INOEL Yamagata University Innovation Center for Organic Electronics

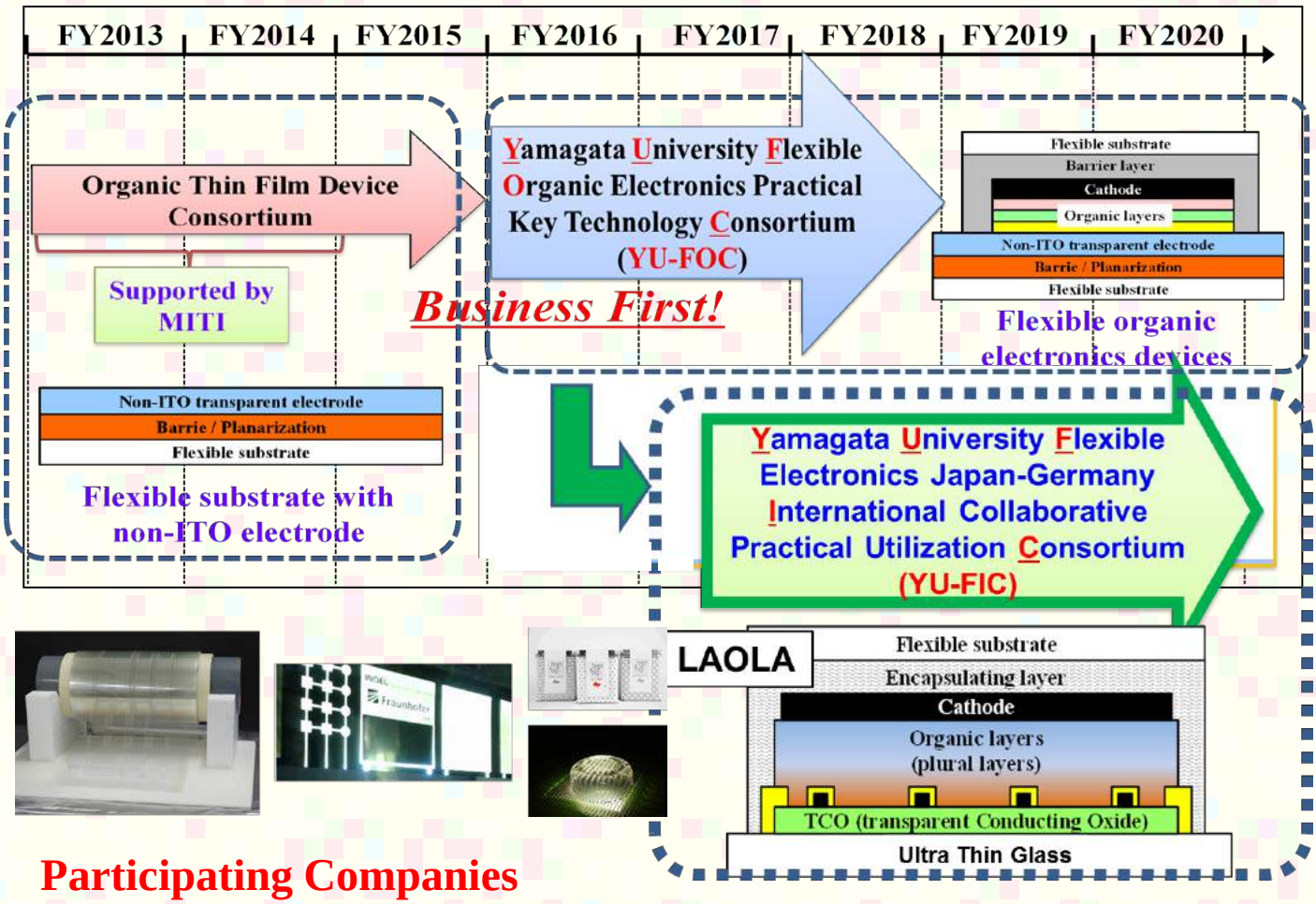
山形大学 YAMAGATA UNIVERSITY

Yamagata University Flexible Electronics Japan-Germany International Collaborative Practical Utilization Consortium (YU-FIC)

Project term Oct. 2017 ～ March 2021

R&D subject

1. **LAOLA:** Large Area Organic Lighting Applications on ultra-thin substrates
2. **IonT:** Internet on Things - Intelligent OLED-OPV based Signage for interactive Advertisement
3. **F2E:** Free Form Electronics - Freedom in design by thermo-formed printed electronics



Participating Companies

- ♥FUJIKURA KASEI CO.,LTD.
- ♥KEIHIN RAMTECH CO., LTD.
- ♥Mitsuboshi Diamond Industrial Co., Ltd.
- ♥Nippon Electric Glass Co., Ltd.
- ♥NIPPON STEEL & SUMIKIN MATERIALS CO., LTD
- ♥Seieido Printing Co., Ltd.
- ♥SERIA ENGINEERING, INC. (KOMORI Group)
- ♥SurFtech Transnational Co., Ltd.
- ♥TAKEDA PRINTING CO.,LTD.
- ♥Tokyo Process Service Co., Ltd.
- ♥The Japan Steel Works, LTD.
- ♥WIREDGATE Inc.

Equipment / Members

Equipment

Four original roll-to-roll (R2R) equipment (Roll width: 30cm)


R2R sputtering &CVD (KOBELCO)


R2R screen printing (SERIA)


R2R Gravure offset and Flexography printing (Komori Machinery/ Taiyo Kikai)


R2R wet cleaning (FEBACS)

Device fabrication equipmennt


Organic deposition (G1 substrate)


Organic deposition


Sputtering


Laminator

Sheet-to-sheet (S2S) printing equipment


Gravure offset and Flexography printing

Screen printing


Ink-jet

Analysis and evaluation equipment

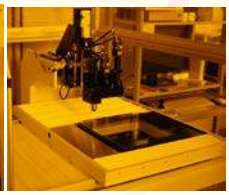

Ca method


WVTR


Bending


Viscoelasticity measurement


Hybrid confocal microscopy


Precise position detector

Members

YU-FIC Fellow

Professor
Dr. Tatsuhiro Takahashi

effort@yz.yamagata-u.ac.jp

(Field)
Polymer chemistry, composite material, Administration, International collaboration

(Biography)

1988	Graduated at Waseda Univirsity (Master degree)
1988～1998	DuPont
1996	Graduated at Yamagata University (PhD)
2002～	Yamagata University
2008～	Yamagata University, Professor
2016～	Yamagata University, Director of INOEL

YU-FIC Chair

Associate Professor
Tadahiro Furukawa

ta-furukawa@yz.yamagata-u.ac.jp

(Field)
Fine patterning technology, Printing, Roll-to-roll technology

(Biography)

1984	Graduated at Saitama University (Master degree)
1984～2011	Kyoto Printing Co., Ltd. R&D and production of Color filter (CF), flexible CF and LCD
2011～	INOEL, Yamagata University (current position)

YU-FLEC Secretary

Professor
Dr. Mitsuhiro Koden

koden@yz.yamagata-u.ac.jp

(Field)
Field: LCD, Display, OLED, Chemistry

(Biography)

1983	Graduated at Osaka University (PhD)
1983～2012	Sharp Corporation (Liquid crystal materials, LCD, OLED display, etc.)
1998～2011	Guest prof. of Nara Institute of Science and Technology
2012～	INOEL, Yamagata University (current position)

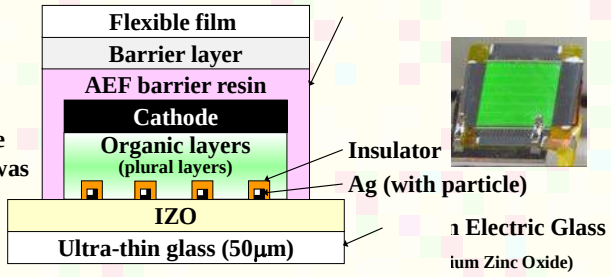
Ultra Thin Glass / Barrier Film / Printing / R2R

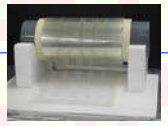
Flexible OLED panel with ultra-thin glass (Collaborating with Nippon Electric Glass and SERIA ENGINEERING)

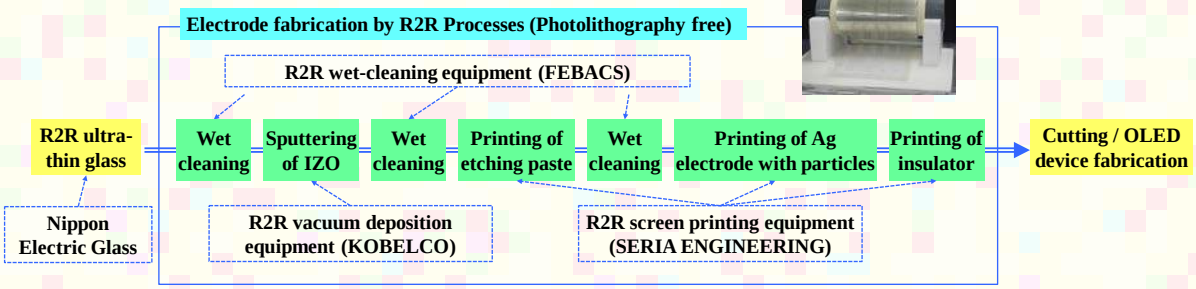
T. Furukawa, N. Kawamura, T. Noda, Y. Hasegawa, D. Kobayashi, M. Koden, IDW'17, FLX6-2 (2017).

Flexible OLED panels were developed on ultra-thin glass (thickness: 50μm) with transparent electrode fabricated by roll-to-roll (R2R) processes.
The following results were also obtained.

1) ITO tends to reduce mechanical strength due to the mechanical stress. As a counter technology, IZO was applied.
2) The inclusion of reflective particles to Ag assisting electrode reduces the attention of the assisting electrode.







The effect of wet cleaning on barrier property of flexible film (Collaborating with FEBACS and Teijin)

T. Furukawa, N. Kawamura, M. Koden, H. Itoh, H. Kuroiwa, K. Nagai, LOPEC (2017).

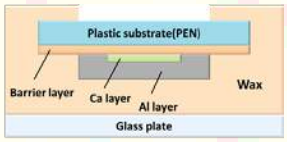
The effect of wet cleaning on barrier property of flexible film was investigated by using roll-to-roll (R2R) wet cleaning equipment, finding that wet cleaning improves barrier property.

R2R cleaning equipment

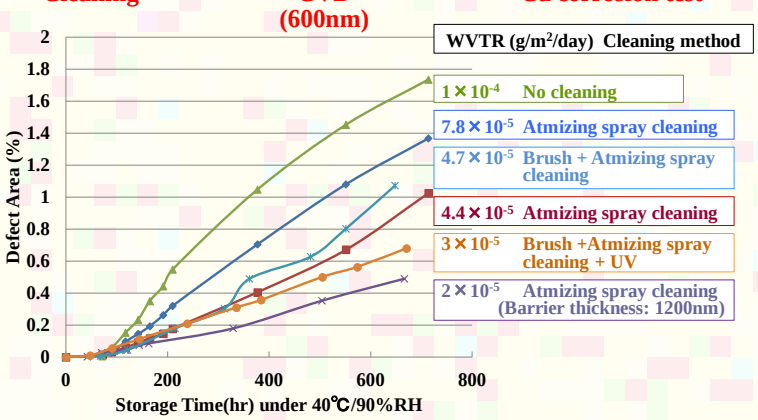
Brush Cleaning
(PVA sponge – Detergent))
↓
Atomizing spray cleaning
↓
Pure water
↓
Air knife
↓
IR
↓
(UV)

Cleaning

CVD (600nm)



Ca corrosion test



Topics / Publication

Award

- H. Nakada, M. Koden, “Award from Minister of State for Science and Technology Policy”, Cabinet Office, Government of Japan, (2017).

Book

- M. Koden, “OLED Displays and Lighting” (Wiley, IEEE Press) (2017).

Paper

- T. Furukawa, M. Koden, IEICE Trans. Electron, E100-C, 949-954 (2017). “Novel roll-to-roll deposition and patterning of ITO on ultra-thin glass for flexible OLEDs”

International Conference

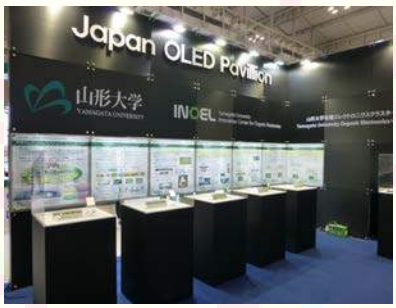
- T. Furukawa, N. Kawamura, T. Noda, Y. Hasegawa, D. Kobayashi, M. Koden, IDW’17, FLX6-2 (2017). “Novel Roll-to-Roll Fabrication Processes of Transparent Electrodes on Ultra-Thin Glass”
- K. Taira, T. Furukawa, N. Kawamura, M. Koden, T. Takahashi, IDW’17, FLXp1-8L (2017). ”High gas barrier film for OLED”
- T. Furukawa, N. Kawamura, M. Koden, H. Itoh, H. Kuroiwa, K. Nagai, LOPEC (Large-area, Organic & Printed Electronics Convention) (2017). “Gas barrier film for OLED devices”
- M. Koden, T. Furukawa, T. Yuki, H. Kobayashi, H. Nakada, IDW/AD’16, FLX3-1 (2016). [Invited] “Substrates and Non-ITO Electrodes for Flexible OLEDs”
- T. Furukawa, M. Sakakibara, N. Kawamura, M. Koden, IDW/AD’16, FLX3-3 (2016). “All-printed non-ITO Transparent Electrodes on Ultra-thin Glass for OLED Lighting”
- T. Furukawa, International Workshop on Flexible & Printable Electronics (IWFPE2016) (2016). [Invited] “Flexible Substrates and Printed Transparent Electrode for OLED Lighting”
- T. Furukawa, N. Kawamura, H. Nakada, M. Koden, The International Conference on Flexible and Printed Electronics (ICFPE 2016), O15-6 (2016). ”Novel ITO fabrication processes on ultra-thin glass”
- M. Koden, 15th International Symposium on the Science and Technology of Lighting (LS15) (2016). [Invited] "Substrates and non-ITO electrodes for flexible OLED Lightings"
- T. Furukawa, 2016 International Conference on Electronics Packaging (ICEP2016) (2016). [Invited] "Printing Technology for Electronics“
- M. Koden, The 10th Taiwan Solid State Lighting (2016 tSSL) Symposium, B-4 (2016). [Invited] "Flexible OLED Lighting"

Exhibition

- “Printable electronics 2017” (Feb. 2017).
- “G7 Exhibition” (May. 2016).
- “Printable electronics 2016” (Jan. 2016).
- “International Photonics Exhibition 2015” (Korea)（Oct. 2015).
- “National Museum of Nature and Science (Japan)” (May 2015).
- “Printable electronics 2015” (Jan. 2015).

“Printable electronics 2017” (Feb. 2017)

“Printable electronics 2016” (Jan. 2016)



“International Photonics Exhibition 2015” (Korea)（Oct. 2015)

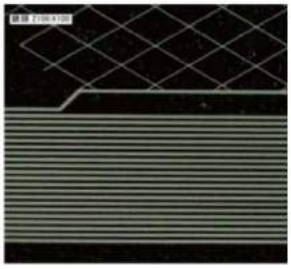
PEPIO F6
Gravure Offset Printer

Super fine line beyond screen printing

Specifications

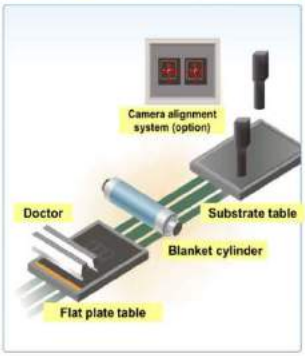
Substrate	Material	Plastic Film, Glass
	Size	Max.160×160mm
	Thickness	0.05～2.0mm
Printing area		Max.150×150mm

Fine line printing



Fine line PRINTING
- L/S=30/30μm
- Metal mesh width: 5μm

Mechanism



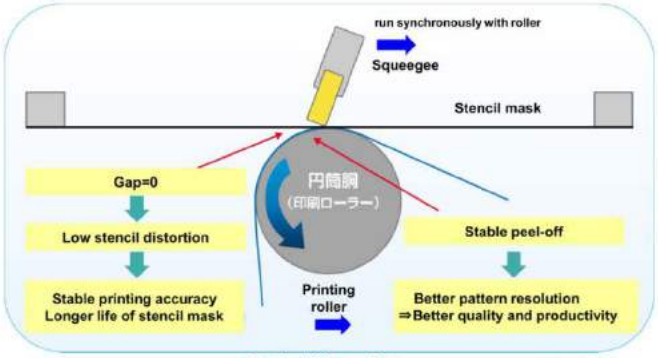
RYURONE 30SZ
Gapless Roll-to-roll Screen Printer

"Gap=0" makes new screen printing world

Specifications

Substrate	Material	Plastic Film Gleen sheet Ultra thin glass
	Maximum width	300mm
	Thickness	25～100μm
Printing area		Max.280×280mm

Mechanism



KOMORI Group
SERIA
SERIA CORPORATION

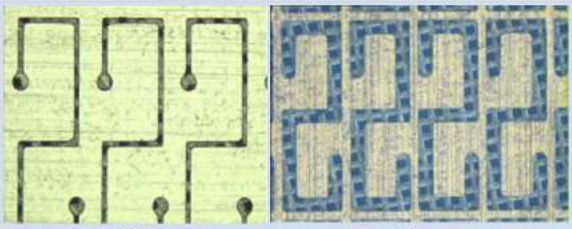
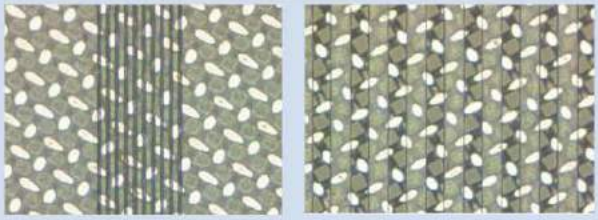
Contact information:
Eiji Iida
Overseas sales dept. (Tokyo Japan)
E-mail: iida@seria.co.jp
Phone: +81-3-3800-1050

TOKYO PROCESS SERVICE CO., LTD.

Global Technology TOPRO

Tokyo Process Service manufactures and sells various masks and their related products. Screen masks and photomasks are our main products. Our major customers include 400 electronic component manufacturers worldwide.

Introduction of an example of a new product

	Screen Mask Next Generation	Usual
Picture	 Line width 10μm　Line width 30μm MESH:Macro-sieve 640 mesh　Thickness 8μm Image:Chip inductor image　Metal film thickness　10μm	 Line width 10μm(could not open)　Line width　30μm *exceeding the resolution limit MESH:SUS304　640 mesh　Thickness 21μm Image:Line resolution test pattern　Emulsion thickness　10μm
Main Material	Non-woven electroforming mesh(nickel) Electroforming stencil(nickel)	Woven mesh(sus304 ,sus316,polyester etc.) Emulsion(vinyl acetate, polyvinyl alcohol, acrylic resin etc.
Charact eristics	No swelling with solvent Less uneven High density mesh pitch(60/inch～1500/inch)	Mesh pitch max:900/inch

https://www.topro.com　E-mail:info@topro.com

FUJIKURA KASEI CO.,LTD.

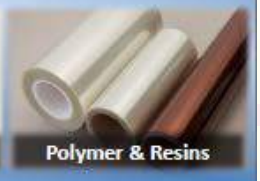
Business Areas


Coatings for Plastics


Architectural Coatings


Electronics Materials


Medical Materials


Polymer & Resins

Company Profile

- Establishment : Sep. 22 1938
- Capital : 5,352 million JPY
- Employees : 394
- Sales(in Y2016) :
  (Non-consolidated) : 18,625 million JPY
  (Consolidated) : 73,741 million JPY

DOTITE Electrically Conductive Paste

In 1957, the first manufacturer in Japan to develop and sell electrically conductive pastes.

Key Technology

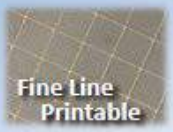

Formable


Stretchable


EMI Shielding


Low Resistivity


Flexible


Fine Line Printable

Contact Window
s-tajitu@fkkasei.co.jp
d-dewey@fkkasei.co.jp
http://www.fkkasei.co.jp/

"TAKEDA PRINTING" overview

Name	TAKEDA PRINTING Co.,Ltd. (URL : http://www.takeda-prn.co.jp)
Head office	1-11-10 Shirakane,Showa-ku,Nagoya JAPAN
Establishment	16 Nov. 1946
Business contents	1.Printing business 2.Electronics business 3.Expand printing business
Capital	JPY 1,937,920,000 (as of Mar. 2019)
Employees	Consolidated 1,093 (as of Mar. 2019)

Business contents

1.Printing business

In the principal printing business, it supports not only general commercial printing but also special printing and newspaper printing.

2.Electronics business

Manufacturing photo masks, screen masks and stencil masks. We are building an integrated production system from designing to manufacturing of masks.

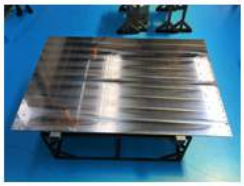
3.Expand printing business

Expanding from printing business, we develop internet sale business and logistics business adjusted to market needs.

RAM
KEIHIN RAMTECH CO.,LTD.

Introduction of Keihin Ramtech

We are started development of several sputtering cathodes and components since 2004.



Started sales of low damage RAM cathodes → 2017

Started development of low damage cathodes → 2013

2012

2011

2008

2007

2004

We were born in 1972

FSW was installed in 2003

July 1972
Keihin Ramtech Co. Ltd was founded

March 2003
Opened Ibaraki Office, 2 Portal MC5 Surface Processors and 1FSW No.1 were introduced

October 2004
Addition of Ibaraki Second Plant and introduction of FSW No. 2

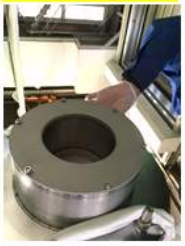
March 2007
Introduction of 1 Portal MC

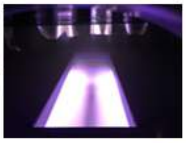
July 2008
Introduction of 1 MC to Ibaraki Office

May 2011
Introduction of 2 MCs to Ibaraki Office, 1 MC to Yokohama Office

Quality management international standard ISO9001 certification acquisition

Low Damage Cathodes



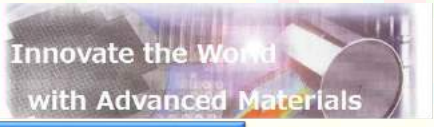


Keihin RAM Tech Co.,Ltd. Telephone : +81-45-473-2481
Mail address : h-iwata@ramtech.jp JAPAN

Revolutionary Adventuring Manufactures

www.ramtech.jp

新日鉄住金マテリアルズ株式会社
NSMAT



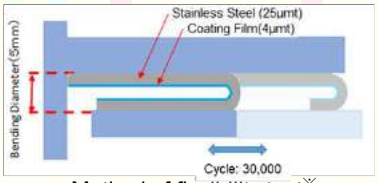
Stainless Steel Foil for Flexible Electronics

NIPPON STEEL & SUMIKIN MATERIALS has developed planarized and electrical insulated stainless steel foil for flexible electronics devices.

TYPICAL SPECIFICATIONS

- Manufacturing Process: Roll to Roll
- Stainless Steel Foil Thickness :20~50μm
- Coating Film Thickness :2~10μm
- Width: Max. 400mm

Schematic of cross section



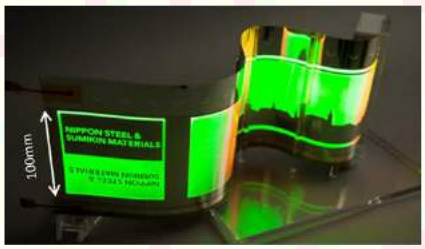
Method of flexibility test※

FEATURES

- Low Surface Roughness（Ra<1nm)
- Electrical Insulation
- High Flexibility (r>2.5mmφ)

Results of flexibility test

Properties	Flexibility test		
	Befor	After	Comment
Roughness Ra nm	0.6	0.6	No Change
Leakage current A/cm^2 at 100V	$\leqq 1^{-10}$	$\leqq 1^{-10}$	No Change
Observation of surface by SEM	No Crack	No Crack	No Change



OLED lighting fabricated by Fraunhofer FEP

CONTACT

NIPPON STEEL & SUMIKIN MATERIALS CO., LTD.
Jun Nakatsuka
16-3,GINZA 7-CHOME,CHUOKU,TOKYO 104-0061 JAPAN
E-mail nakatsuka.7zs.jun@nsmat.nssmc.com
URL https://nsmat.nssmc.com/english/

※ U-shape sliding plate test was carried out as a part of the activity of "Yamagata University Flexible Organic Electronics Practical Key Technology Consortium (YU-FOC)".

NIPPON STEEL & SUMIKIN MATERIALS CO., LTD.

Nippon Electric Glass Co.,Ltd

GLASS FOR FUTURE
Nippon Electric Glass

G-Leaf™

- **G**lass/**G**reen
- **L** ightweight
- **e** cological/**e**ndurable
- **a** dvanced
- **f** lexible

Rolled-up form is available

<Contact Information>

Nippon Electric Glass Co.,Ltd
Display Glass Division, Sales
Tel:+81-6-6399-2711

MDI MITSUBOSHI DIAMOND INDUSTRIAL CO.,LTD.

Ultimate high quality cutting for ultra thin glass

Successful solution for implementing ultra thin glass.
Cutting-edge mechanical glass scriber/novel solution for minimum radius and less chipping.

Examples of processing

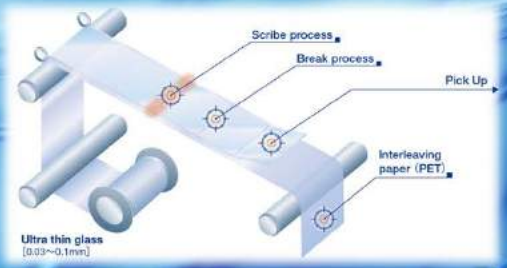
Maximal bending is possible using resin laminated glass. *Resin cutting with MDI laser processing machine.

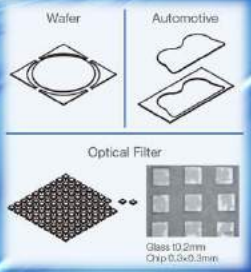
Roll to sheet cutting

Free shape cutting

Feature

- Clean cutting
- Narrower (Pitch vs. thickness)
- High strength
- Higher verticality





Application

Flexible lighting, flexible display, flexible touch sensor panel, flexible PV cell, semiconductor barrier glass & interposer, small glass window, and others.

Contacts

Mitsuboshi Diamond Industrial Co., Ltd. 32-12 Koroen Settsu, Osaka 566-0034, Japan TEL +81-72-648-5211
https://www.mitsuboshidiamond.com/en/
MDI Advanced Processing GmbH Obere Austrasse 6, 55120 Mainz, Germany TEL:+49(0)6131-7321-0
http://www.mdi-ap.de/