SEKISUI

Development of Additive Technology for Advanced Packaging

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SHIFT 2019 -Fusion-

SEKISUI CHEMICAL GROUP

A Diverse Chemical Conglomerate

Housing

Renovation for SEKISUI HEIM Owners

Real Estate

Residential Services

Housing Company
484.9billion yen

Others
2.7 billion yen
(elimination etc. -19.7 billion yen)

Electronics

High Performance Plastics Company
357.5billion yen

Automobiles and Transportation

Piping and Infrastructure

Building and Living Environment

Urban Infrastructure & Environmental Products Company
240.3billion yen

Advanced Materials

Life Sciences

Building and Infrastructure

With a Broad Materials Expertise

SEKISUI

Materials

PVB Polyvinyl Butyral

PVA Polyvinyl Alcohol

Acrylic Resin

Epoxy Resin

Processing

Micro-sphere

Nano Membrane

Nano Hybrid

Foam

Precision Molding

Analysis & Evaluation

Chemical Analysis

laboratory diagnosis

TPF

Adhesion Control

Physical Properties Innovation

Energy Control

Business Fields

- Electronics
- Automobiles & transportation
- Buildings & Infrastructures
- Life Sciences
- Industry

Agenda

- Why Inkjet Printing?
- Sekisui's Inkjet Technology
- Die-attach Adhesive Applications
- High Aspect Ratio Applications
- Inkjet Platform

Semiconductor Packaging Trends

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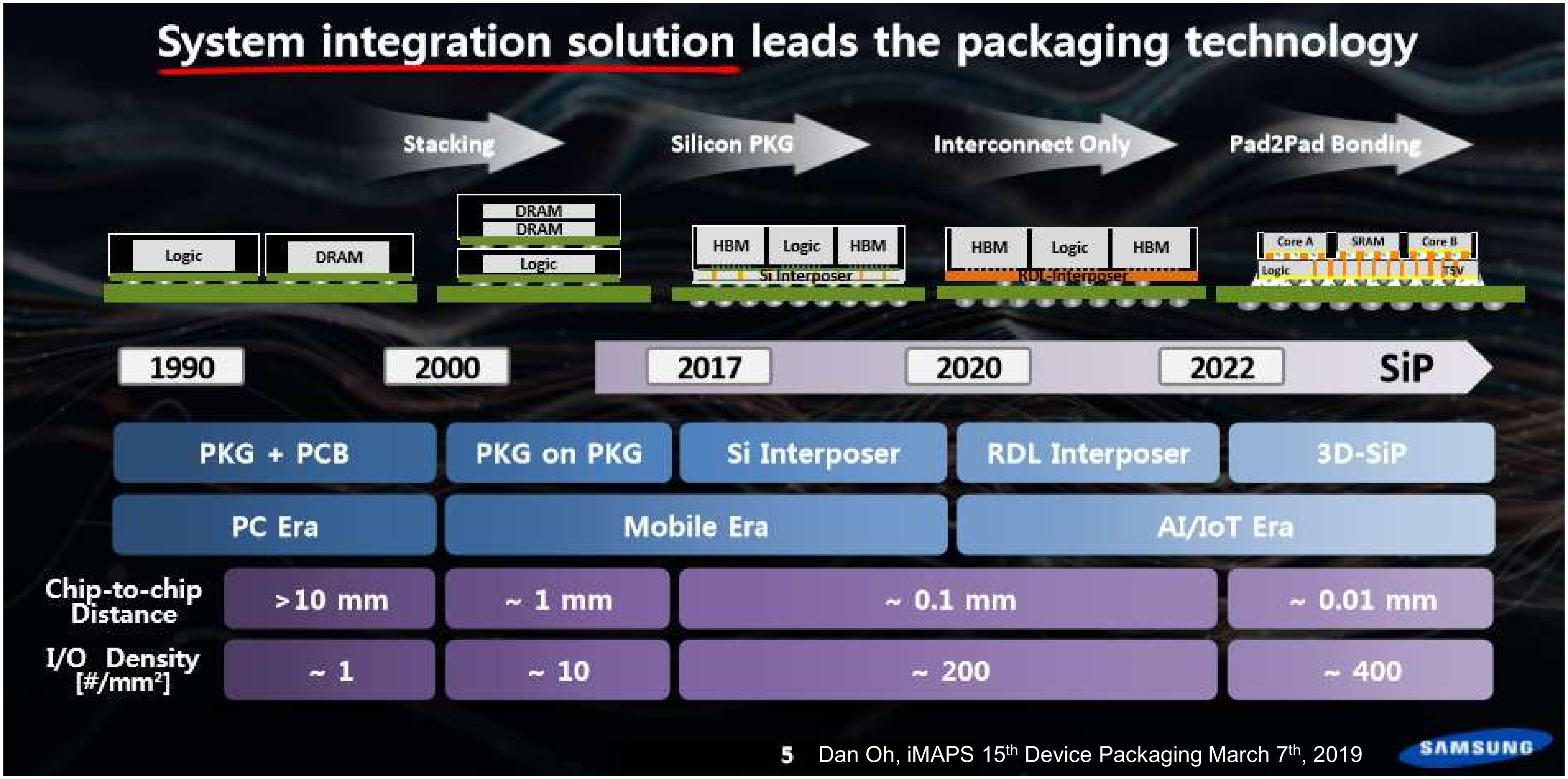


System integration solution leads the packaging technology

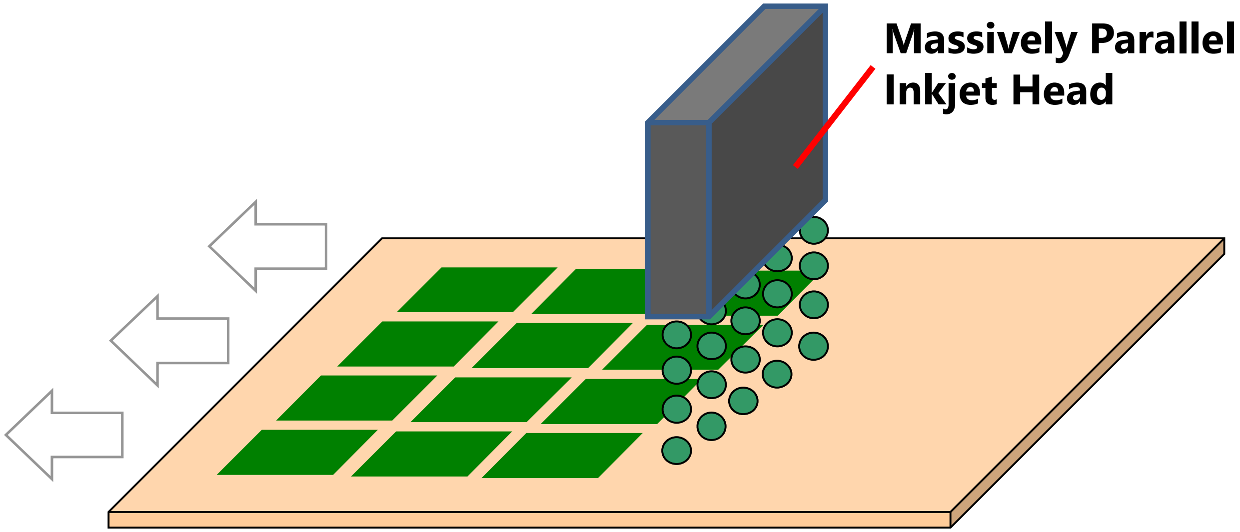
	PKG + PCB	PKG on PKG	Si Interposer	RDL Interposer	3D-SiP
	PC Era	Mobile Era		AI/IoT Era	
Chip-to-chip Distance	>10 mm	~ 1 mm	~ 0.1 mm		~ 0.01 mm
I/O Density [#/mm^2]	~ 1	~ 10	~ 200		~ 400

5 Dan Oh, iMAPS 15th Device Packaging March 7th, 2019

SAMSUNG

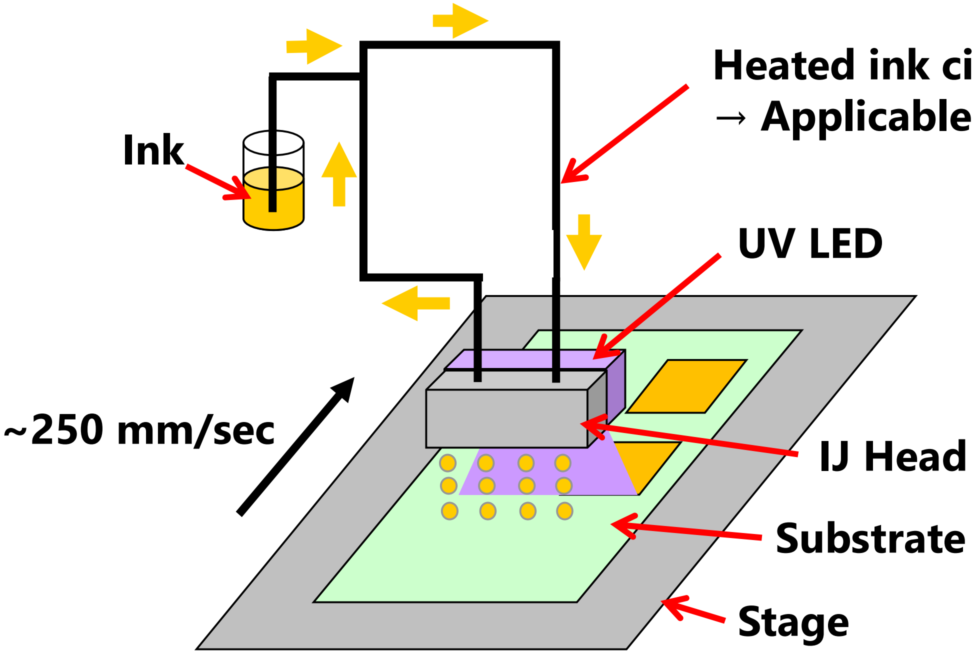
Trend : Smaller , Thinner , Denser ➡ **Requires miniaturization technology**

Why is Inkjet technology so appealing?

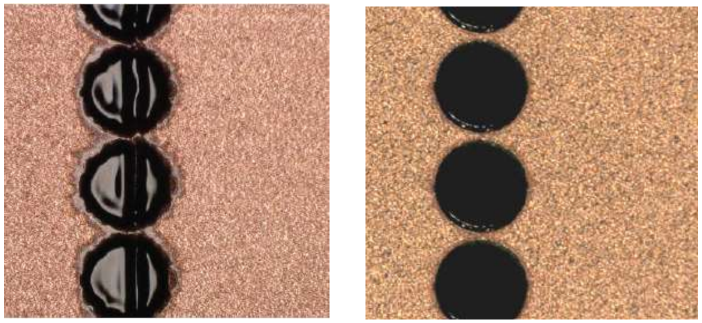


- ➢ **Process flexibility: Arbitrary placement, thickness, and shapes possible**
- ➢ **Non-contact deposition: Applicable to uneven surfaces**
- ➢ **On-demand: No need to fabricate screens/stencils**
- ➢ **Reduction in materials consumption: Chemicals and supporting processes**

SEKISUI technology: Rheological Control



Heated ink circulation system
→ Applicable for high viscosity material



Competitor (Low Viscosity)

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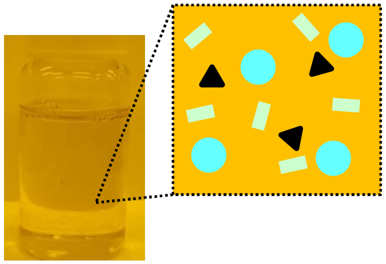
- **Development of inkjet fluids with unique rheology**
- **Application of initial-UV curing to control bleed and impart Z-axis build-up**

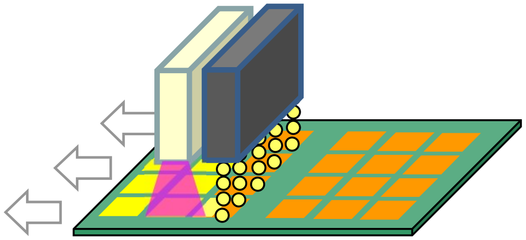
SEKISUI technology: Dual-cure Mechanism

A-stage → **B-stage (After UV-Cure)** → **C-stage (Heat-Cure)**

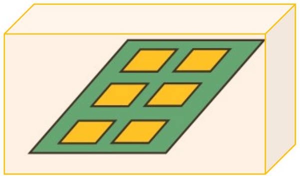


Material composition

- **UV-curable segments**
- **Heat-curable segments**



Immediate UV-curing
→ Fine printing

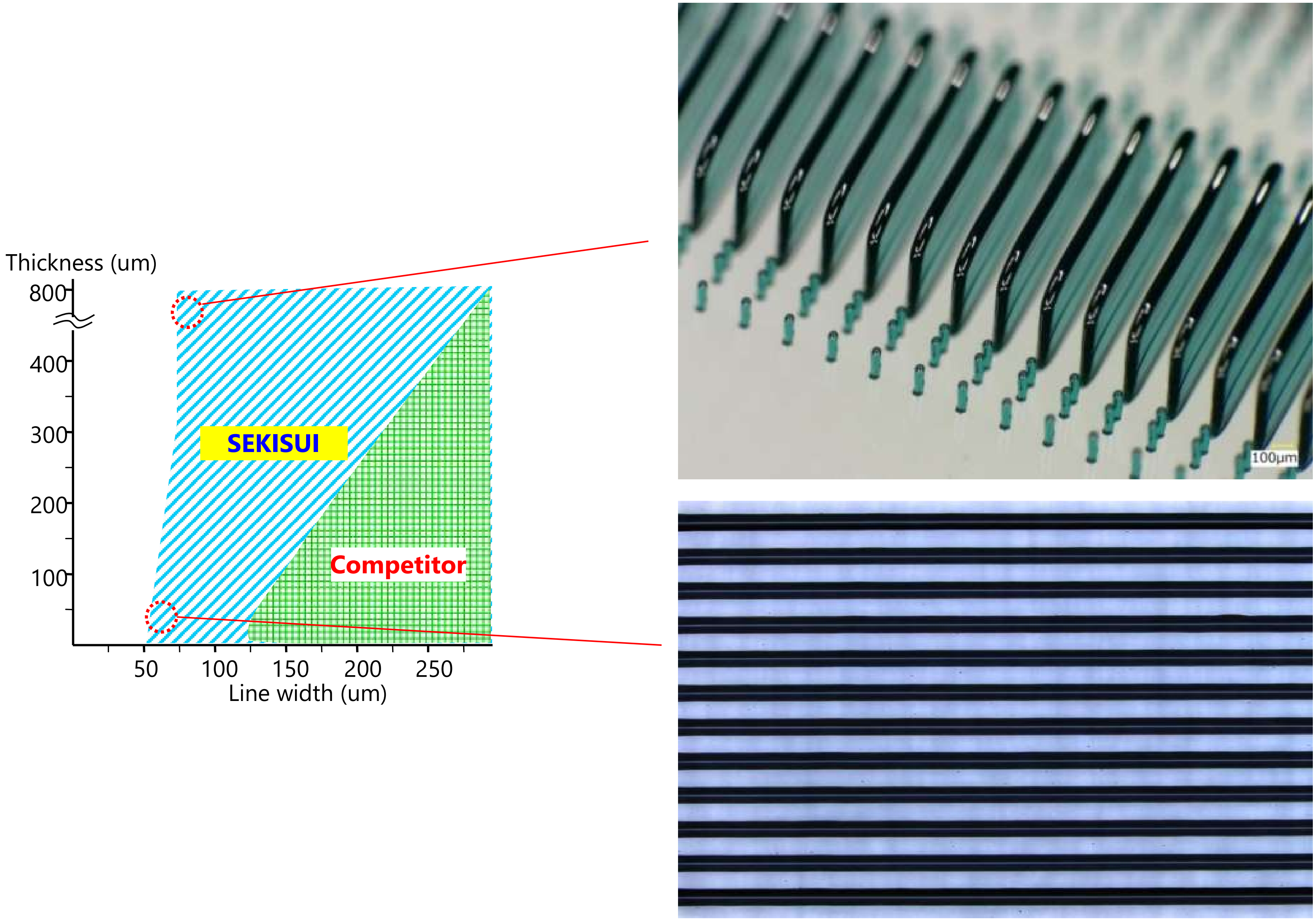


3D network formation
→ Good heat-resistance

- ➢ **Fluid Characteristics: Rheology, Initial UV-setting, and Final Heat Curing**
- ➢ **System Development: Inks, Jetting/Curing, and Processing Platform**

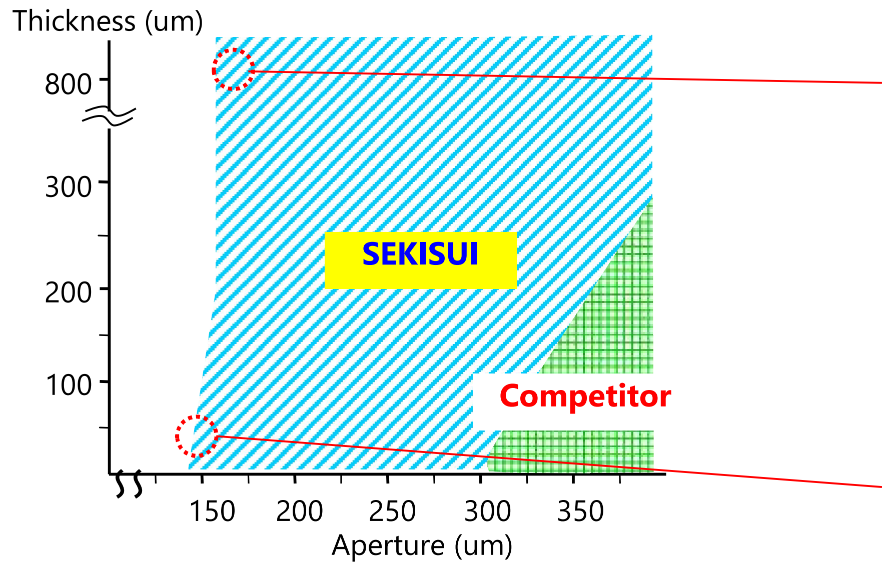
Inkjet Printing Video

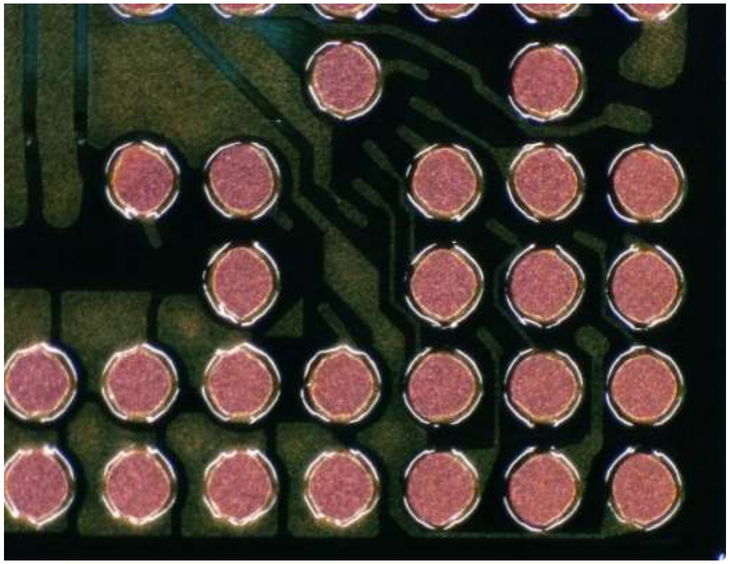
Excellent L/S Control with Unique Aspect Ratios



L/S=70/70µm

3-Dimensional Structures

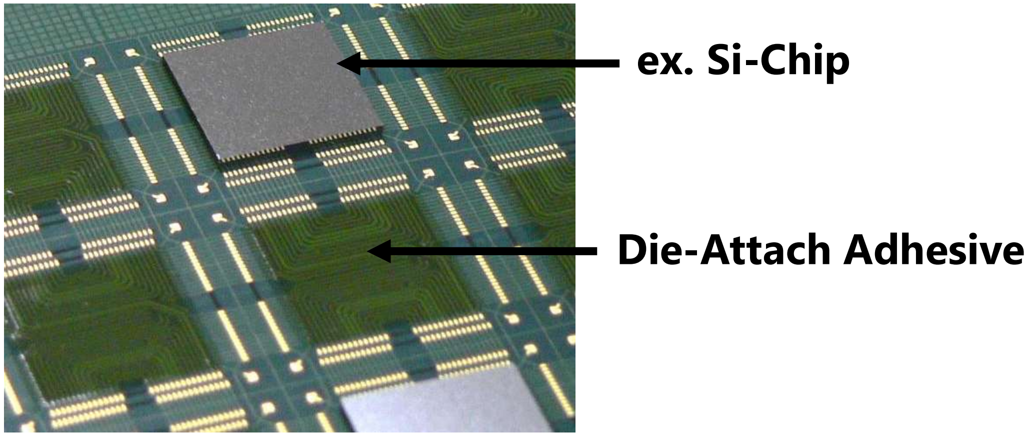




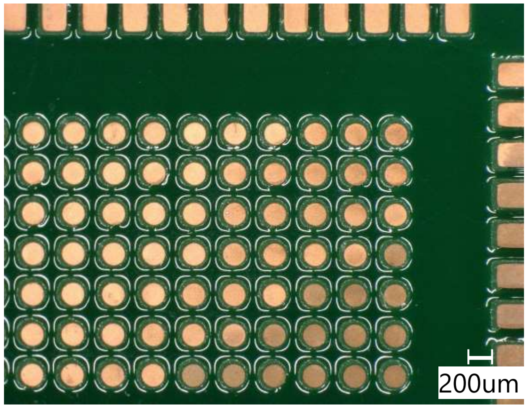
Solder Mask Opening=150um

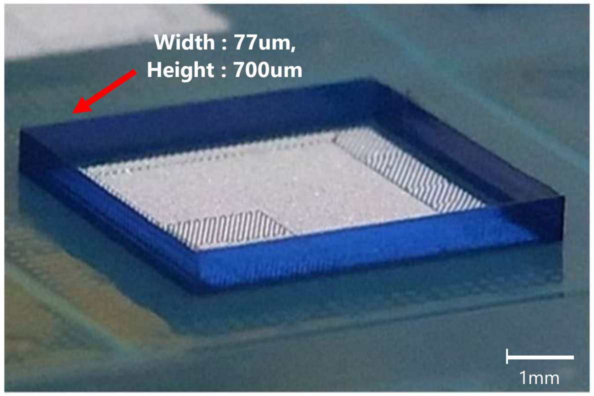
SEKISUI Inkjet Materials: 2 Types

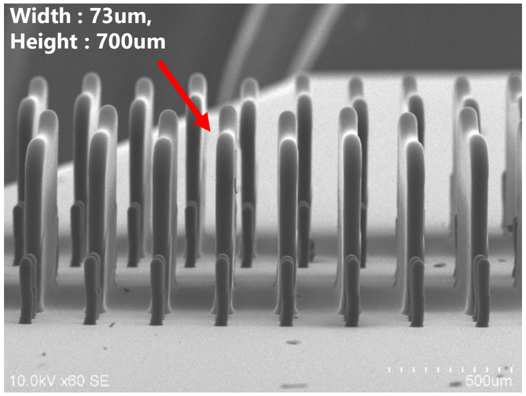
1. Die-Attach Adhesive for Semiconductor Packaging



2. High Aspect Material for PCB and LED







Die-Attached Applications

Inkjetable Die-Attach Adhesive

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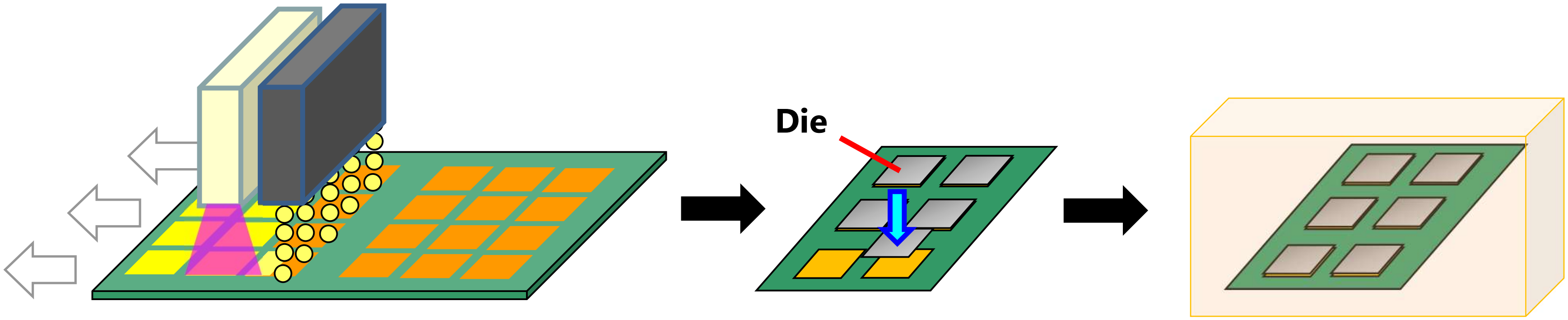
Concept

Combine Die-Attach Paste and Die-Attach Film Properties

1. IJ Printing **2. Die-Attach** **3.Heat Curing**



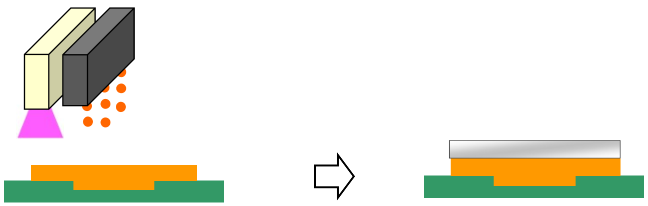
Printing Time (t=20um) : 25sec / strip

Attribute Fusion:

- **From DAF: Thickness Control, Flatness/Tilt Contoll, and Fillet Control**
- **From DAP: Ease of Use, Surface Unevenness, Void Filling**

Application on Patterned Substrates

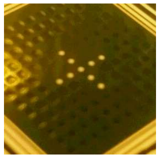
Substrate with uneven surface



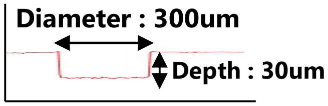
DA Printing

Die-Attach

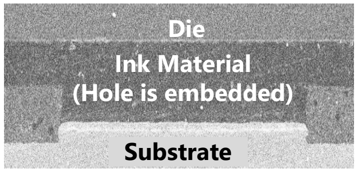
Ink thickness control



BGA substrate with holes

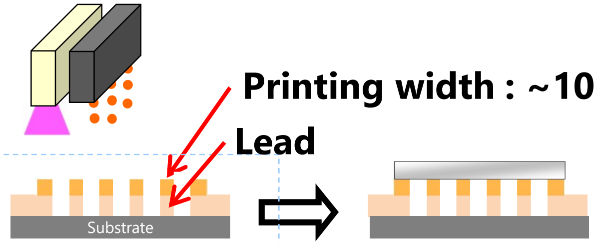


Sample X-Section



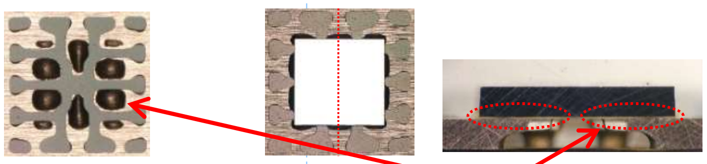
Void less

Lead frame (QFN) package



DA Printing

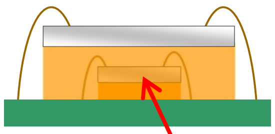
Die-Attach



DA

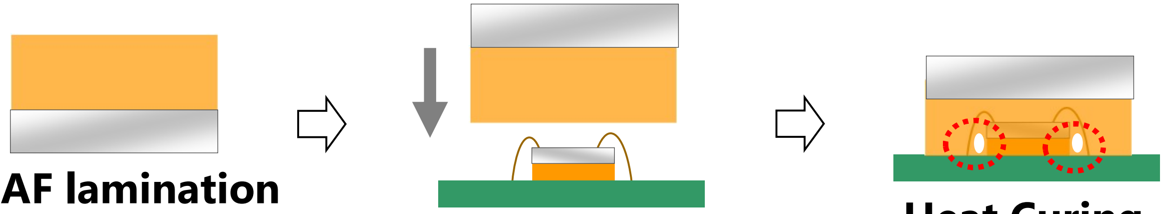
Patterning printing

Application in Wire-Type PKG

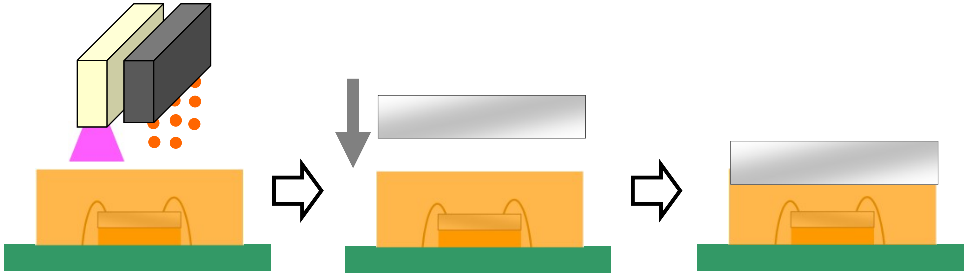


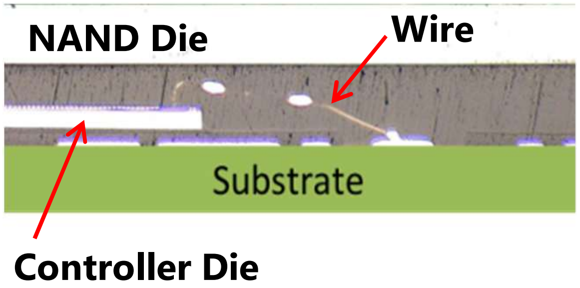
Trends
- Larger controller chip
- Decreased die thickness

Conventional Process (Film)

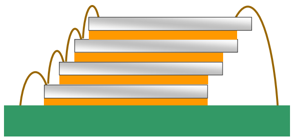


Inkjet Process





Application as a Stacked Die Support

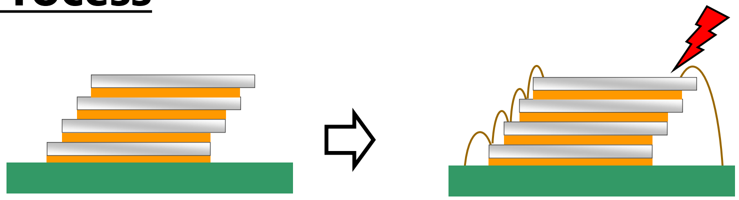


ex. NAND Flash Memory

Trends

- **Thinner Die**
- **Multiple Die**

Conventional Process

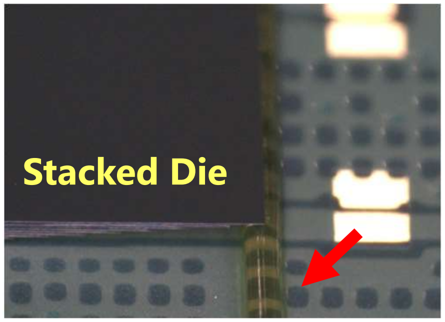


Crack around edge

Die Lamination ⇨ **Wire Bonding**

Inkjet Process

DA Printing ⇨ **Die Lamination** ⇨ **Wire Bonding**



Die-Attach Reliability Testing

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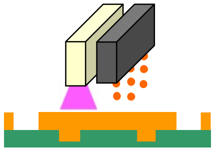
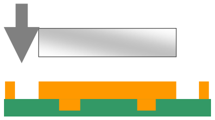
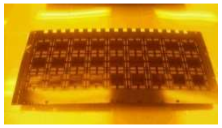
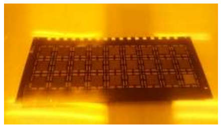
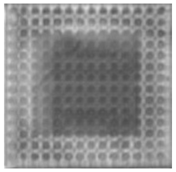
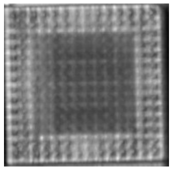
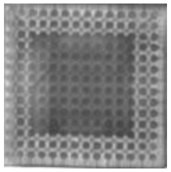
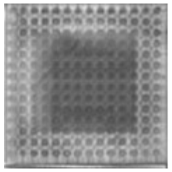
Sample Preparation

	Inkjet	Die bonding/curing	Molding	Package dicing
				
Equipment		 Shibaura FTD7000	 Towa YPS2060M	 Disco DFD6361
Sample				

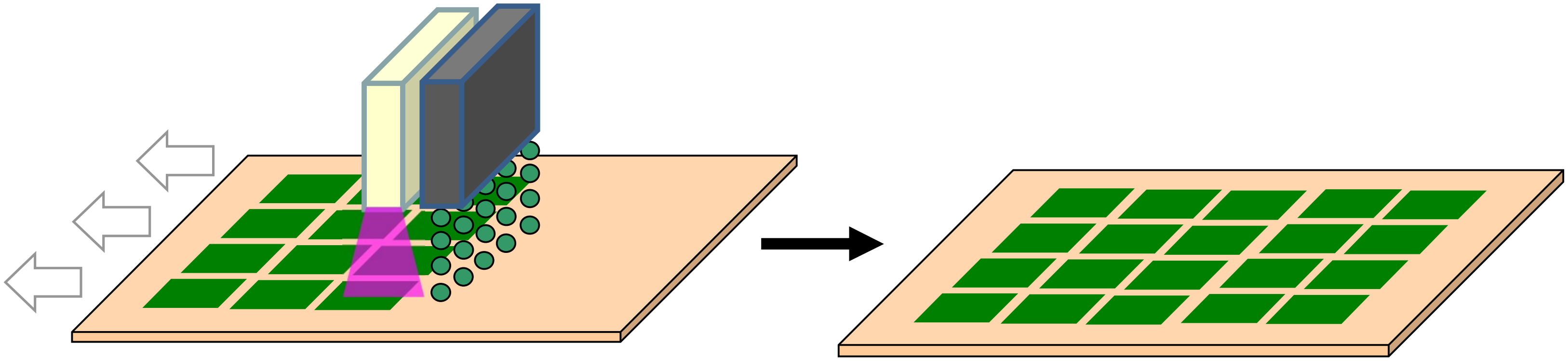
Die size: 9x9 mm
DA thickness: 30um

Reliability Tests

	MSL	HAST	TCT	THT
Conditions	85°C/85%RH/72h (Moisture) 265°C x 3 (Reflow)	130°C/85%RH/100h	-65～150°C/1000cycles	85°C/85%RH/1000h
Results (SAT)	 Void : 0 / 30p	 Void : 0 / 30p	 Void : 0 / 30p	 Void : 0 / 30p

High Aspect Ratio Applications

Solder Mask Processing via Inkjet Printing



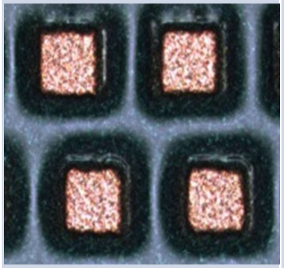
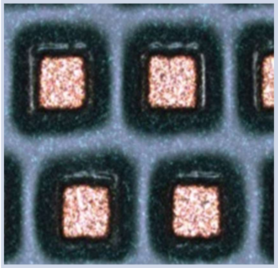
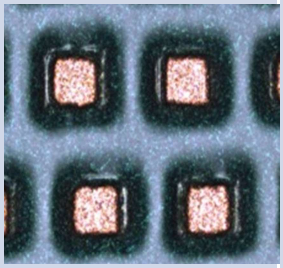
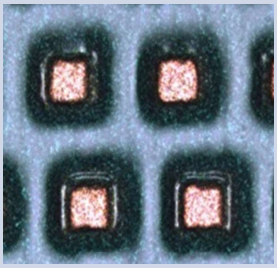
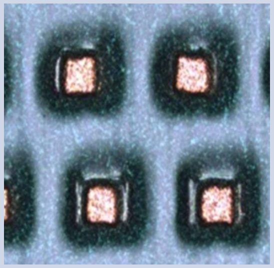
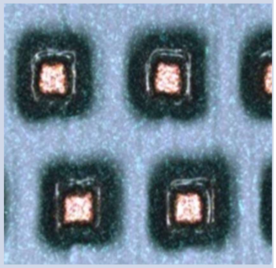
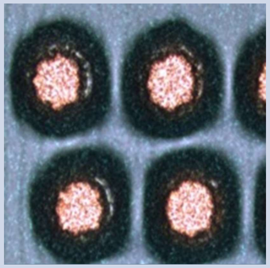
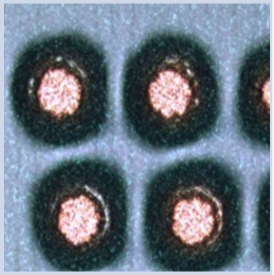
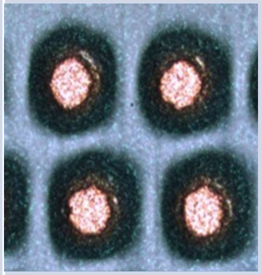
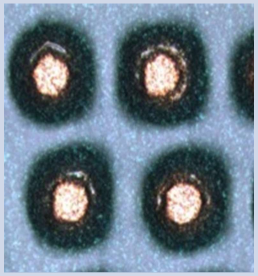
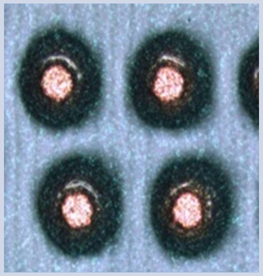
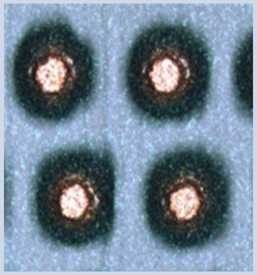
1. IJ printing＋UV Pre-curing

2. UV Post-Curing
3. Heat Curing

	1	2	3	4	5	6	7	8
Standard Process	Mixing [30min]	Screen Printing [0.1min]	Prebake [40min]	Exposure [1min]	Developing [0.5min]	Silk Printing [0.5min]	Exposure [1min]	Post Bake [60min]
Inkjet Process	IJ Printing <2 min			-	-	-	Exposure [1min]	Post Bake [60min]

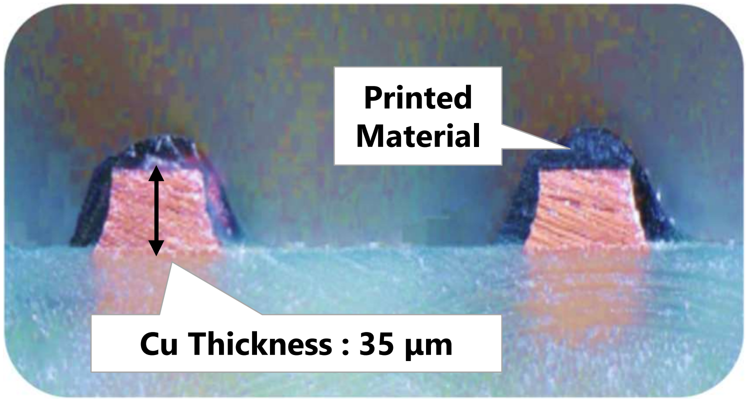
Inkjet Benefits:
- **Environmental: Reduced chemical and energy usage**
- **CAPEX: Reduction in equipment and floor space**
- **Process flexibility: Ability to process thick Cu layers**

High-precision Printing of Features

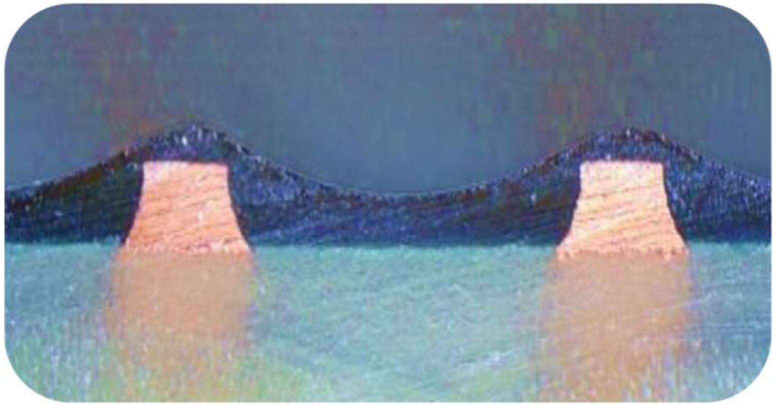
Target	200um	180um	160um	140um	120um	100um
Square						
	X:203um **Y:195um**	**X:193um** **Y:185um**	**X:173um** **Y:164um**	**X:145um** **Y:144um**	**X:125um** **Y:127um**	**X:105um** **Y:107um**
Circle						
	X:210um **Y:215um**	**X:183um** **Y:178um**	**X:166um** **Y:164um**	**X:145um** **Y:142um**	**X:125um** **Y:124um**	**X:105um** **Y:107um**

Variable Substrate Coverage Printing

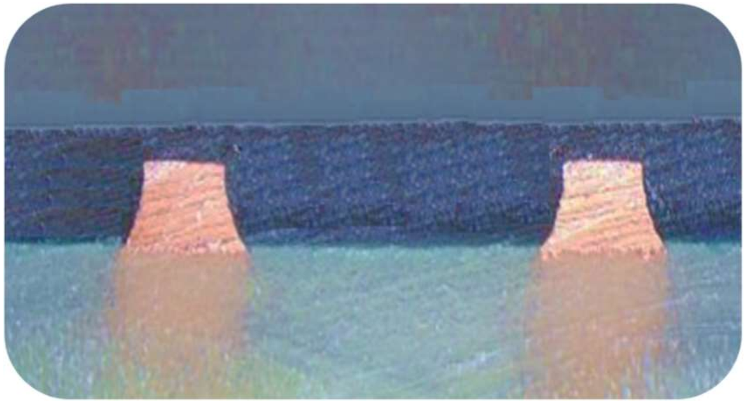
Conformal Coverage



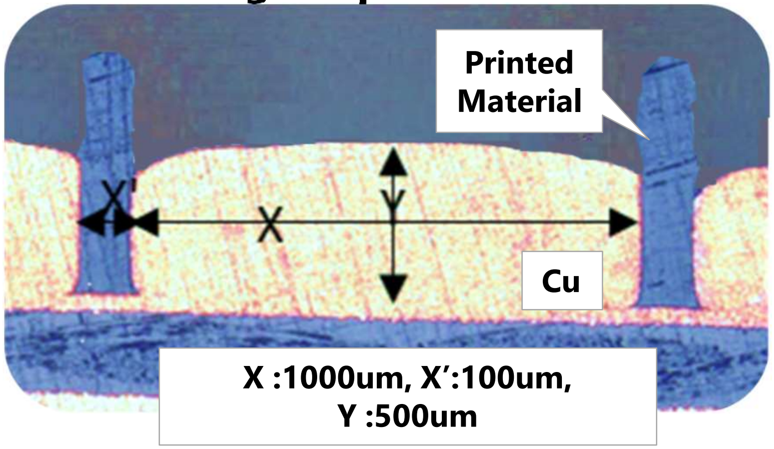
Adjusted to Substrate



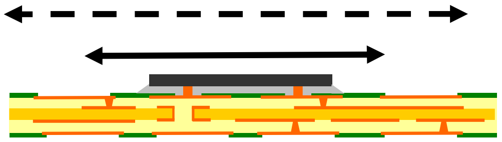
Flatness



High Aspect Ratio



Application as a DAM to Control Underfill

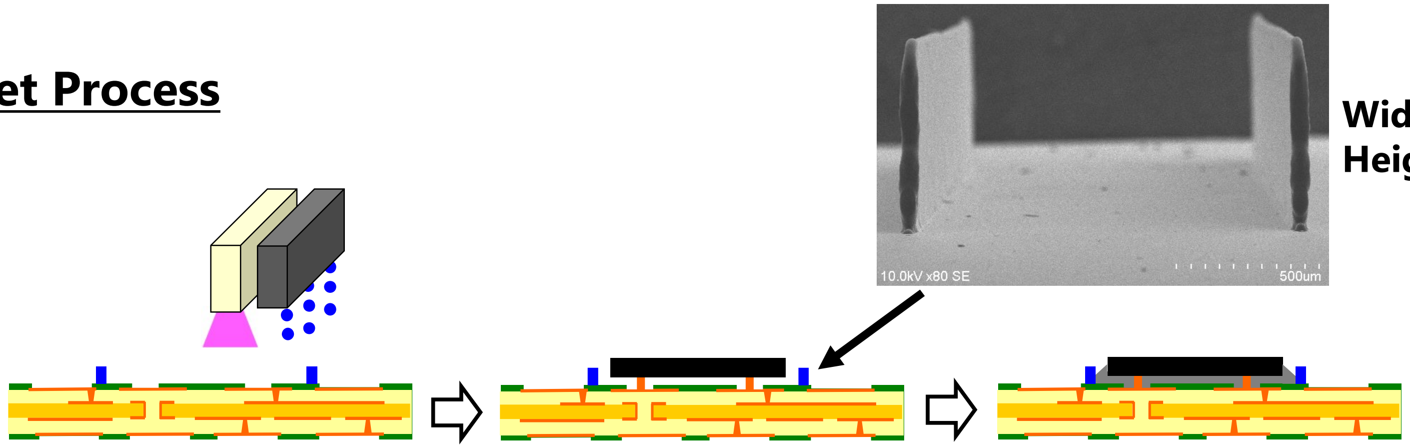


Miniaturization of mounting area

Conventional Process

Bumping **Underfill**

Inkjet Process

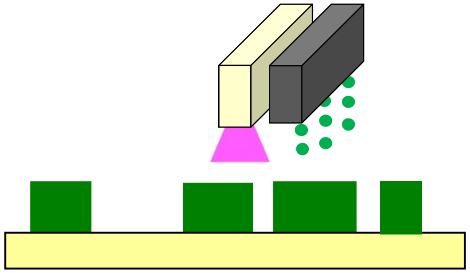


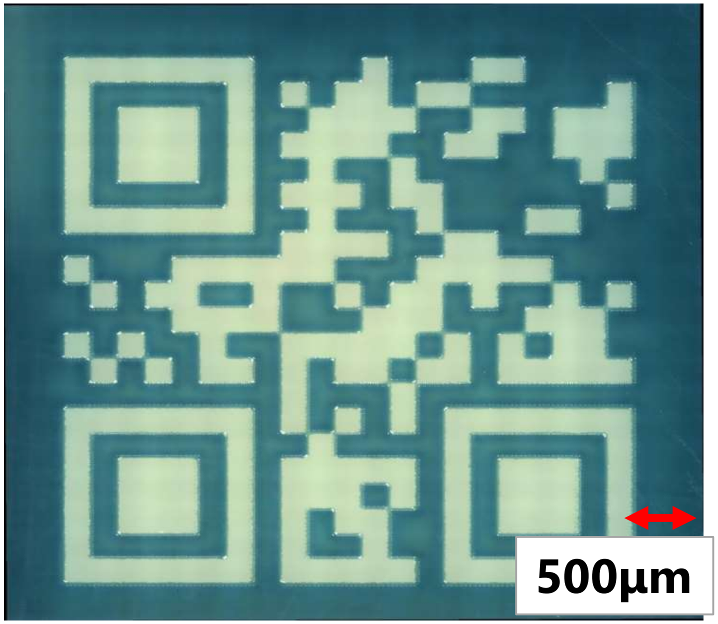
Width: 77um
Height: 700um

DAM Printing **Bumping** **Underfill**

Application for QR Codes

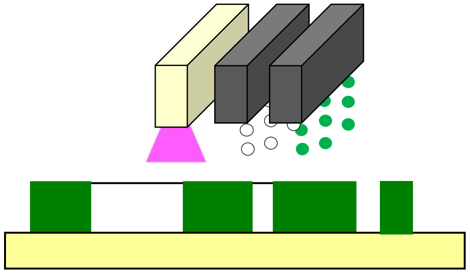
Single Color Printing

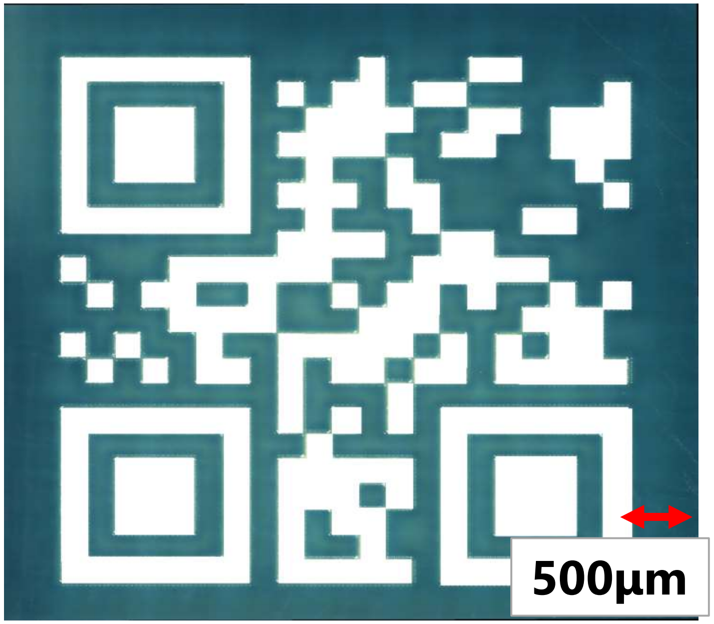




Two Color Printing

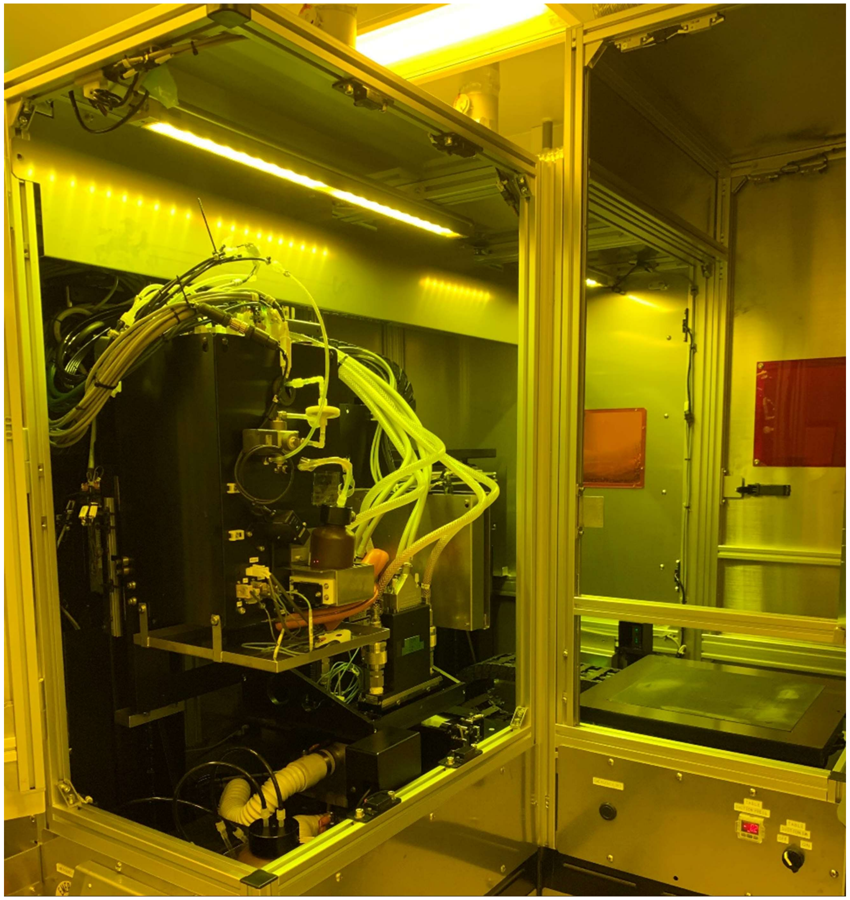
White(developing) and Green





Inkjet Platform

Inkjet Platform



Size = ~ 2 m by 2 m

Panel-Level Production Capability!

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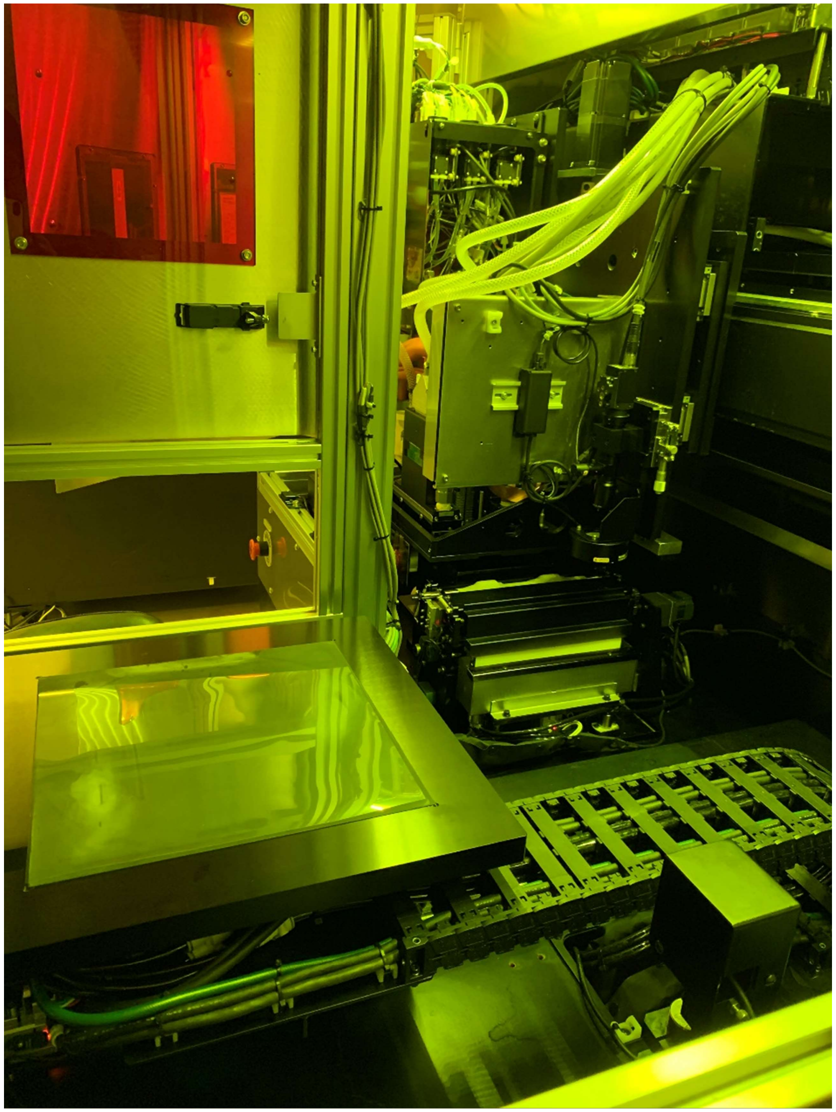

Board Size : 300*400mm

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– produce a better world with creative techonlogies.

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