorganic particles. In this way, pellets made through material recycling...
In standard laminated lithium-ion batteries (LIB), a metal tab-lead, through which the battery is charged and discharged, is fused to the anode and cathode to connect the battery to a device. Higher capacity LIB, however, require a thicker tab-lead to handle higher discharges. Thicker tab-leads create a larger step in the heat seal where the tab-lead exits the LIB, risking electrolyte leakage. In response, Showa Denko Packaging Co., Ltd. has developed a new LIB structure made using dry lamination adhesive pattern coating technology. This approach has allowed them to realize a tab-leadless LIB in which the battery is discharged directly through the metal foils in the casing. In this way, they eliminated the risk that the electrolyte will leak from the seal around the tab-lead, but the approach has also allowed them to realize a smaller, lighter LIB with an improved heat radiating property. In moving towards sample production early in 2016, they are currently collecting data that will prove the performance of the structure.

**Adhesive Pattern Coating Technology Used to Develop a Tab-leadless LIB**

**Long-term LIB Reliability**

For the past 20 years, Showa Denko Packaging has produced the aluminum laminated films used in laminated LIB casings. Initially, the most common types of LiB used a metal canister packaging, but Showa Denko Packaging picked up on the fact that the US was developing an aluminum laminated film to replace the metal canister. As a result of being the first to research this technology in Japan, they have been able to steadily supply such materials to Japanese LIB producers who have adopted these aluminum laminated films.

Standard laminated LIB require a tab-lead, however, through which the battery is discharged, to be connected to the collector foil of the anode and cathode to connect the battery to the device. This creates problems, so early in 2015 Showa Denko Packaging applied its proprietary technology to successfully develop a novel battery structure that is able to discharge without using a tab-lead.

Koji Minamitani, group leader of the development team, explained their reasoning for the approach by saying that more than 20 years have passed since they

---

**Step in the Tab-lead Section of Conventional LIB**

When the tab-lead is made thicker for higher capacity batteries, the step in this section becomes larger, which risks leakage of the electrolyte from the inside of the battery. If the tab-lead can be eliminated, the entire battery can be made thinner by the thickness of the tab-lead.
Incontinence is a problem for many hospital patients and nursing care facility residents. As such, devices that can automatically detect urination and send a signal via a transmitter would ease the lives of nursing attendants and caregivers in that they would know exactly when the patient’s or resident’s diaper needed to be changed. At the same time, the ability to measure urine glucose levels could lead to early detection of diabetes. In this light, The Itagaki/Shitanda Laboratory of the Tokyo University of Science has developed a prototype sensor using a fully screen printed enzyme biofuel cell with a paper substrate. The fuel cell generates electricity through a reaction between the glucose in urine and an enzyme, which drives a transmitter to send a signal. In this way, the prototype serves as both a power source and a sensor. The device is also composed of inexpensive materials, such as paper, and can be produced through a simple screen printing process, which should allow for high-productivity and low cost when completed.

Printable Electrochemistry

The Itagaki/Shitanda Laboratory at the Tokyo University of Science uses screen printing for many of their research and development projects. More recently, Isao Shitanda, associate professor, has been developing devices under the concept of printable electrochemistry.

The core of Dr. Shitanda’s research is to screen print devices that utilize bio-technology, such as bio-sensors, which are expected to become increasingly important in the future. Biosensors rely on the molecular recognition capability of biological molecules, such as enzymes, antibodies, and genes. For example, most approaches use substance B, which only reacts to substance A, to detect substance A. More specifically, when substance B encounters substance A, a chemical reaction occurs, which is ultimately detected as an electrical current that can be used to measure the amount of substance A.

Dr. Shitanda also aims to use screen printing to produce all of the electrode components and for affixing the biological molecules (here, substance B in the preceding example) onto the electrodes. Dr. Shitanda explains that although different printing methods are being developed for printed electronics today, the devices they are working with are difficult to produce with methods other than screen printing. In particular, screen printing is suited to producing these devices because it can print thick-films and handle inks with different natures.

Screen Printing Glucose Sensors

Although there are different types of bio-sensors, using the molecule recognition capability of enzymes, which function as catalysts in biochemical reactions, is one method being researched by research institutes and companies. For example, lipase, an enzyme that is able to break down lipids (fat), reacts
CLEAN AIRSHAFT 1000

Minimal Dust
Clean AIREX Air Shaft

Features

○ Appropriate for Class 1000 (*1) clean room use
○ Corresponds to all standard type AIREX air shafts (*2)
○ In order to reduce dust generated by core contact, the head cap and lug are plastic parts.
○ Fluctuates the lug in Class 1000 clean rooms to affirm dust particles of 0.5 μm or larger are less than 100/ft³

*1 Federal Specifications and Standards Fed. Std. 209D (number of fine particles larger than 0.5 μm per 1 ft³) defines Class 1000 as having less than 1000 airborne particles of 0.5 μm or larger per 1 ft³.
*2 Refers to single and dual side support type AIR SHAFT series products with external diameters of 2-6 inches.
Film Sensor Designed to Realize Three-Dimensional Electronics

Masanori Shimura
TOYO LABEL CO., LTD.
www.toyolabel.co.jp

1. Development Background

Capacitance sensors are increasingly being used in smartphones, PCs, and home appliances, as well as in automobile electronics, such as car navigation systems and air conditioner control panels. In all cases, however, the structure combines a decoration panel and a film sensor, making it necessary to select sensor materials and production methods that suit the design and geometry of the decoration panel.

ITO (indium tin oxide) sensors are used with display units, such as LCD screens, whereas PEDOT (polyethyleneoxythiophene) sensors can also be used with non-display units (switch units through which an LED light is shown). In the case of conventional flat or nearly flat decoration panels, ITO can be applied without wire breakage, but given that ITO places limits on the geometry, today, materials with good flexibility, such as PEDOT, are chosen. When it comes to automobile components, which must be attractive and easy to operate, we assume that sensors will increasingly be used in parts with complex geometries or uneven surfaces in the future. To respond to such needs, we are developing ways to modularize PEDOT sensors and decoration panels.

2. Development Concept and Characteristics

With today’s latest technology, components composed of a sensor attached to a decoration panel with a hub or hook on the backside are common. In contrast, when the surface of the product to which the sensor is bonded has an uneven geometry or curved geometry of a certain degree, there is a significant risk of problems, such as those with the bonding precision, optical clear adhesive (OCA) conformability, or durability during environmental testing. In response, we are using the characteristics of PEDOT sensors and our three-dimensional film molding technologies to research and develop a decorative sensor module panel (simultaneously molded decoration and sensor unit) that can conform to uneven surfaces, small curve geometries, and differences in elevation. Recently, we produced a prototype module (Photos 1 and 2). Figure 1 shows the layer structure of the panel.

The most important feature of our approach is that injection molding is used to mold the film sensor, which is perfectly adhered along the geometry of the backside of the panel with-
1. Introduction

There has recently been increasing interest in printed electronics as a method for producing electronic devices using conventional printing techniques. Unlike traditional electronic device production that relies on the ability of photolithography to produce ultra-fine patterns, printed electronics is being positioned to replace this approach because the initial costs in printing equipment and running costs are lower, the processes are faster, and the environmental compatibility is higher due to lower amounts of wasted electronics ink.

On the other hand, the photolithography equipment in use today has already depreciated in value, so in terms of cost, printed electronics does not stand a chance if it simply attempts to mimic photolithography. Therefore, the value of printed electronics lies in the method’s potential to produce devices that could not have been produced with photolithography.

One such application made possible using printed electronics is patterning on curved surfaces, in other words, the production of curved electronic devices. At the Research Center for Organic Electronics (ROEL), Yamagata University, our research into using printing technology to form electronic interconnects on curved surfaces and three-dimensional objects is focused on two types of printed electronics—a curved surface printing technology using a soft blanket gravure (SBG) technology. In this article, we will introduce the curved surface printing technology using a soft blanket gravure (SBG) technology.

2. The Need for Patterning Circuitry on Curved Surfaces

Because photolithography is only able to pattern hard, flat substrates, all conventional electronic devices today are planar and flat. Recently, however, we have seen an increasing number of opportunities for and interest in wearable devices, in other words, devices connected to a data network that can be worn by a person to continuously monitor health conditions and activity levels. The human body consists entirely of curved, elastic lines and surfaces, so wearable devices that can conform to these curved surfaces and lines using elastic or flexible materials are necessary so that they can be worn on the body without causing discomfort.

If we take a look at other products around us, however, we see that many of these also consist of curved surfaces and lines. Essentially, humans prefer curved lines to straight lines, curved surfaces to flat surfaces, and soft objects to hard objects. Therefore, it is only natural that future electronic devices will be made in flexible, wearable curved geometries.

Taking one common example, automobiles contain very few parts that consist of only straight lines and flat surfaces. The only such part is the car navigation display, which only takes this form because it is produced using photolithography, a technology that cannot be used with curved surfaces. As such, this geometry was not adopted as a matter of choice. When we look at the web sites of different automobile manufacturers, we see that automobile concept designs tend to contain a center console with a soft, curved surface, which points to the need for curved electronic devices, such as curved touch screens and displays.
1. Categorizing 3D Printing Technologies and Demands

Printing is a technology with a long history, but more recently it has been part of a new technological revolution that has garnered much attention. This revolution is the advent of 3D printing technology. Whereas earlier printing technologies were limited to use on two-dimensional surfaces, 3D printing technology is designed for three-dimensional objects and is thus expected to be applied to various applications.

Here, we divide 3D printing technology into three categories depending on the application: molding, decoration, and electronics. In addition, we categorize each of these applications based on the measure of dimensionality of the printed object (Table 1). In this case, the dimensionality of standard flat objects (2D), somewhat uneven surfaces that are nearly flat (2.5D), and fully three-dimensional objects (3D). In this article we will refer to technologies that print 2.5D and 3D objects as 3D printing technologies.

3D printing technology molding applications rely on so-called 3D printers. Given that these printers are now less expensive and able to easily form objects designed on a computer, they have become a topic of interest. Although there are different types of 3D printing methods, in all cases the material being molded is designed specifically for that method, so in general there is a limited choice of materials. As such, it is currently difficult to use 3D printers for applications other than molding, such as decoration and electronics.

Next, 3D printing technology for decorative applications conventionally relies on screen or pad printing, but these methods have problems with quality, consistency, and productivity. In hopes of overcoming these issues, developments have recently been with inkjet technology using special inks that cure under ultraviolet (UV) light. Even so, only 2.5D objects can be printed with these conventional technologies, whereas 3D objects are difficult to print. As such, when attempting to print 3D objects in decorative applications, further technological innovations are required. If this becomes possible, it would allow us to easily decorate all kinds of common objects using printing. Moreover, as these printers become less expensive, like today’s 3D printers, there is a good chance that decorative applications will become as common as conventional 3D printer applications.

Finally, there are almost no reports that relate to 3D printing technology in electronics applications. The reason for this is that limitations in electronics materials make applying the 3D printing technology used for 2.5D objects, such as that used for decorative applications, difficult to apply to electronics ap-

Table 1 3D Printing Technology Categories

<table>
<thead>
<tr>
<th>Object Dimensionality</th>
<th>Application</th>
<th>2D</th>
<th>2.5D</th>
<th>3D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molding</td>
<td>Conventional Printing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decorative</td>
<td>Screen, PAD, UV-IJ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electronics</td>
<td>Standard Printed Electronics</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Over the past few sessions we have introduced several examples of applied printed & flexible electronics. Although there are still many other practical applications, the procedures required to obtain publication permission for the figures and photographs are complex, so we brought this topic to a close in the previous session.

Meanwhile, we have received many requests from readers to provide a more detailed explanation of the roll-to-roll production methods used to manufacture flexible electronics devices. We have touched upon the topic of roll-to-roll production methods in several previous sessions, but these have not provided a sufficient understanding. One telling sign of this lack of understanding is the emergence of a gap between the level of expectation and reality. Therefore, over the next few sessions we will make a fairly comprehensive introduction of flexible electronic device roll-to-roll production methods.

1. Introduction: A Major Misunderstanding

Although not necessarily a recent development, many engineers who have developed new flexible electronics devices explain that because roll-to-roll production methods can be used to produce these new products, they expect significant cost savings in producing items that will replace existing products. We have not made a detailed analysis, but in most cases, roll-to-roll production has not even been attempted, and in the cases where it has, the lines are like toys and have only been used to confirm the technological ability to apply roll-to-roll production. In short, we have almost never seen good productivity or economic performance during mass-production. Meanwhile, low-productivity prototype data is used when comparing these methods to sheet processes, so the values only seem to show good results. In this way, this approach has led to a major misunderstanding, which has resulted in a large gap between reality and the level of expectation when building and operating actual lines. In fact, not only do roll-to-roll methods fail to reduce costs, they do not operate as expected and in fact produce mountains of defects. As such, many manufacturers become discouraged with their initial roll-to-roll lines, which often require major modifications, or, at worst, must be scrapped.

Most people’s image of a roll-to-roll line is a fully automated production facility in which the material is loaded in the form of a roll, and a switch simply flipped to start a machine that continuously outputs products without any further interference by humans. In practice, however, even standard roll-to-roll lines suited to the application cannot be immediately operated after purchase and installation. Moreover, producing the simplest flexible circuits and flexible devices requires several steps. In fact, it is almost impossible to conduct a series of processes with a single roll-to-roll line, so in practice several roll-to-roll lines must be installed. Some processes are extremely difficult to handle in roll-to-roll lines, and in such cases the roll must be cut into individual sheets and processed in manual or semi-automatic devices. In other words, actual flexible device roll-to-roll production lines are only used for some of the early production steps, while many of the remaining steps rely on manual labor. As such, the space in the plant occupied by roll-to-roll lines is small, whereas most of the space is used for processing by brute-force manual labor.
18. Register Marks and Visual Correction

18.1 The Role of the Encoder
As introduced in previous sessions, edge position and tension control were developed based on analog technologies, whereas the development of register mark position detection has been based on digital technologies for most of its history. In this way, the encoder is at the heart of register mark position detection. Some examples of register control introduced previously include cut-off control (Fig. 380), gravure printing compensator roller control (Fig. 381), sectional drive system control (Fig. 382), and offset newspaper printing machine control (Fig. 383). All of these different control systems use an encoder that measures the web position and printing cylinder rotation angle.

18.2 Register Mark Position Detection and Encoder Signal (cut-off control, gravure printing)
As introduced in Session 19 (May/June 2014, Section 14.1.4), the register mark position is detected by the scanning head (sensor) and the mark position is measured using the encoder, clock pulse signals, and gate technology. A register mark is selected from among those indicated on a display, the position of which is then measured from the encoder pulse and clock pulse. The mark position is then recorded and used as a reference during operations. In cut-off control, simply setting the repeat length of the pattern allows the controller to automatically determine which part of the pattern to use as a reference, which it will then use as a mark to control the cutting position.

In multi-colored printing, the image for each color is overprinted at the same location. The pass length between each...
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.

Feedback information is used to correct the web's movement.

Controller informed of degree of edge position change

Web passage control

Normal web passage

Web skew

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 pivot guide roll mechanism provides a high level of response to control commands.

NIRECO CORPORATION
Head Office: 2951-4, Ishikawa-machi, Hachioji, Tokyo 192-8522 JAPAN
TEL: +81-42-660-7409
http://www.nireco.com/en E-mail: world@nireco.co.jp
Part 15

Packaging Film Production and Functionalizing Technology

Research and Development (9)

“r-ICB Web Coater” Metalized Film Manufacturing System Development

Akira Hayashi

14. Ionized Cluster Beam Web Coater

Figures 198 and 199 show detailed schematics of the metal deposition Ionized Cluster Beam (ICB) Web Coater. As we discuss the basics behind the ICB theory, we will explain the major points of the structural units (vacuum chamber, crucible, heating method, cluster generation, ionization and acceleration units, deposition unit) and each of the processes.

The ICB deposition method was originally proposed as a means of producing advanced metal thin-films at an industrial level. In this respect, the most important feature of the ICB method is that the energy required to structure the thin-film relies on the metal ion kinetic energy of some of the accelerated ions. Here, the ions are accelerated by passing the metal vapor flow through an electron shower and acceleration electrode. The second feature is that the metal vapor flow is jetted from a sealed crucible with nozzles. By designing an appropriate orifice size (roughly 2 mm in diameter) and crucible internal-external pressure difference (greater than $10^4$), we can ensure that the adiabatic expansion effect causes the metal atoms in the metal vapor flow to gradually combine into clusters (100–2,000 atoms) through a process called clustering. The ionized clusters are then accelerated by applying a voltage, which provides them with kinetic energy and allows for easy control of the necessary and appropriate energy to form the structure.

14.1 Vacuum Chamber

Deposition takes place in a vacuum chamber, where a degree of vacuum is required that will allow the metal atoms jetted from the heated crucible to reach the substrate without colliding or reacting with gas atoms (molecules) in the vacuum, which would otherwise block their travel. Therefore, we use a vacuum of less than $10^{-4}$ Torr (mean free path of approx. 10–100 cm).

14.2 Crucible

The ICB method, which relies on a vapor stream jetted from nozzles, requires a sealed crucible with a unique structure. As shown in Figure 199, this crucible has multiple nozzles in the width direction. The crucible is made of carbon because carbon is easy to process and because the crucible must be made of a material that does not react with metal.

14.3 Heating Method
Fully Automatic Coater and Applicator Properties As Seen From Test Results

President T suede Tate
COTEC
www.cotec.co.jp

1. Introduction

Producing a layer or film with a uniform thickness throughout is extremely important to developing products that require functionality. The reason for this is that without such uniformity, it will be impossible to know if the cause of performance variation stems from the coating materials or from deviation in the thickness. In fact, the need for trial and error testing or cause of failures does not always come from the materials being developed, but often comes from a problem with the coating technology. In this way, it might be necessary to reconsider whether a past failure was, in fact, a failure at all.

There has been a rapid increase in the use of film applicators to reproduce layers or films with the same thicknesses, but in many cases the operator encounters difficulties because the user is unable to determine the coating conditions given a lack of information on the peculiarities and structure of the applicator itself. We have made various tests for applicator viability and hope that the results presented in this article help when selecting a coater.

2. Is Hand Operation Bad?

When we see coating failures, it seems as though the majority of these failures are caused by the rate of travel being too high. In practice, the ideal rate of travel (the speed at which the bar coater is drawn) in most cases is far lower than the rate assumed by the user. As such, we must ask why the rate of travel is increased. When operating a coater by hand it is difficult to maintain a constant speed at low rates of travel, causing obvious coating variation. As such, the operator tends to speed up without realizing it.

The preface to JIS K5600-4-1 (hiding power), a standard for evaluating the hiding power of a coating, states that:

“Different operators will produce coating films with clearly different film thickness even when using the same film applicator, so an absolute method is required.”

Regardless of how much attention is paid to the applicator specifications and precision, however, manual operation will necessarily result in variation. As such, when using an applicator such as a bar coater, it is best to use automatic coaters (automatic bar coater, table top coater) in most cases.

In examples where the coating conditions, such as those for viscosity, were repeatedly adjusted, we were prepared to sacrifice performance because of the difficulty of film forming. By operating the automatic coater at a rate of 2 mm/sec., however, we were surprised that we could produce uniform films without problem. Such examples are surprisingly common. Photo 1 shows an example of a typical automatic applicator.
uum is drawn through a plate containing many holes, locks down the entire coating substrate uniformly. With thin-films, such as thin-film silicon, however, the vacuum method can cause the coating substrate to bend. In such cases, the double chamber vacuum method should be considered.

(2) Applicator Holding Method
Applicators that do not roll, such as the baker and bird film applicators, only need to be drawn at a constant rate by the running mechanism. In the case of the spiral bar coater, however, this approach might cause the bar to roll backwards over the freshly coated surface at the end point. As such, spiral bar coaters require a mechanism that raises the bar at the end of coating and locks it in place.

(3) Vacuum Area Adjustment
If there are areas of the vacuum holes that are not covered by the coating substrate, the vacuum air will escape, which will break the vacuum. As such, the ability to switch the vacuum area between A4 and A3 sheet sizes is convenient.

(4) Rate of Travel
The reference range for the rate of travel is wide, and, as can be seen from this series of coating tests, even a tiny difference in speed will significantly affect the coating thickness depending on the coating fluid properties. Moreover, it is obvious that the setting precision and reproducibility should be high, with a speed setting graduation of 1–2 mm/sec. and a speed precision of ±3%. In addition, the rate of travel setting range should be no more than 2 mm/sec.

(5) Switching Between Locking Methods
Conventionally, most models cannot be switched between the clamp and vacuum locking methods. The latest models, however, can be switched between the two types. As such, these applicators can use the vacuum and clamp methods simultaneously, which is convenient if the vacuum is insufficient to lock down the substrate.

9. Closing
Coating failure is, surprisingly, often caused by the applicator’s rate of travel being too high, variation in this rate, or improper applicator selection. As such, to move forward efficiently with development, it is best to use the appropriate applicator and an automatic coater.
4. Drying Equipment

4.1 Introduction

Heat transfer mechanisms used in drying equipment can be divided into three types: convection through hot air or gas, conduction through contact with a heated plate, and radiation through infrared rays or sunlight. Although drying equipment is designed to effectively take advantage of these types of heat transfer mechanisms, it must have both a sufficient drying capacity and utilize a high grade drying process. Recently, we have seen the need to dry larger and larger substrates, which has led to increased drying performance. Meanwhile, we have also seen pressure and temperature control applied to drying equipment, as well as the development of methods that suppress coating film deterioration resulting from overheating and Laplace forces. Other important aspects are the availability of a large chamber and drying uniformity. In this way, it is necessary to select a drying system that suits the product.

In this session, we will focus on several types of typical drying systems, including hot-air drying, infrared drying, reduced pressure (vacuum) drying, freeze drying, supercritical drying, and spin drying as we introduce the drying mechanisms and equipment configurations. In particular, we will look at a quality evaluation of coating films that have been dried with reduced pressure drying and spin drying, two commonly used methods in industry.

4.2 Drying Equipment

4.2.1 Heater Drying (drying furnace)

The heater is a type of drying system that is able to dry the coating film under ideal conditions. As mentioned in the previous session, the larger the temperature difference between the coating film and the surrounding area, the larger the water vapor pressure difference, which facilitates drying. In general, we define drying rate $K$ for hot-air drying as

$$K = \frac{a(T_\text{h} - T_\text{f})}{q}.$$  

Here, $a$: coefficient of heat transfer, $T_\text{h}$: hot-air temperature, $T_\text{f}$: film temperature, $q$: latent heat of vaporization.

Increasing the temperature difference $(T_\text{h} - T_\text{f})$ and increasing the coefficient of heat transfer are both effective means of raising the drying rate. As such, these are the targets employed when designing the drying equipment.

Figure 2.59 shows an image of a commercially available hot-air drying system. There are various sizes and types of such drying systems designed for different applications. In general, the maximum hot-air temperature of these types of drying systems is $300^\circ\text{C}$, so the heating chamber is covered with insulation to prevent thermal transpiration to the surrounding area. Insulation is made of fibers, such as glass wool, and the metal heating element is often made of nickel-chrome or iron-chrome-aluminum alloys. Drying equipment in the
Improved Operability and Quality of the D Chamber Coating System

1. Introduction

Led by the Food and Agriculture Organization of the United Nations (FAO), there has been a recent movement called “Save Food.” The drive behind this movement is the importance of linking global food waste to starvation resulting from the explosive growth of the global population and global warming. In fact, the amount of food discarded globally, including leftovers and expired food, has reached 1.3 billion tons annually.

Hearing this, the author (Morikawa) remembers working part-time at a restaurant during his student years and seeing the huge amount of discarded food that filled several garbage bags the day after Christmas. Although this was still a time when leftover food could be eaten by employees and given to friends, in more recent years, this type of frugality is not allowed for health reasons. Given that so much food is discarded from just a single restaurant every day, it is easy to imagine that 1.3 billion tons are wasted globally each year.

Meanwhile, the spread of the internet has made the world a smaller place, and as we come to know the suffering of starvation in far away places, the world is starting to recognize the importance of reducing food loss. Japan is no exception, and we have seen a move to review business practices that are a cause of food loss. Among these developments, it is only natural to see changes taking place in food packaging, where there has been a shift in thinking in the industry from the conventional view that packaging is something to be discarded to a new idea of packaging as something that protects food. Going forward, we can easily imagine that plastic film, with its combination of flexibility, thinness, lightweight, barrier properties, and design properties, will be an important material in the fight to bring an end to the problem of food loss. More specifically, laminated materials that can protect food from oxidation and drying out are important, but it is the layer bonding adhesive coating technology that is increasingly important in determining the quality of laminated films.

FUJI KIKAI KOGYO has a long history of developing dry laminators—one of the primary laminating methods—as a core product, and nearly 35 years have passed since we delivered our first machine. Since then, we have sold roughly 300 machines, which are used by a range of converters. From the beginning of our development of dry laminators, we have been interested in environmental concerns, which has led us to focus on the development of the chamber doctor. One of the reasons that our laminators continue to be used by so many customers today is this chamber doctor.

In this article, we will introduce the development of our new D Chamber coating system, which has been significantly improved in terms of operability and quality.

2. Birth of the D Chamber

2.1 What Is a Chamber Doctor?

As shown in Figure 1, the chamber doctor is a sealed doctor coating method consisting of three components: ① a chamber doctor unit, ② an adhesive circulation system, and ③ a gravure cylinder. In the 1990s, sealed doctor systems were first adopted by flexo printing machine manufacturers in the US and Europe. Compared to the conventional coating system shown in Figure 2, the sealed doctor system has several advantages, including reducing solvent diffusion to the atmosphere, one reason chamber doctors are still commonly used today. In 1995, we began developing such a sealed doctor system. In 1998 we received the support of the New Industry...
Coating technology, however, is highly dependent on operator experience, as well as trial and error, so there is no question that a more concrete, cost-effective method of preventing defects and improving productivity is necessary. In response, we believe our D Chamber will provide a revolutionary capability that will increase quality and productivity. Going forward, we foresee that the expansion of coating industry markets in all roll-to-roll fields will lead to the use of various coating fluids and films, making the technological innovation of chambers an unending endeavor. Seeing a future for chamber coating, we hope to continue focusing on development of the industry.

3. Closing

Plastic film has a long history of use in packaging many common items, but the importance of the flexible packaging industry for reducing global food loss will only increase in the future. Meanwhile, Japan has seen a shift to dining alone, internet commerce, and higher quality materials for reasons of safety as its population contracts and ages. In this way, as lifestyles change, so too does the design of packaging, which has led films and coatings to take on various forms. Given this situation, any limits on coating equipment operation that impede production efficiency must be avoided at all costs. Coating technology, however, is highly dependent on operator experience, as well as trial and error, so there is no question that a more concrete, cost-effective method of preventing defects and improving productivity is necessary. In response, we believe our D Chamber will provide a revolutionary capability that will increase quality and productivity. Going forward, we foresee that the expansion of coating industry markets in all roll-to-roll fields will lead to the use of various coating fluids and films, making the technological innovation of chambers an unending endeavor. Seeing a future for chamber coating, we hope to continue focusing on development of the industry.

References

4. Release Paper History

In this part we will cover some of the major developments that have taken place throughout the history of release paper in the US and Japan.

4.1 Growth Coincides With PSA Labels

Let us begin by looking at release paper in the US (Table 8). Even before the invention of PSA (pressure sensitive adhesive) labels in the US, release paper was used to wrap asphalt and other sticky substances. It was not until after the invention of PSA labels, at which time release paper started to be used as a liner, however, that the production volumes showed remarkable growth and a large market was formed. In this way, the growth of the PSA label market led to significant growth in release paper.

PSA labels were invented in 1935 during the Great Depression. This was six years after the start of the Great Depression and the death of Wyatt Earp, well-known from Westerns, at the age of 80 in 1929. This was also one year before a famous coup attempt in Japan in February 26, 1936.

The inventor, Stanton Avery, was born the son of a congregational church clergyman in 1907 and majored in psychology at university. As a student, he formed an expeditionary team with some friends to study the orient, and took a year off from school to visit China, Inner Mongolia, Korea, and Japan. It is said that his experiences during this journey had a strong influence on the formation of his management ethics philosophy. After graduation, he worked at the Los Angeles County Philanthropic Division, and entered a PSA products company owned by a friend in 1933. The company later went bankrupt, and he ended up taking temporary employment at the San Lorenzo Nursery (for seeds, saplings, and flowers). Having become enamored with PSA products, however, he would run home everyday after packing flowers at the nursery to his attic workshop, which served as his research lab where he conducted his research into PSA products. It was at this time that he invented a PSA label using a release paper. This was a new type of label that would replace the commonly used gum labels, which had a paper coated re-moistening adhesive that needed to be moistened during application like with

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1930</td>
<td>R. Drew of 3M invents cellophane PSA tape</td>
</tr>
<tr>
<td>1931</td>
<td>Cellulose–higher fatty acid esters back coating invented</td>
</tr>
<tr>
<td>1935</td>
<td>S. Avery invents PSA label with release paper</td>
</tr>
<tr>
<td>1942</td>
<td>Release paper coated with lacquer containing castor oil</td>
</tr>
<tr>
<td>1945</td>
<td>C. Dahlquist of 3M invents long-chain alkyl back coating</td>
</tr>
<tr>
<td>1950</td>
<td>Super Calendered Kraft (SCK) release paper</td>
</tr>
<tr>
<td>1952</td>
<td>Silicone release paper developed</td>
</tr>
<tr>
<td>1954</td>
<td>M. Andrews label printing die-cutter machine</td>
</tr>
<tr>
<td>1957</td>
<td>Dow Corning develops Syl-off 23 solvent condensation reaction type silicone release agent</td>
</tr>
<tr>
<td>1958</td>
<td>Automated label applicator developed</td>
</tr>
<tr>
<td>1967</td>
<td>Dow Corning develops tight-release control agent</td>
</tr>
<tr>
<td>1972</td>
<td>Dow Corning develops solventless addition reaction type silicone release agent</td>
</tr>
<tr>
<td>1977</td>
<td>Full-scale production of solventless silicone release paper begins with installation of B.M.B’s first solventless silicone multi-roll coater</td>
</tr>
</tbody>
</table>
4. Adhesive Coating and Adhesives

The components of dry lamination and solventless lamination adhesives are nearly the same. The biggest difference between the two is the coating method. As explained in the previous section, the product characteristics also differ significantly.

The following will detail the coating methods for these two lamination approaches.

4.1 Adhesive Coating Method

4.1.1 Dry Lamination Adhesive Coating

Two typical dry lamination coating methods are the flat (smooth) reverse kiss roll coating method and the gravure roll coating method. The gravure roll coating method shown in Figure 3 is the most common type, of which there are two subcategories—the conventional pan type and the chamber doctor type. Currently, the chamber doctor type is increasingly being used given its ability to reduce adhesive splatter and prevent foul odors from escaping the workspace.

The adhesive solid component coating weight is determined by the depth of the gravure roll cells and the solid content concentration of the adhesive. If the rolls and the coating weight are controlled regularly, there is little chance of failure.

Replacing the adhesives and cleaning the equipment is a troublesome task for all converters because the machines must be stopped, which wastes time. How these issues are handled depends on the work procedures of the individual converter, but productivity can be increased by shortening the time required to replace the adhesives and by reducing machine downtime.

During adhesive replacement, the adhesive in the adhesive circulator from Figure 3 is transferred to a can after the machine is stopped, and the circulator cleaned with a solvent. Next, the pan in the doctor unit, the chamber, and the gravure roll are cleaned. During this time, the circulator cleaning unit and circulator pump are cleaned separately by circulating solvents through them. Preparing a spare circulator pump will make it convenient to start the next adhesive coating job.

In some cases, converters may have more than 10 grades of adhesives on hand, but the development of advanced dry lamination adhesives means that it is best to put together a production system that minimizes the number of adhesives and limits these to one type of ether adhesive, one type of polyester adhesive, and one special adhesive, for a total of three.

4.1.2 Solventless Lamination Adhesive Coating

As shown in Figure 4, the solventless lamination coating method uses a four
The world around us is full of industrial products made of relatively thin materials, including paper, textiles, plastic films, thin-film glass, nonwoven fabric, and metal foils. Although this overview shows that these materials are essential to our daily lives, they are also critical in furthering the development of high-tech industries that will eventually form the core of the global economy. Some examples from the IT, energy, and medical fields include optical films for flat panel displays, solid polymer membranes used in fuel cells, and artificial biological membranes for medical applications. During the manufacturing process, however, we call these materials webs.

Web manufacturing technology relies on the converting technologies of coating, laminating, and printing, as well as well as on web handling technology (here we include unwinding, slitting, cutting, drying, and rewinding, etc.). Among these, coating and printing have established themselves as cutting-edge technologies, for which academics have shown great interest. In contrast, web handling technology has conventionally been refined through production plant experience; although the technology itself has reached a fairly advanced level, its academic understanding is poor.

At the strong behest of the industry, the author has spent the past 20 years working to theoretically understand the physical phenomena related to web handling, and predicting and preventing the problems that occur during manufacturing. Our research has been studied widely in Japan by industries that utilize web handling technology, and has been praised for the help that it has provided in eliminating defects and developing new products.

On the other hand, we have also received strong interest from around the world in publishing our results in English given the desire to understand the strength of Japan’s web handling technology. Given that the theoretical research into web handling began outside of Japan, we are elated to be able to publish an English version of our work as it will allow us to repay our debt to those who came before. At the same time, nothing would make us happier than to see this work contribute to the opening of new horizons for readers around the world involved in web handling technology.

## Contents

<table>
<thead>
<tr>
<th>Chapter 1</th>
<th>Background to Web Handling</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Introduction</td>
<td></td>
</tr>
<tr>
<td>1.2 Key Points of Web Handling Technology</td>
<td></td>
</tr>
<tr>
<td>1.3 History of Web Handling Research</td>
<td></td>
</tr>
<tr>
<td>1.4 Growth of Roll-to-Roll Printed Electronics</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 2</th>
<th>Web Handling Fundamentals</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Introduction</td>
<td></td>
</tr>
<tr>
<td>2.2 Mechanical Characteristics of the Web</td>
<td></td>
</tr>
<tr>
<td>2.3 Web Surface Roughness Characteristics</td>
<td></td>
</tr>
<tr>
<td>2.4 Friction Characteristics Between Solids</td>
<td></td>
</tr>
<tr>
<td>2.5 Web-roller Interface Problems</td>
<td></td>
</tr>
<tr>
<td>2.6 Web Bending Stress and Strain</td>
<td></td>
</tr>
<tr>
<td>2.7 Web Tracking Ability</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 3</th>
<th>Web Deformation</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 Introduction</td>
<td></td>
</tr>
<tr>
<td>3.2 Relationship Between Web Material Structures and Elasticity</td>
<td></td>
</tr>
<tr>
<td>3.3 Liquid Structures and Viscosity</td>
<td></td>
</tr>
<tr>
<td>3.4 Viscoelastic Bodies and the Mechanical Model</td>
<td></td>
</tr>
<tr>
<td>3.5 Web Bending</td>
<td></td>
</tr>
<tr>
<td>3.6 Web Buckling</td>
<td></td>
</tr>
<tr>
<td>3.7 Web Creasing</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 4</th>
<th>Tribology in Web Handling</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 Introduction</td>
<td></td>
</tr>
<tr>
<td>4.2 Web Transport and Tribology</td>
<td></td>
</tr>
<tr>
<td>4.3 Friction Force and Coefficient of Friction</td>
<td></td>
</tr>
<tr>
<td>4.4 Amontons-Coulomb Friction Law</td>
<td></td>
</tr>
<tr>
<td>4.5 Measuring Coefficient of Friction</td>
<td></td>
</tr>
<tr>
<td>4.6 Euler’s Belt Equation</td>
<td></td>
</tr>
<tr>
<td>4.7 Rigid Body Surface Roughness</td>
<td></td>
</tr>
<tr>
<td>4.8 Rigid Body Contact and Friction</td>
<td></td>
</tr>
<tr>
<td>4.9 Friction Mechanism</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 5</th>
<th>Web Slippage</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1 Introduction</td>
<td></td>
</tr>
<tr>
<td>5.2 Criteria for the Occurrence of Web-Roller Slip</td>
<td></td>
</tr>
<tr>
<td>5.3 Theoretical Prediction Equation for Slip</td>
<td></td>
</tr>
<tr>
<td>5.4 Slip Observation Test</td>
<td></td>
</tr>
<tr>
<td>5.5 Pilot System Experimental Verification</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 7</th>
<th>Winding Mechanics</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1 Introduction</td>
<td></td>
</tr>
<tr>
<td>7.2 Rewinding Drive Method Categorization</td>
<td></td>
</tr>
<tr>
<td>7.3 Relationship Between Internal Wound Roll Stress and Roll Quality</td>
<td></td>
</tr>
<tr>
<td>7.4 Internal Roll Young’ s Modulus Anisotropy</td>
<td></td>
</tr>
<tr>
<td>7.5 Hakiel’ s Rewinding Theory</td>
<td></td>
</tr>
<tr>
<td>7.6 Rewinding Equation Numerical Solution</td>
<td></td>
</tr>
<tr>
<td>7.7 Hakiel Model Calculation Example</td>
<td></td>
</tr>
<tr>
<td>7.8 Web Rewinding Theory Accounting for Air Entrainment</td>
<td></td>
</tr>
<tr>
<td>7.8.1 When a Nip Roller is Not Used</td>
<td></td>
</tr>
<tr>
<td>7.8.2 When Using a Nip Roller</td>
<td></td>
</tr>
<tr>
<td>7.9 Modified Hakiel Model Experimental Verification</td>
<td></td>
</tr>
<tr>
<td>7.9.1 Test Web Physical Properties</td>
<td></td>
</tr>
<tr>
<td>7.9.2 Radial Stress Inside the Roll</td>
<td></td>
</tr>
<tr>
<td>7.9.3 Rewinding Experiments and Internal Stress Measurement Results</td>
<td></td>
</tr>
<tr>
<td>7.10 Taper Tension</td>
<td></td>
</tr>
<tr>
<td>7.11 Optimization Theory for Rewinding Tension</td>
<td></td>
</tr>
<tr>
<td>7.12 Viscoelastic Rewinding Theory</td>
<td></td>
</tr>
<tr>
<td>7.13 Theory Considering Post-rewinding Temperature Changes</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 8</th>
<th>Tension Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1 Introduction</td>
<td></td>
</tr>
<tr>
<td>8.2 Web Transport Systems and Tension Control</td>
<td></td>
</tr>
<tr>
<td>8.3 Mechanical System Modeling for Tension Control</td>
<td></td>
</tr>
<tr>
<td>8.4 Web Tension Control System</td>
<td></td>
</tr>
<tr>
<td>8.5 Rewind Tension Control</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 9</th>
<th>Web Spreading</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.1 Introduction</td>
<td></td>
</tr>
<tr>
<td>9.2 Web Separating and Spreading Principle</td>
<td></td>
</tr>
<tr>
<td>9.3 Web Separation Theoretical Prediction Model</td>
<td></td>
</tr>
<tr>
<td>9.4 Experimental Verification</td>
<td></td>
</tr>
<tr>
<td>9.4.1 Measuring Separation of the Slit Web</td>
<td></td>
</tr>
<tr>
<td>9.4.2 Crease Prevention Function Verification</td>
<td></td>
</tr>
</tbody>
</table>
### 2015 Advertising Rates

<table>
<thead>
<tr>
<th>2-Color*</th>
<th>1×/year</th>
<th>2-4×/year</th>
<th>5-6×/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Page</td>
<td>$3,200</td>
<td>$2,940</td>
<td>$2,680</td>
</tr>
<tr>
<td>½ Page</td>
<td>$2,000</td>
<td>$1,840</td>
<td>$1,680</td>
</tr>
<tr>
<td>¼ Page</td>
<td>$1,500</td>
<td>$1,380</td>
<td>$1,260</td>
</tr>
<tr>
<td>¼ Page</td>
<td>$1,400</td>
<td>$1,280</td>
<td>$1,170</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4-Color</th>
<th>1×/year</th>
<th>2-4×/year</th>
<th>5-6×/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Page</td>
<td>$4,500</td>
<td>$4,140</td>
<td>$3,780</td>
</tr>
<tr>
<td>½ Page</td>
<td>$3,000</td>
<td>$2,760</td>
<td>$2,520</td>
</tr>
<tr>
<td>¼ Page</td>
<td>$2,500</td>
<td>$2,300</td>
<td>$2,100</td>
</tr>
<tr>
<td>¼ Page</td>
<td>$2,000</td>
<td>$1,840</td>
<td>$1,680</td>
</tr>
</tbody>
</table>

**Premium Position**

<table>
<thead>
<tr>
<th>1×/year</th>
<th>2-4×/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover</td>
<td>$6,000</td>
</tr>
<tr>
<td>Inside Front Cover</td>
<td>$5,300</td>
</tr>
<tr>
<td>Inside Back Cover</td>
<td>$5,300</td>
</tr>
<tr>
<td>Back Cover</td>
<td>$5,800</td>
</tr>
<tr>
<td>Front Top 4C</td>
<td>$5,100</td>
</tr>
<tr>
<td>Front Top 2C</td>
<td>$4,100</td>
</tr>
</tbody>
</table>

*2-color ads: Combination of Black and Cyan, Magenta, or Yellow  
** All premium positions are 4-color unless otherwise specified  
*** Premium positions are filled on a first come first serve basis  
**** For additional options (spread, island, etc.) contact us directly

---

### Reach the World

Advertising in Convertech & e-Print provides you with a way to reach all corners of the converting world. Our readership is not limited to one aspect of the industry, so your advertisements will be seen by potential customers, as well as those who will ask your customers to use your products.

Combining an advertisement with a short 1 or 2 page article is a great way to provide more information in detail to the world.

For more information, access our site and visit us at:

www.ctiweb.co.jp/eng/

---

### Contact Information

**JAPAN/INTERNATIONAL**

CONVERTING TECHNICAL INSTITUTE  
Shigeo Araki  
Iwamotocho-Takahashi Bldg., 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  
Yeoong 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

---

### January/February Advertisers:

- THINK LABORATORY CO., LTD.  
- PRINTING SOUTH CHINA 2016/SINO LABEL 2016  
- 6th ALL IN PRINT CHINA  
- KOBAYASHI ENGINEERING WORKS, LTD.  
- TOKUDEN CO., LTD.  
- HIRANO TECSEED CO., LTD.  
- OKAZAKI MACHINE INDUSTRY CO., LTD.  
- MITSUHASHI CORPORATION  
- NIRECO CORPORATION  
- YAMABUN ELECTRONICS CO., LTD.  
- TAIYO ELECTRIC INDUSTRY CO., LTD.
2016 Converting Technology Exhibition
Bringing Japan’s Converting Strength to the World!

Advanced Films
Functional Materials
Functional Resins/Additives
Contracted Processing
Converting Equipment
Flexible Electronics
Decoration Technologies/Film

Material Zone
Technical Zone
Mechanical Zone

Exhibition Guide
Jan. 27 (Wed.) - Jan. 29 (Fri.) 2016
Tokyo Big Sight East Hall
Organizer: Converting Technical Institute
Co-organizer: ICS Convention Design
www.converttechjapan.com