

Introduction for **FOLP**® Technology

FOLP® (*Fan-Out Leaded Package*)/ *FOPLP*

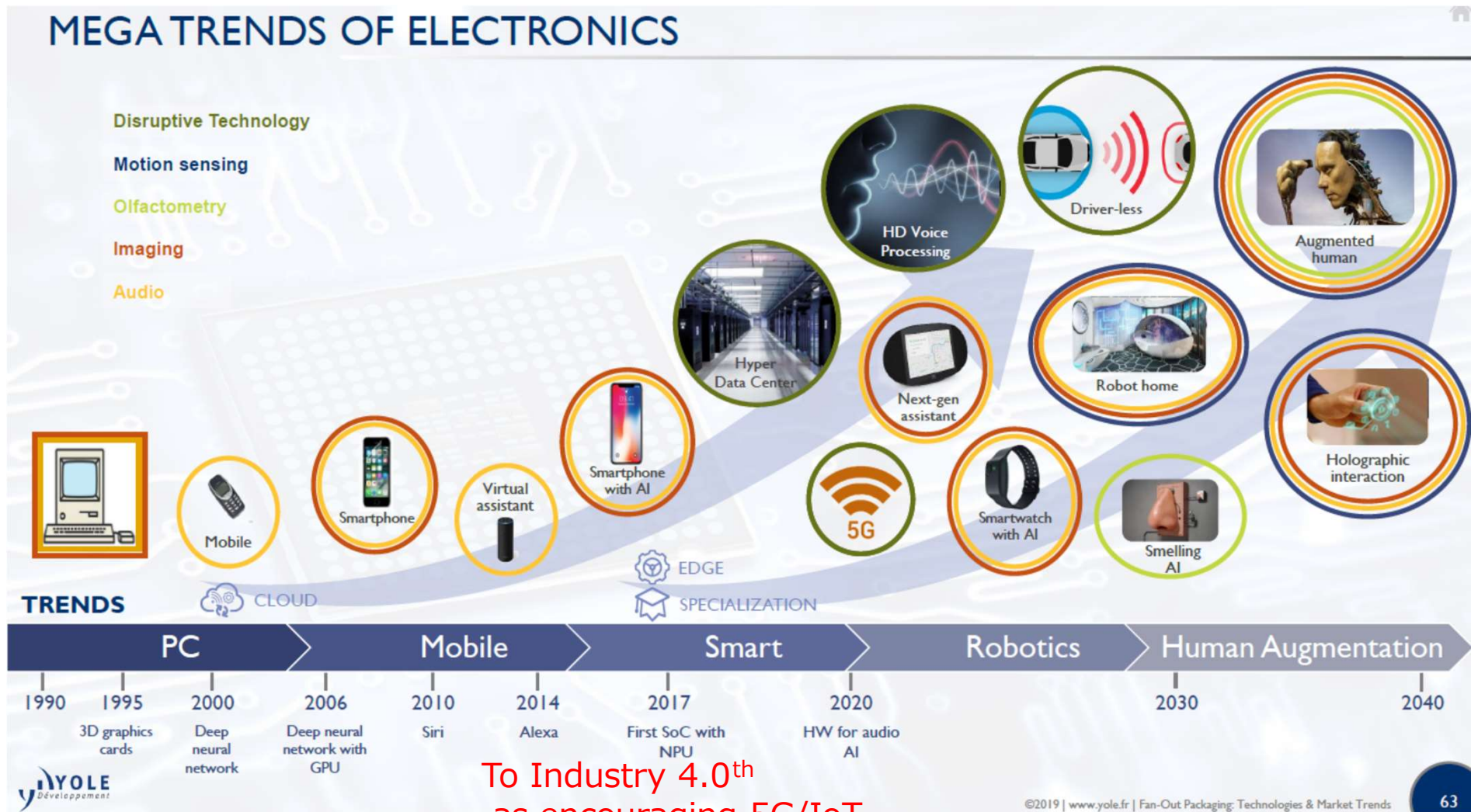


2020.Aug



Development background

Technical Packaging trend for Applications



To Industry 4.0th
as encouraging 5G/IoT

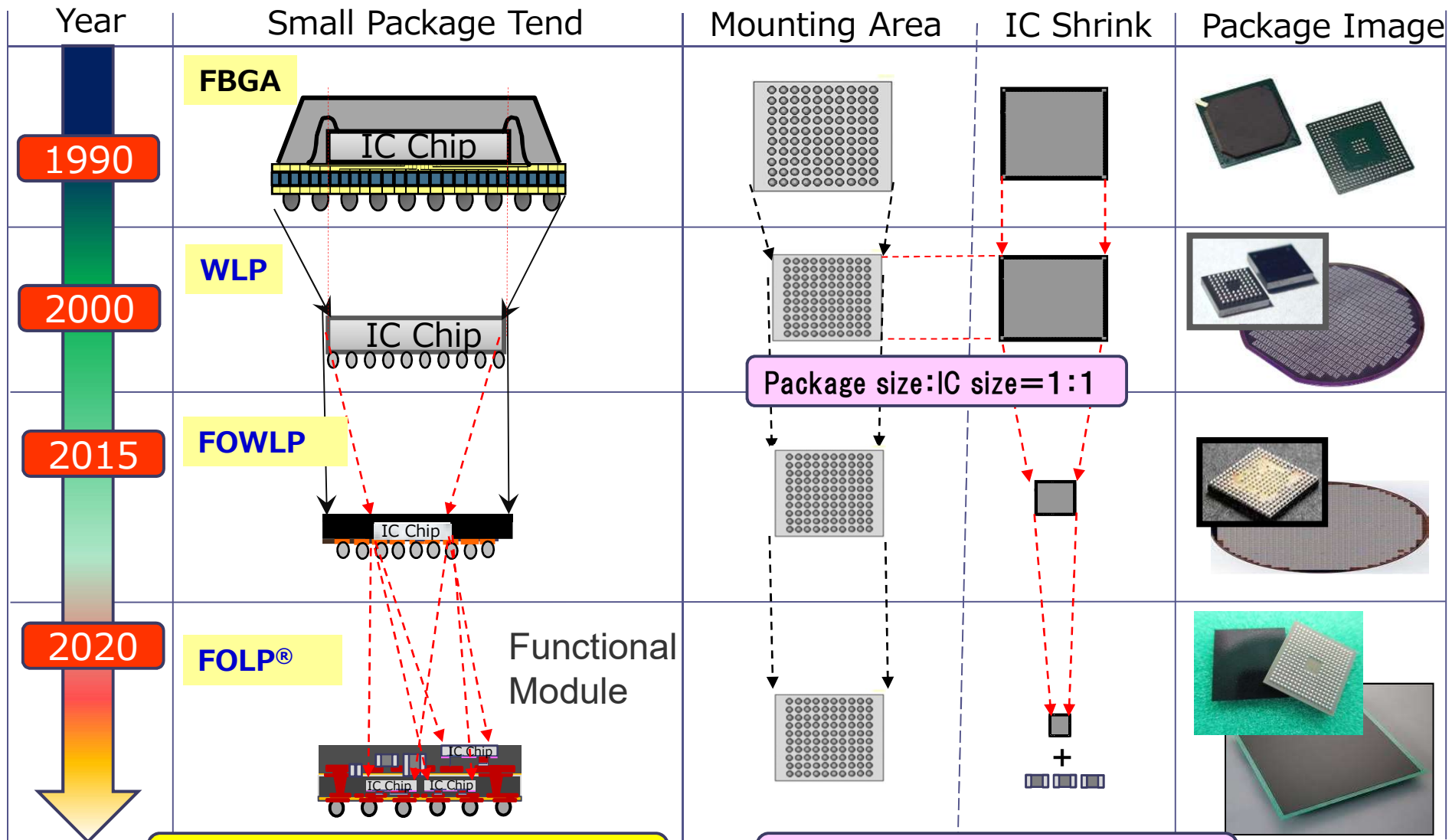
1990
CSP/BGA SiP
Technology

2000
WLP/FCBGA/POP
Technology

2010
FO-WLP/3D/TSV/Cu Pillar /
Si interposer Technology

2020~.
3D Integrated **FOPLP** Technology

BGA Package miniaturization trend for mobile·IoT/5G



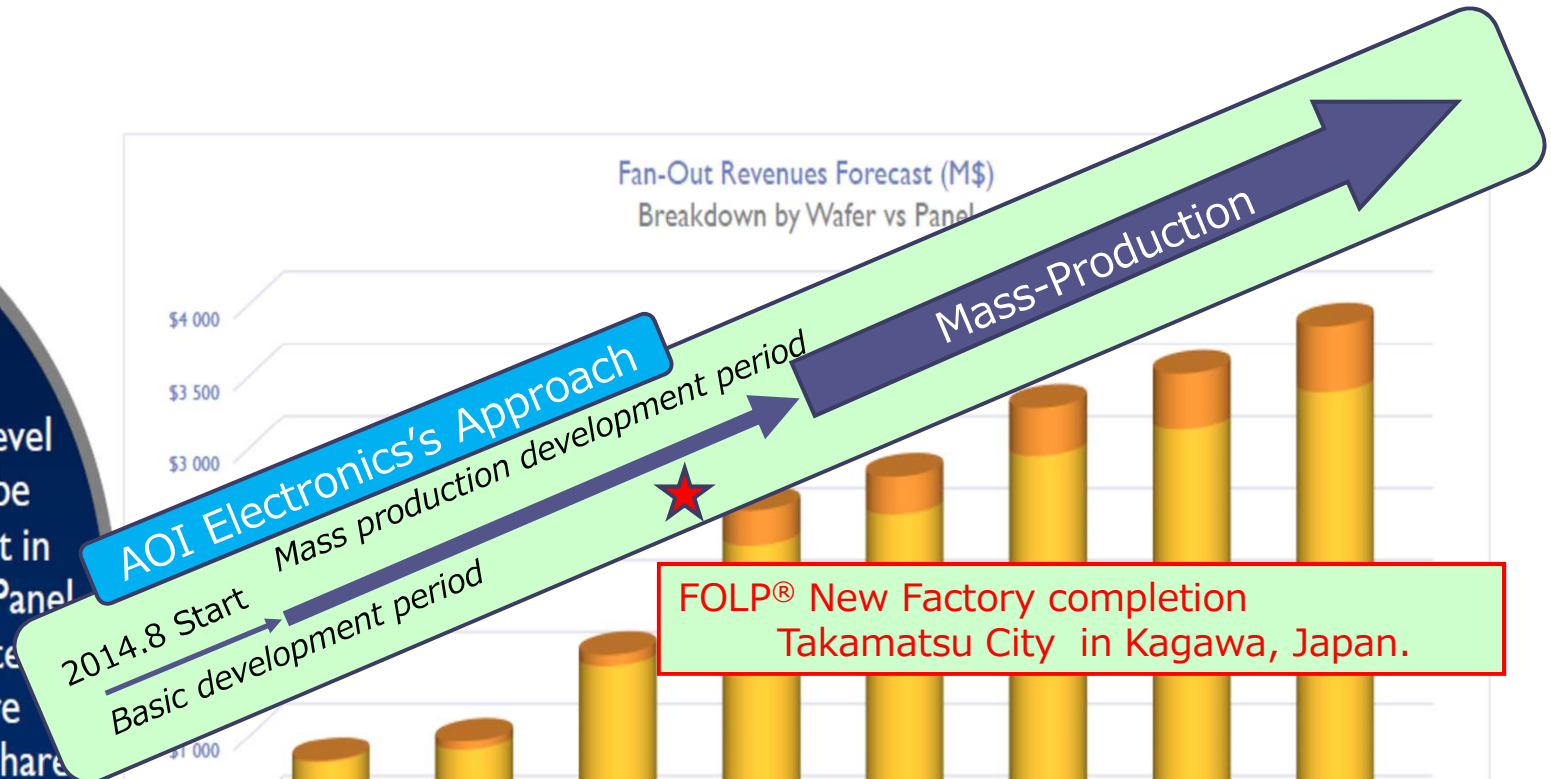
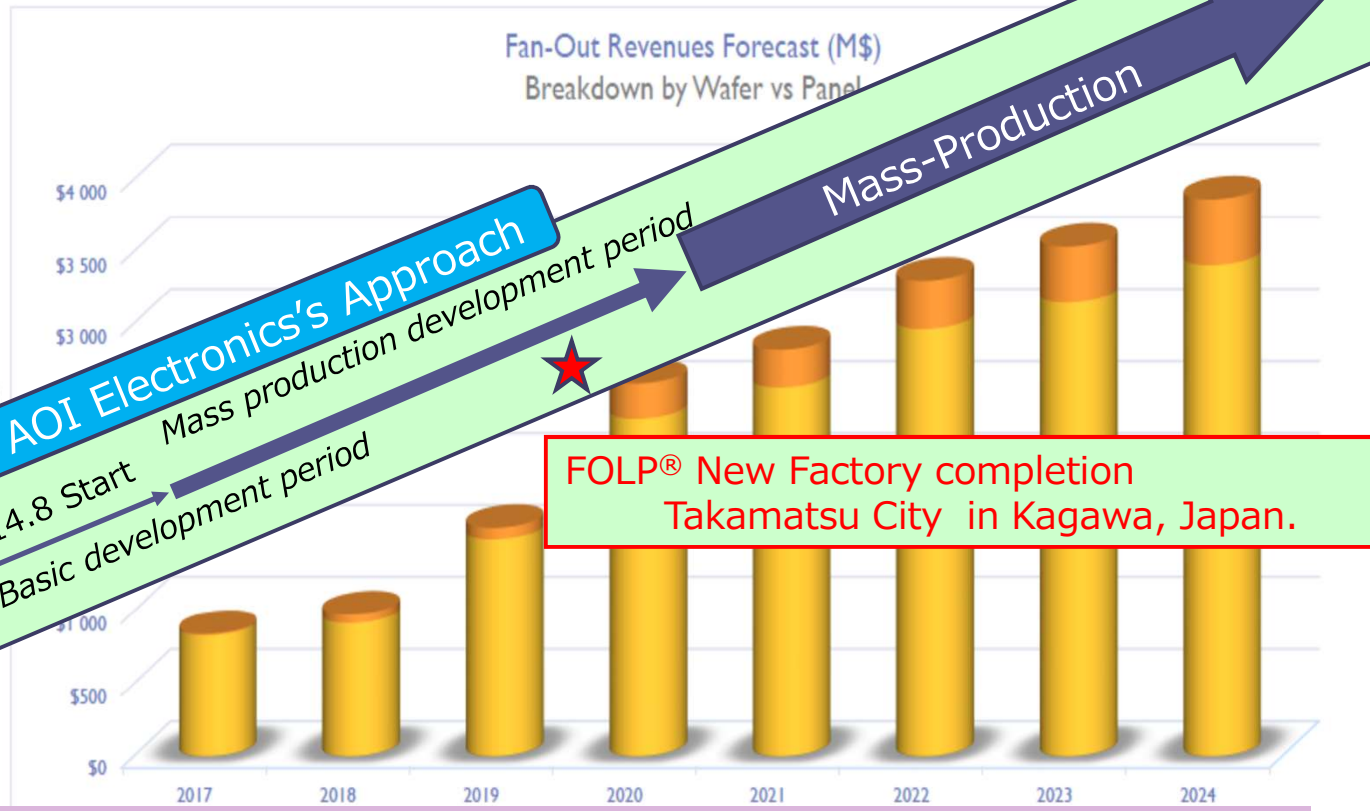
Package size:IC size=1:1

A technique to widen is necessary for a rule of the SMT wiring.

Progress of the miniaturization of the semiconductor is faster

FOLP® Development History

Wafer-Level will still be dominant in market. Panel is expected to gain more market share in 2020.

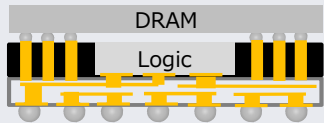
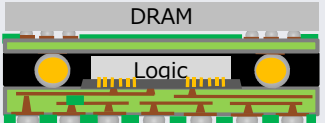


FOLP® New Factory completion Takamatsu City in Kagawa, Japan.

| History | |
|------------|--|
| Aug/2014 | Joint Development with 2 overseas OSAT. |
| Aug/2017 | FOLP® development switched from Wafer type to Panel type. |
| Jul/2019 | New Factory was built at Takamatsu city in Kagawa, Japan. |
| March/2021 | FOLP® is planning to start Mass-production in the spring of 2021 |



AOI Target's application and specification

| | Level 1 | Level 2 | Level 3 |
|--|--|---|---|
| Application | RF , PMIC. MEMS , Sensor | BB Combo , Single-Chip High-end | APE , SiP |
| L/S Rule Target | (L/S:20/20-15/15) | (L/S:10/10um) | (Under L/S:5/5um) |
| Cu Pillar Pitch | 80~200um | 40~80um | Less than 40um |
| Example of Current PKG (Smart Phone) | RF: Front End module RF: Power amp module RF: Wi-Fi BT GPS module RF: Antenna SW module RF:RF Transceiver PMIC Electric Compass Accelerometer Gyroscope NFC | Baseband Processor APP PMIC | POP   |
| Expect Specification of FOPLP | Size:2-6mm sq. 1chip:compass,P.M. 1Layer 2chip:Another 1-2Layer | Size:6-10mm sq. 1chip:P.M. , APP 1Layer 2chip:BB combo 1-2Layer | Size:10-20mm sq. APP&DRAM 2chip side by side SIP 2Layer |

1ST Target

Next Stage Target



FOLP[®] was born in the synergy
of AOI Electronics group.

AOI ELECTRONICS GROUP

Packaging Technology



■ AOI-ELECTRONICS TAKAMATSU PLANT

FOLP is made with the synergy of AOI group.

FOLP®

RF TEST Technology



■ HIGH COMPONENTS AOMORI

Fine Pitch RDL Technology



■ AOI-ELECTRONICS KANONJI PLANT

Wafer Level Package Technology



■ OUME-ELECTRONICS

Plating Technology for RDL

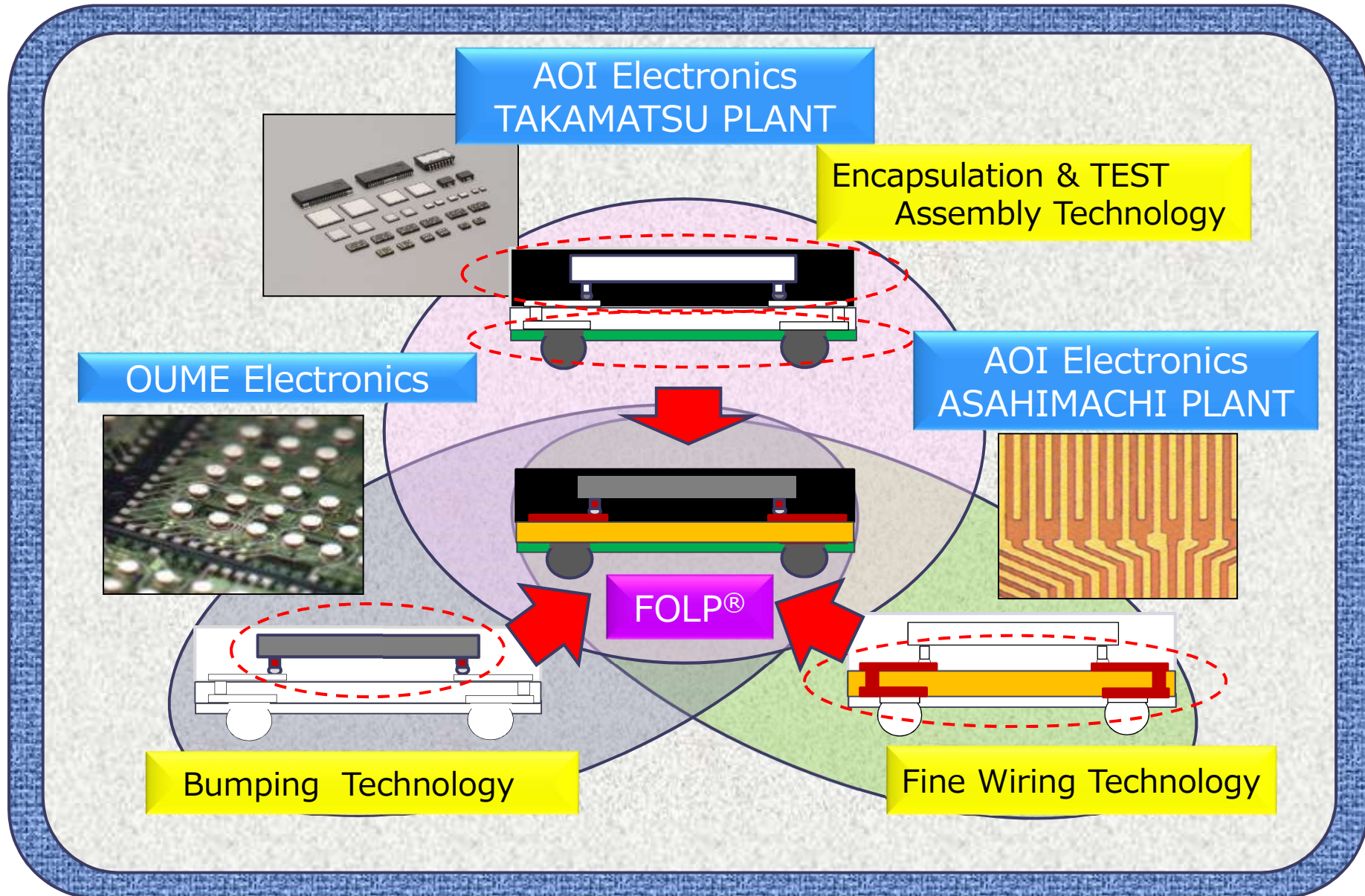


■ AOI-ELECTRONICS ASAHIMACHI PLANT
HAYAMA INDUSTRIES



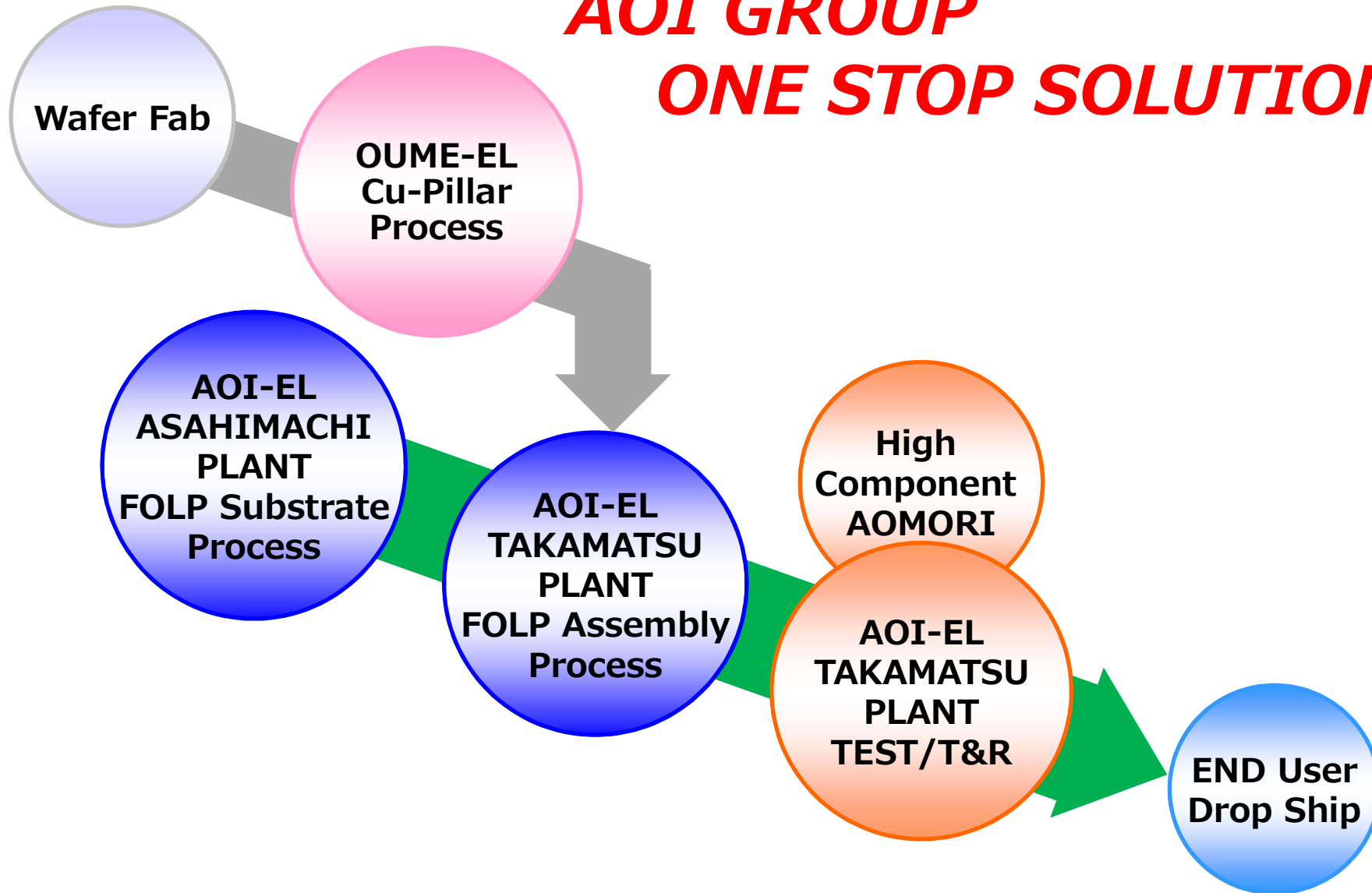
■ AOI-ELECTRONICS
TOKYO Sales Office

AOI Group Package Technology



FOLP® Business Flow Between AOI Group Company

AOI GROUP ONE STOP SOLUTION!



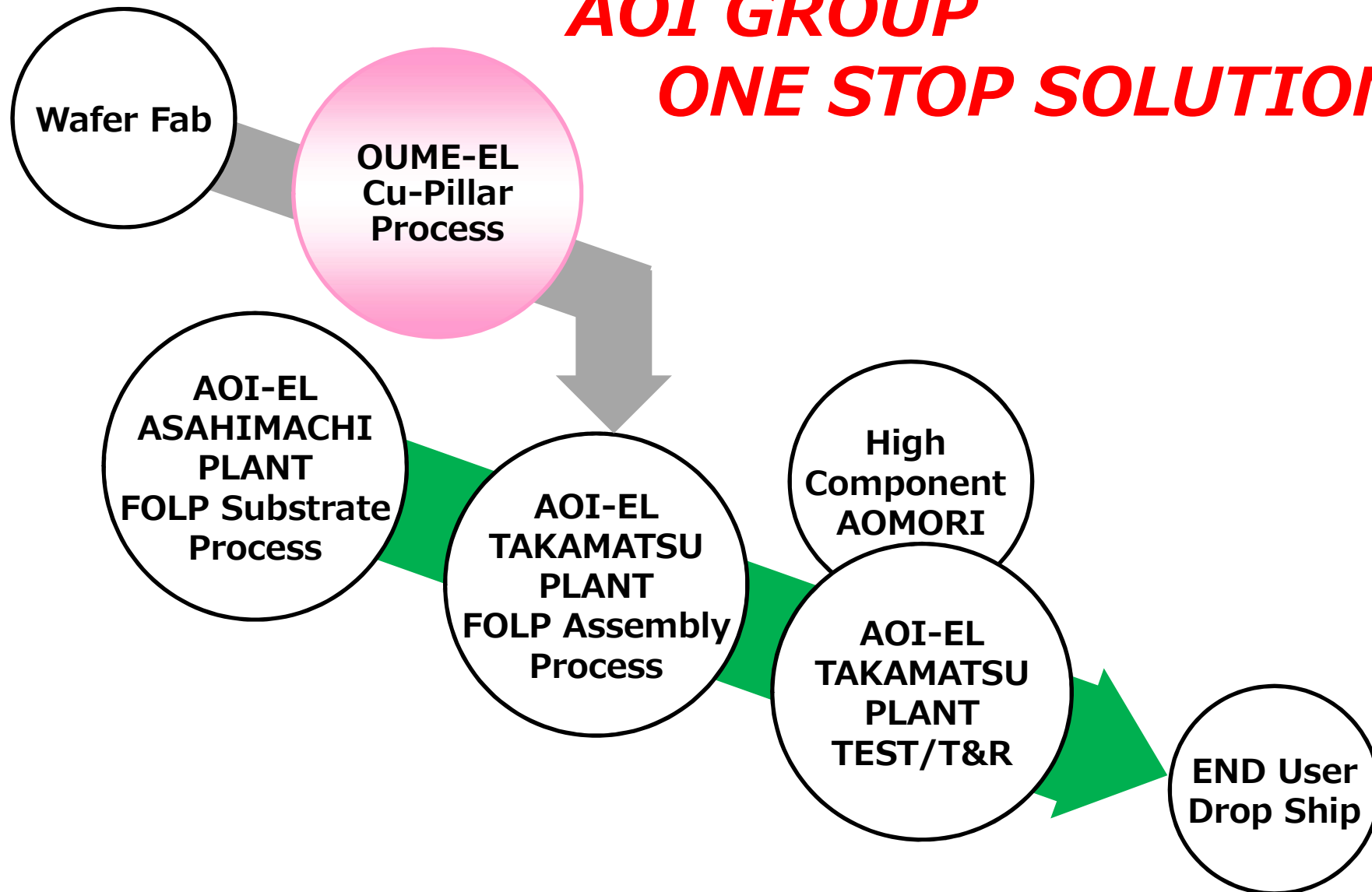
Wafer Level Bumping Technology

<OUME-ELECTRONICS Co.,Ltd>



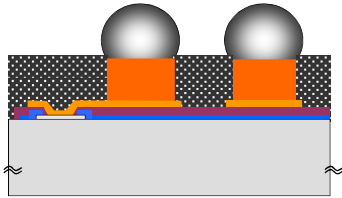
FOLP® Business Flow Between AOI Group Company

AOI GROUP ONE STOP SOLUTION!

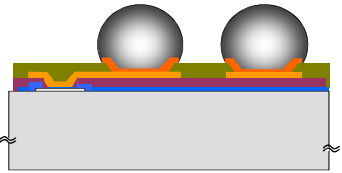


Types of WLP and Bumping new development

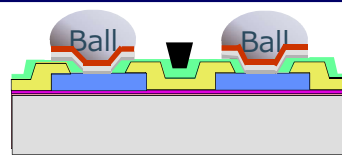
Cu POST WLP



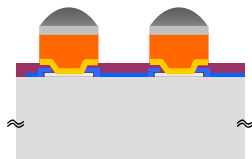
U type WLP



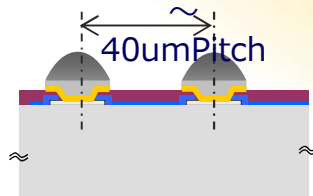
With Solder ball



Cu Pillar

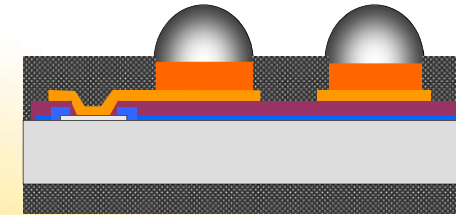


Micro Bump (Solder)

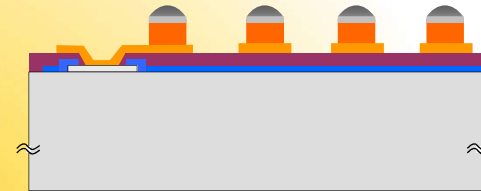


Developing new technology

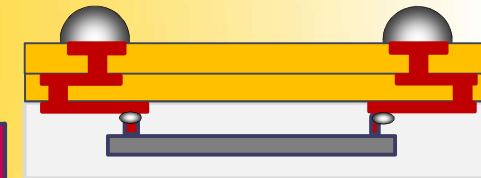
- Improving WLP reliability
- Cu pillar technology
- FOLP® technology
- N in 1 Module technology etc.



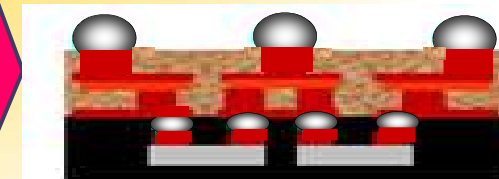
Improving WLP reliability



Fine pitch Cu Pillar



FOLP® (FOPLP/Chip Last)



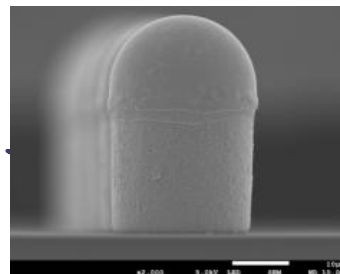
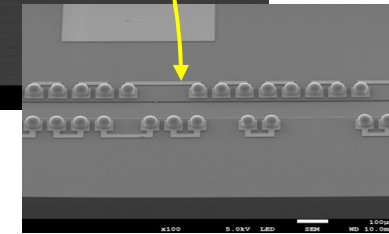
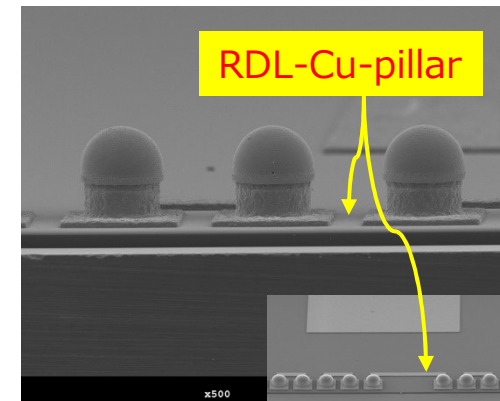
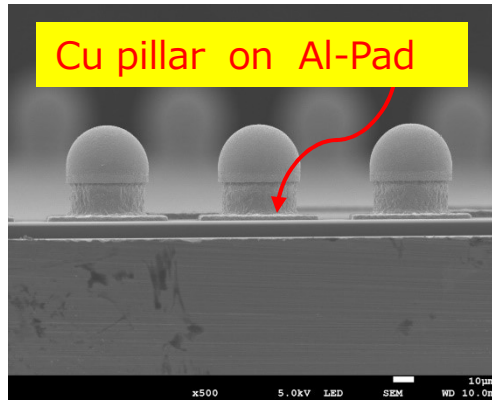
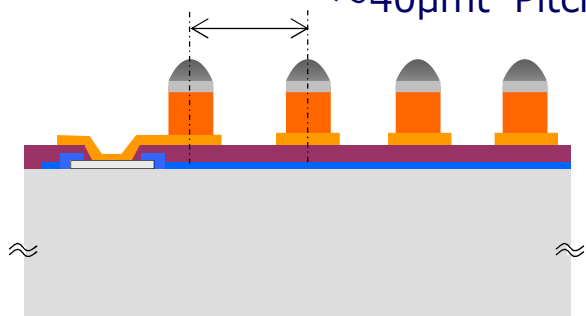
N in 1 (FOLP® module)

Cu-Pillar Variation

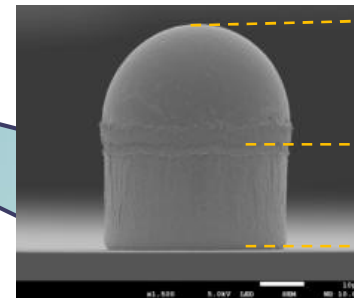
| | [μm] |
|--------------------|-----------------------|
| | Current |
| Wafer Size | 6,8&12 inch |
| Aspect | 2.5 |
| MIN Diameter | 20 |
| MAX Height | 50 |
| Terminal structure | SnAg/Ni/Cu SnAg/Cu |

MIN Cu-Pillar pitch

$\sim 40\mu\text{m}$ Pitch

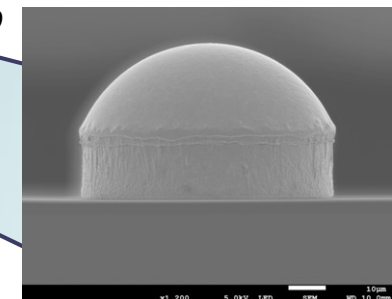


$\Phi 25 \times t40$



$\Phi 45 \times t50$

Aspect $a : b \cong 1 : 1$



$\Phi 70 \times t45$

Oume Electronics's Cu-pillar bumping are well-known for their reliability due to its long history of achievements from 2006y.

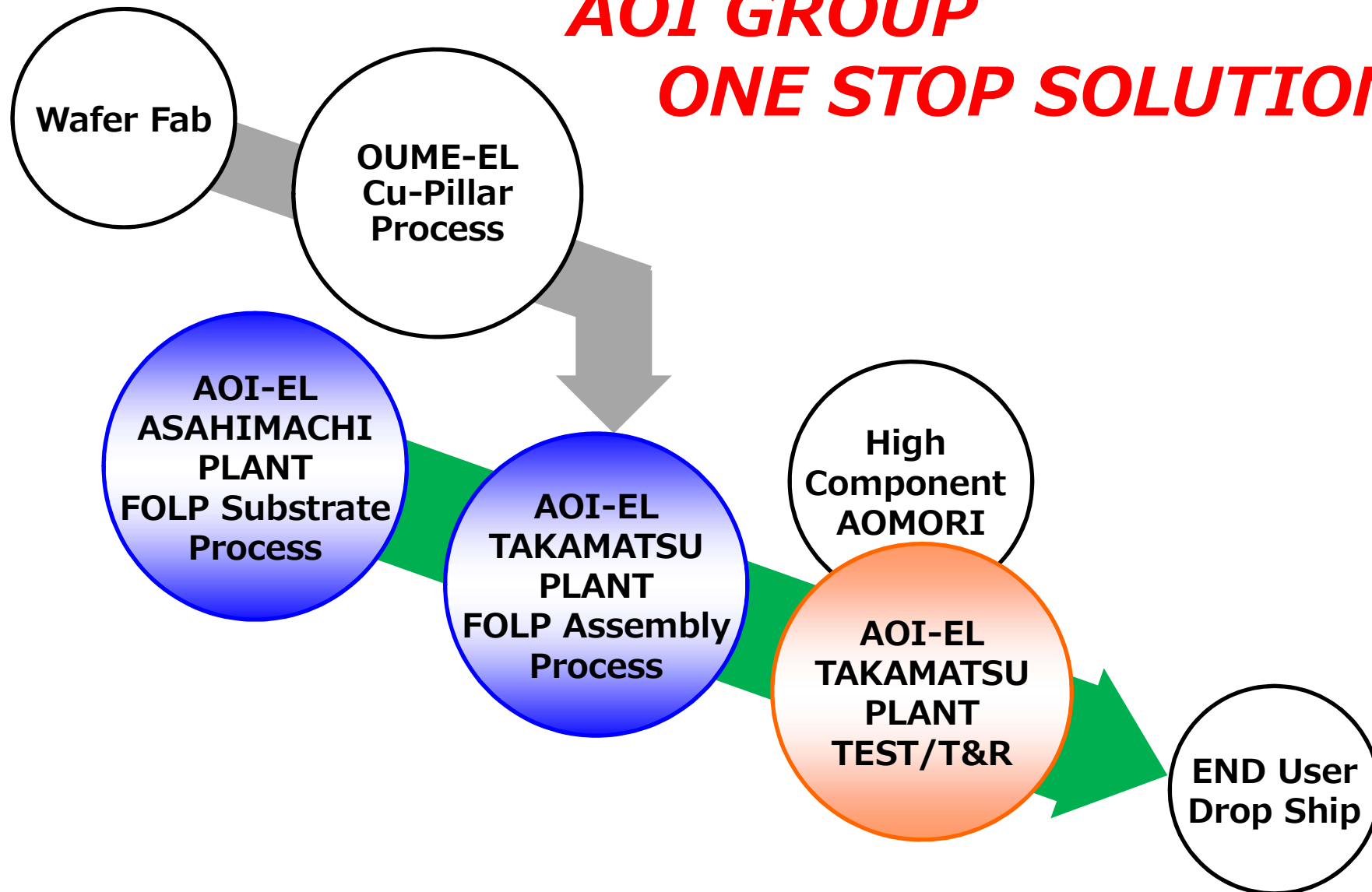
FOLP[®] Technology

<AOI-ELECTRONICS Co.,Ltd>



FOLP® Business Flow Between AOI Group Company

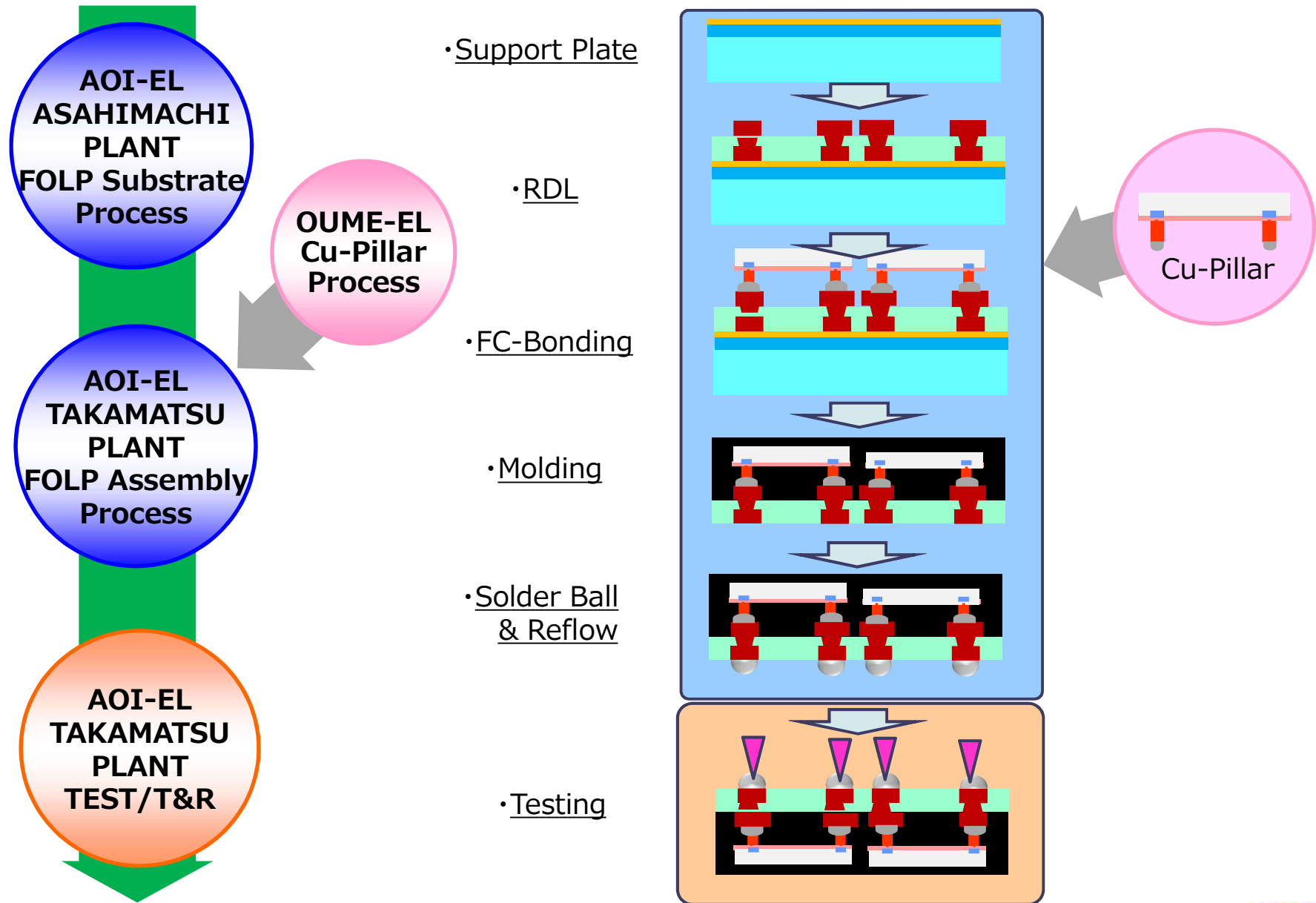
AOI GROUP ONE STOP SOLUTION!





Process Flow for FOLP®

FOLP® (FOWLP) Process Flow (RDL First Method)



FOLP[®] Process Merit & AOI's Advantage

1.High Yield : KGD +KG Substrate Combination

2.Short cycle time : Horizontal specialization Process

*Wafer Bumping /OUME-ELECTRONICS

*Substrate(RDL) Process/AOI-ELECTRONICS ASAHIMACHI PLANT

*Assembly +TEST/T &R Process/AOI-ELECTRONICS TAKAMATSU PLANT

3.Low Cost : -No use PI system

-In a batch-molding method without Cu-pillar capillary underfil.

-Adopting the mechanical de-bonding system.

4.One stop solution in AOI-ELECTRONICS Group.

5.High reliability : -Modified Epoxy resin

-Solder materials of various composition attach

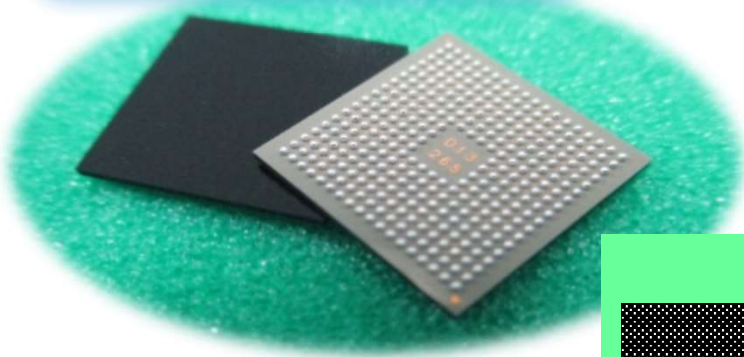
6.High performance :AOI can use the Low Dk,Df substrate materials for RF 5G devices.



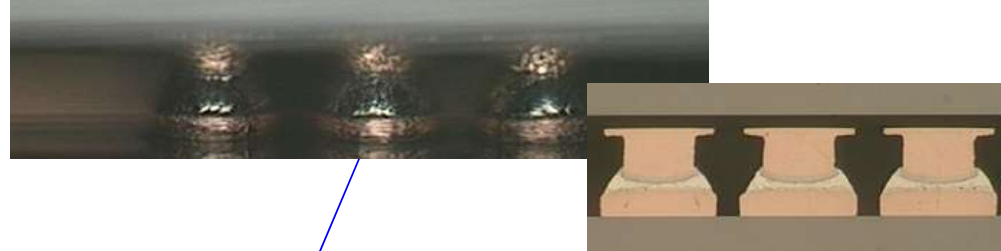
Example of application for FOLP®

FOLP® Elemental Technology (1)

Basic Model

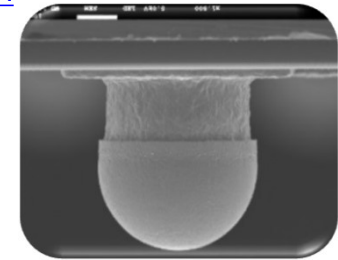


C4 bonding & encapsulation



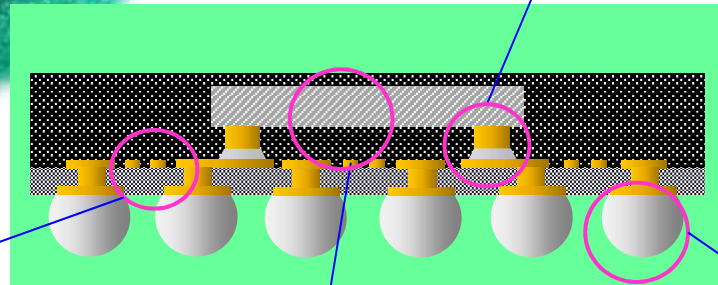
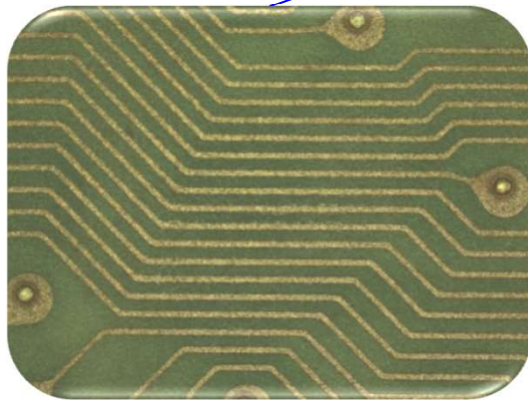
Cu Pillar Bump

~40µm Pitch



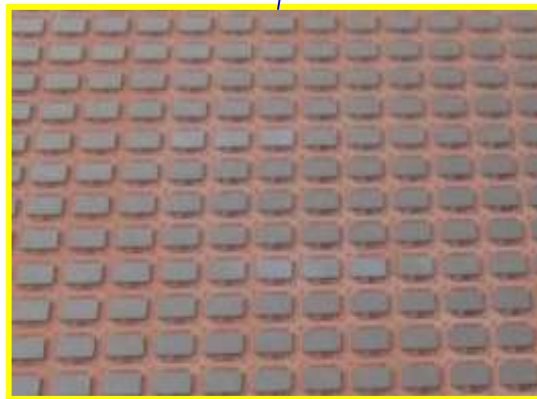
Fine Pitch RDL

(Line=10µm)



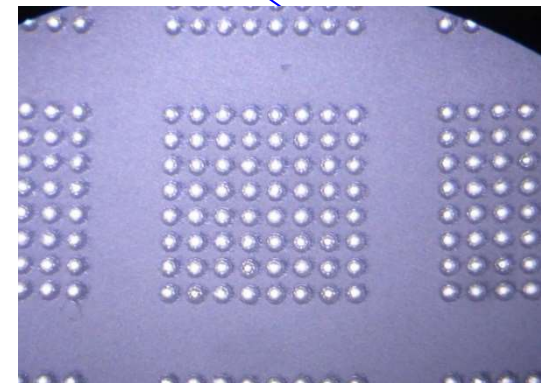
FC-Bonding

Si, SiGe, GaN, GaAs, Others (100µm)



Solder Bump

SAC, SACN, SACNBi, Others



FOLP® Elemental Technology (2)

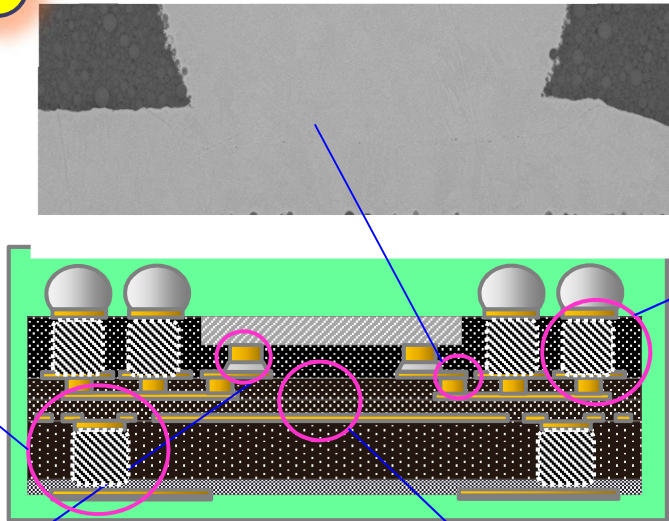
Applied Model

AiP Case

Detail of Via bottom

New Through Via Type②
ToM(Terminal on Mold)

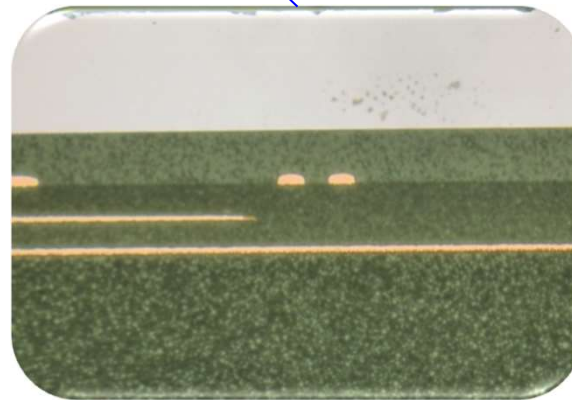
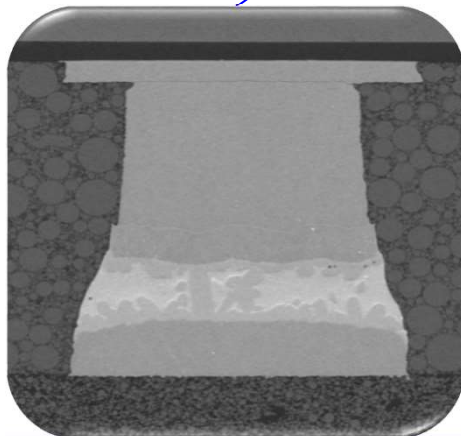
New Through Via Type①



Backside Grinding

No capillary underfill

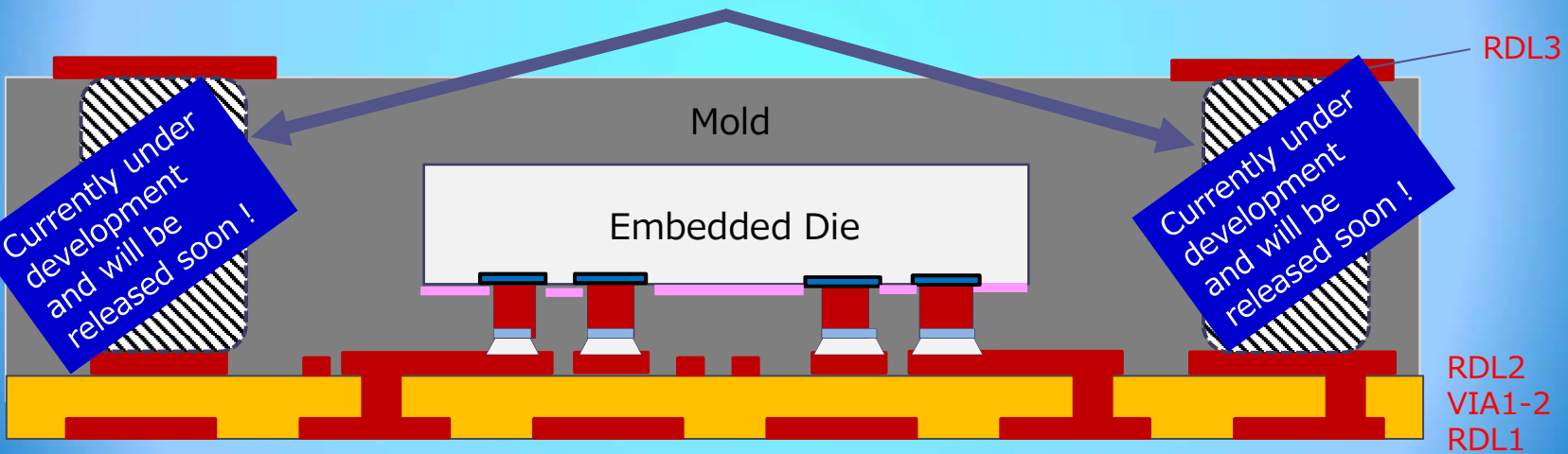
C4 bonding



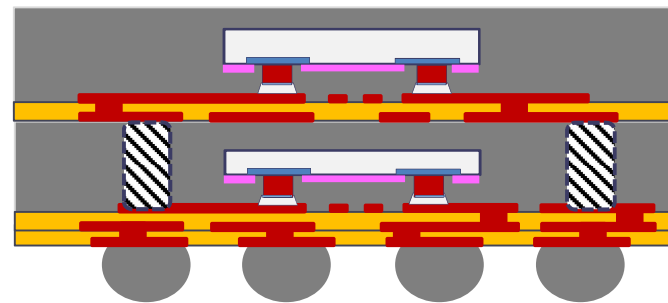
Stacked FOLP®

Through Via Type

New Through Via structure

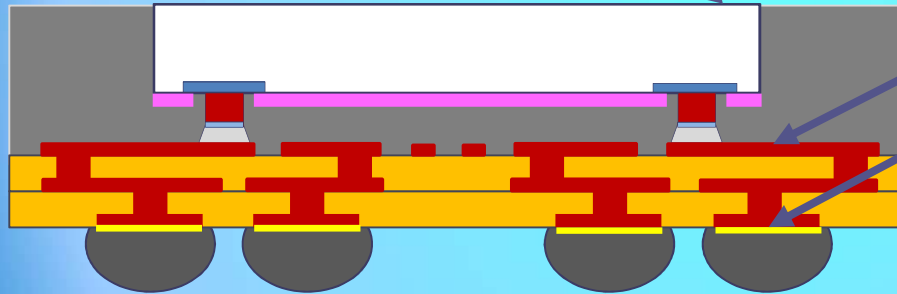


Stacked FOLP®



Active + Passive Device FOLP® Module

Heat dissipation structure

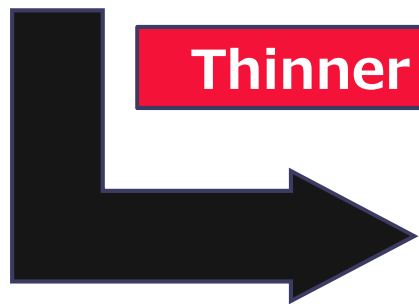


Backside grinding exposure

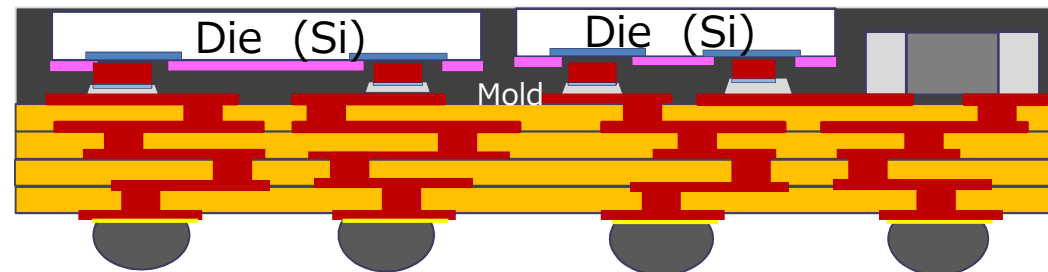
Multi-layer RDL

Solder Ball on Au-Pad

Thinner FOLP®

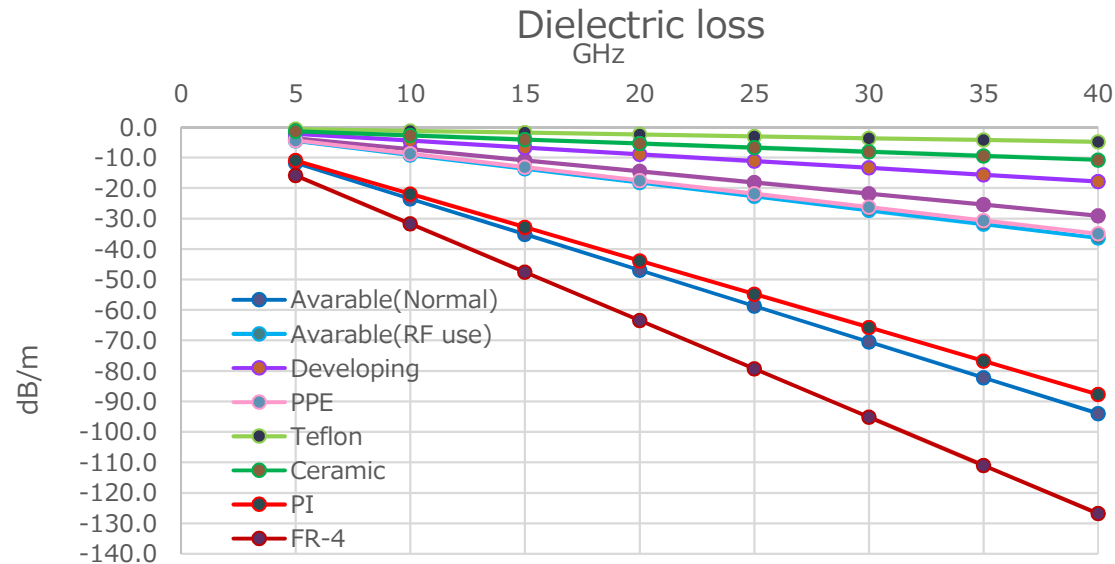


It is possible to form five RDL layers



RDL5 (L5)
RDL4 (L4)
RDL3 (L3)
RDL2 (L2)
RDL1 (L1)

FOLP[®] Isolation Materials for RF devices



Sample



Length: 1m
 Cu Thickness: 10~35 μm(VLP)
 Impedance: 50 Ω (20)

| Type | Film thickness | Dk | | | Df | | | Breakdown Strength (kV/mm) |
|------------|-----------------|-------|-------|-------|--------|--------|--------|----------------------------|
| | | 20GHz | 40GHz | 60GHz | 20GHz | 40GHz | 60GHz | |
| Normal | 35umt (Typical) | 3.3 | 3.3 | 3.3 | 0.0151 | 0.0170 | 0.0170 | 15.1 |
| Thick film | ~200umt | | | | | | | |
| Low stress | 35umt (Typical) | | | | | | | |
| RF | 35umt (Typical) | | | | | | | |
| Developing | 35umt (Typical) | 3.1 | 3.1 | 3.1 | 0.0077 | 0.0030 | 0.0037 | |

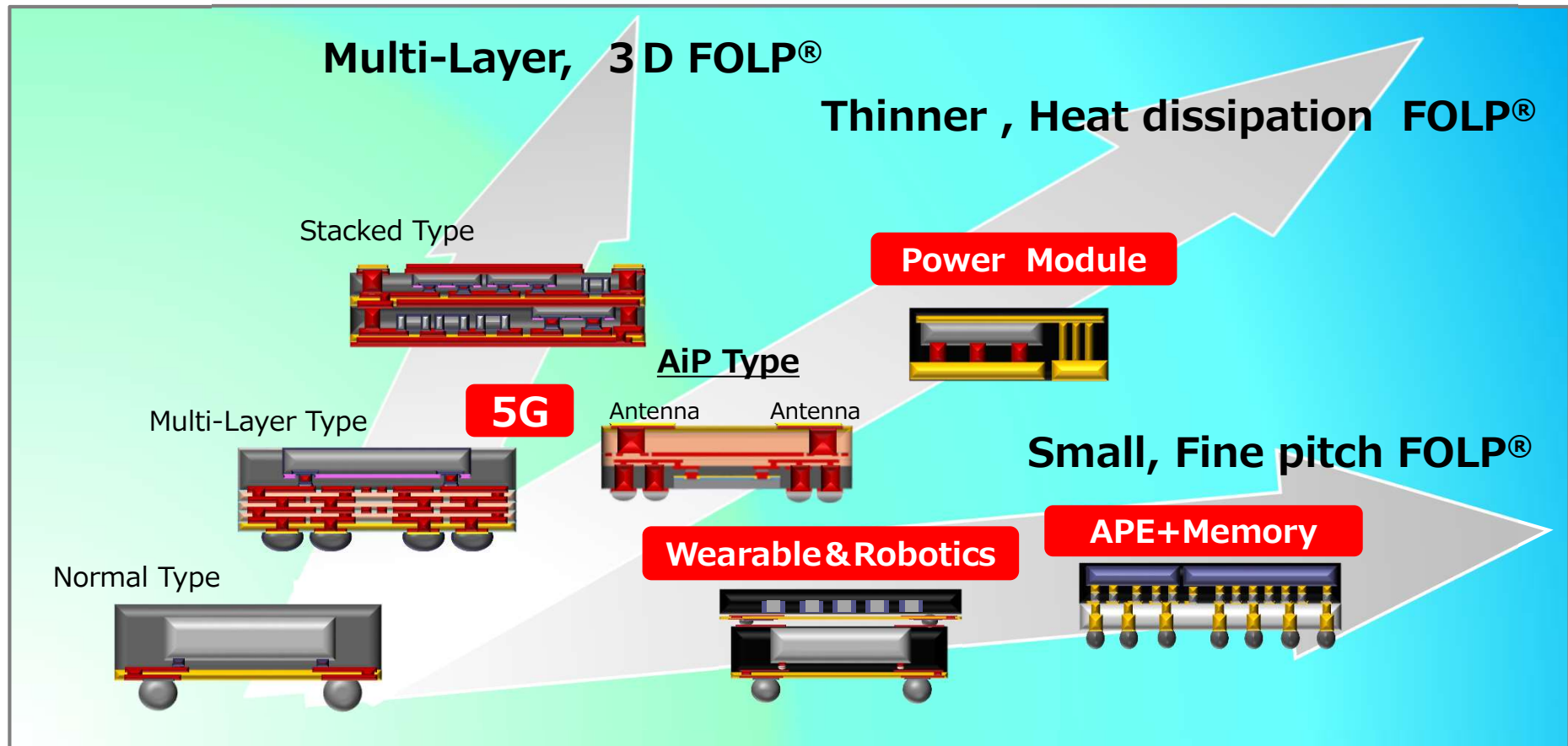
Please feel free to contact us about the isolation material characteristics.





Technology Roadmap

FOLP[®] Technology Roadmap



| | year | 2020 | 2021 | 2022 | 2023 | 2024 |
|------------------|------------|----------------------|---------------------------|---------------------|--------|------|
| Die to Substrate | | 75 to 60 | 60 to 40 | < 40 (For High END) | | |
| RDL L/S | | 20 to 15 | 15 to 10 (For Middle END) | | 8 to 2 | |
| Solder Pitch | [μ m] | 650 to 400 (For 5G) | | 400 to 300 | | |

Reliability

Reliability results

FOLP® SPEC.

【FOLP®】

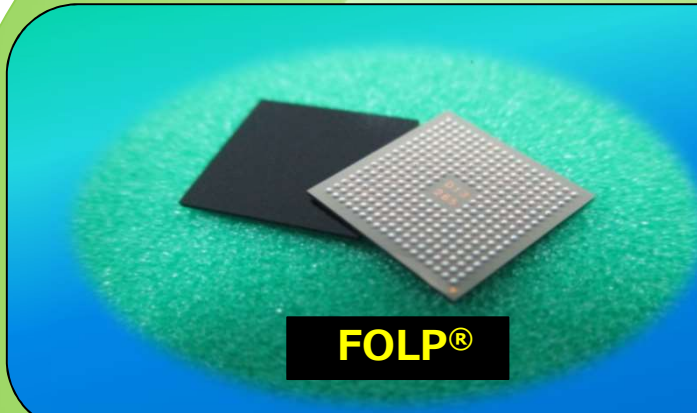
Size :4.1mm□
 Terminal Pitch :0.4mmP
 Height :0.7mmt
 I/O count :64pin

【Si Chip】

Chip Size :2.1×3.0mm
 Cu Pillar :Pitch :75μmt
 Diameter :40μmΦ

| Items | Condition | N count | Result |
|-------------------|---|---------|--|
| MSL Level 1 | 85°C/85% 168hr ⇒260°C 30sec 3X | 22 | No fail |
| PCT (PKG) | Pre-condition ⇒121°C 100% 500 c y c | 22 | No fail |
| HTHH (PKG) | Pre-condition ⇒85°C 85%RH 1000 h r | 22 | No fail |
| HTS (PKG) | Pre-condition ⇒150°C 168hr,500hr,1000hr | 22 | No fail |
| TCT (PKG) | Pre-condition(各15min/RT2min) ⇒-65°C~RT~150°C 1000cyc | 22 | No fail |
| Drop Test (Board) | JEDEC 【JESD22-B111】 1500G time : 0.5msec | 2 | MTTF 546 times 1 ST Fail 76 times Pass/Fail :30 times |

AOI-ELECTRONICS'S FOLP[®] supports IoT Technologies



IoT/M2M Communication module
LTE / 5G / WiMAX / Z-Wave / ZigBee / Bluetooth / RFID
NFC/ Transfer Jet / Felica / PLC / Tuner / GPS /

Sensor / MEMS Device
CIS / Compass / Tunable capacitor

Analog / Power / Driver / RF / Memory ICs
PMIC / RF / BaseBand / Switch / Converter / Battery
Control /Flash / DRAM/ OLED control SoC / Others

Automotive ICs
Radar system/ RF tuner for Navigation systems



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