



■ MicroLED enables next level of ■ AR & Human-Machine-Interface

Ruby YAN: Director IoT End Market

Technology continually changes how we connect

From a hub, to a device network, to the Digital Twin



GF[®] technologies are at the front line to enable Digital Twin



Feature-Rich CMOS
Complementary Metal-Oxide Semiconductor



RF SOI
RF Silicon-on-Insulator



SiGe
Silicon Germanium



FinFET
Fin Field-Effect Transistor



FDX
Fully-Depleted SOI



SiPh
Silicon Photonics



WBG: GaN
Gallium Nitride

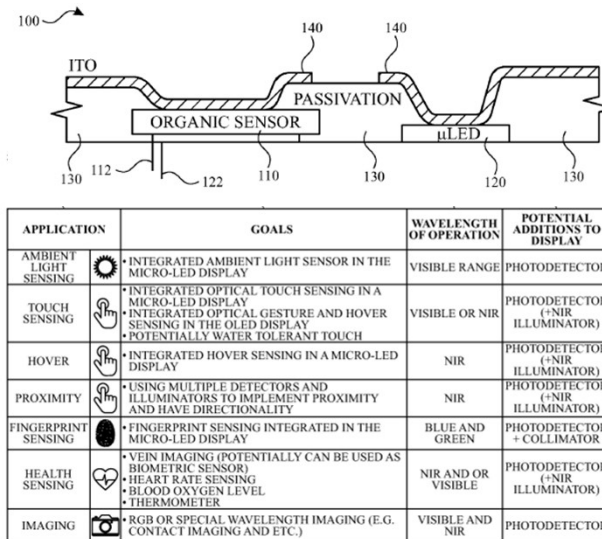
All eyes on MicroDisplay

Sony microOLED



Source: Sony Company Website

Apple patent on microLED display with optical sensors



Source: USPTO US20220068900A1

Samsung Display says MicroLED-on-Si will be used in AR over OLED



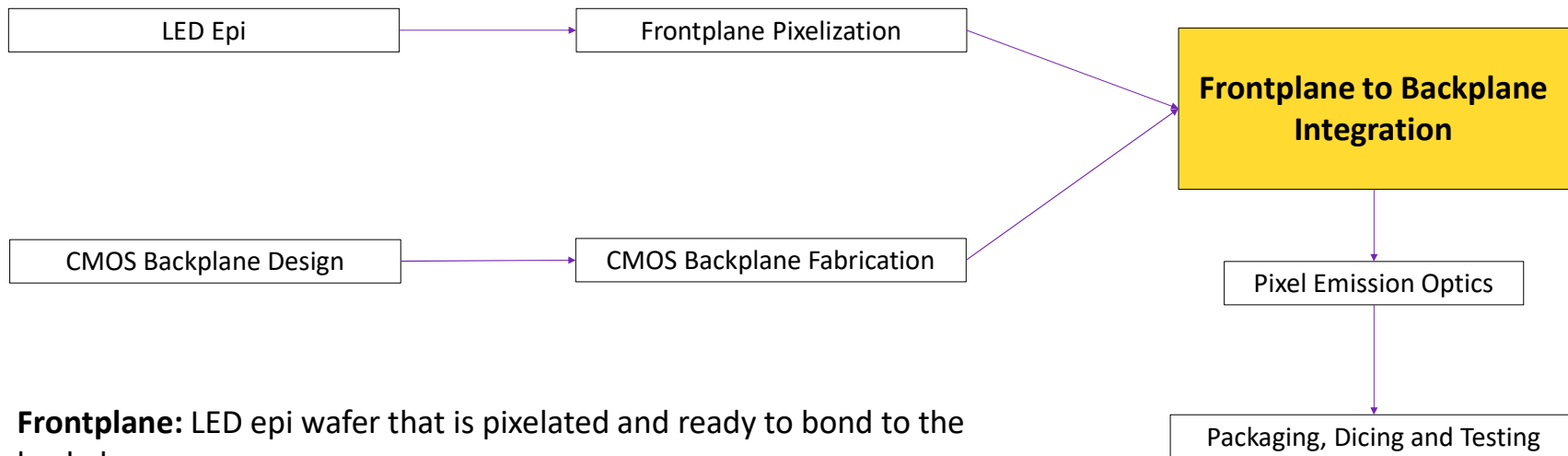
Image: TheElec
Korea Electronics Industry
Media (<http://thelec.net>)

Is microLED the final solution?

	LCOS	OLED	microLED
Brightness	Medium	Low	High
Contrast ratio	Low	Excellent	Excellent
Refresh rate	Low	Medium	High
Resolution	High	Medium	High
Power efficiency	Low	Medium	High
Endurance	-10 ~ 85 °C	-50 ~ 70 °C	-100 ~ 120 °C
Manufacturing Maturity	High	Medium	Low
Full color Solution	Mature	Mature	Red color challenge

MicroLED display integration method

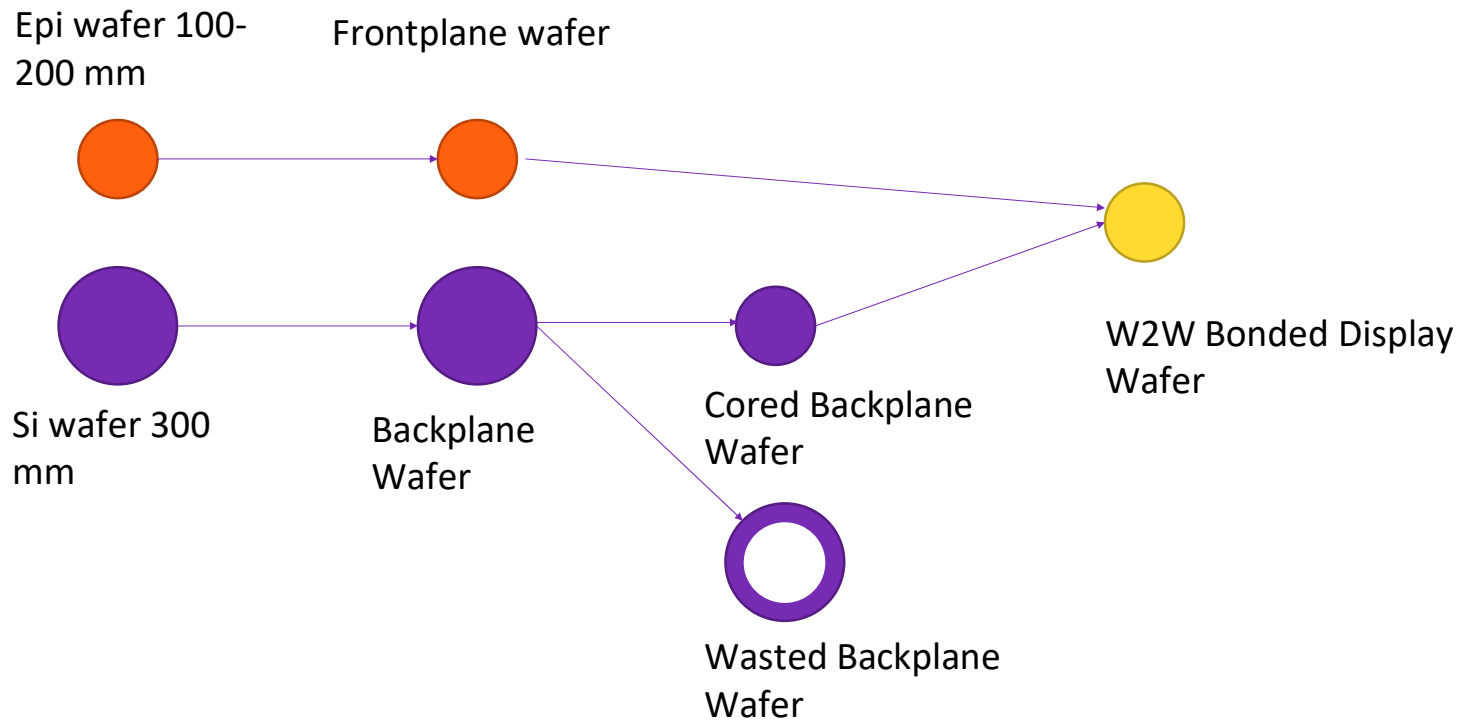
uLED “Micro Display” Process Flow



Frontplane: LED epi wafer that is pixelated and ready to bond to the backplane.

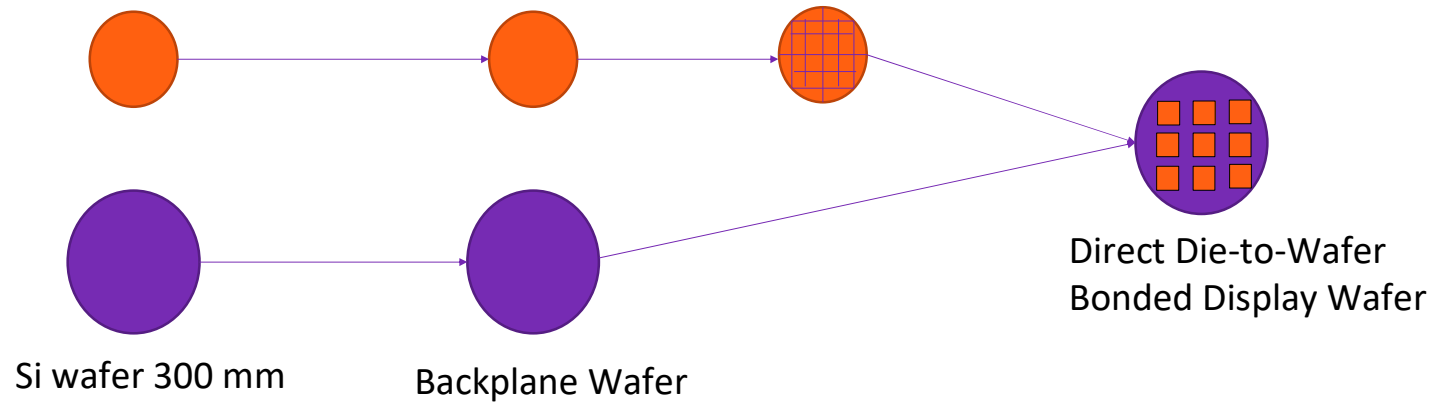
Backplane: CMOS wafer that has pixel driving and image processing functionality that is ready to bond to the frontplane.

Integration Approaches - Coring

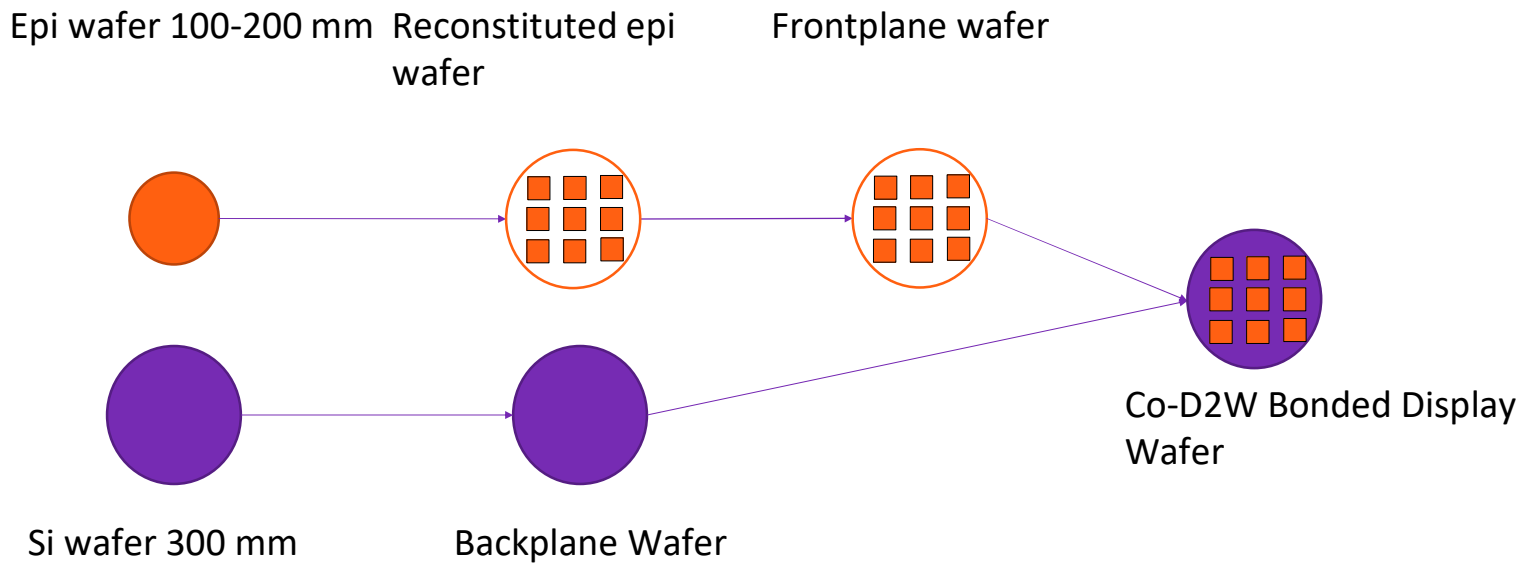


Integration Approaches – Direct D2W

Epi wafer 100-200 mm Frontplane wafer Diced Frontplane wafer



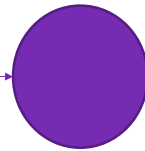
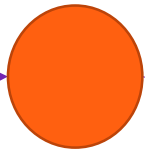
Integration Approaches – Collective D2W



Integration Approaches – W2W

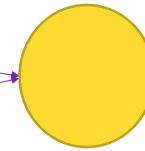
Epi wafer 300 mm

Frontplane wafer



Si wafer 300 mm

Backplane Wafer



W2W Bonded Display Wafer

uLED Frontplane and Backplane development is making progress steadily

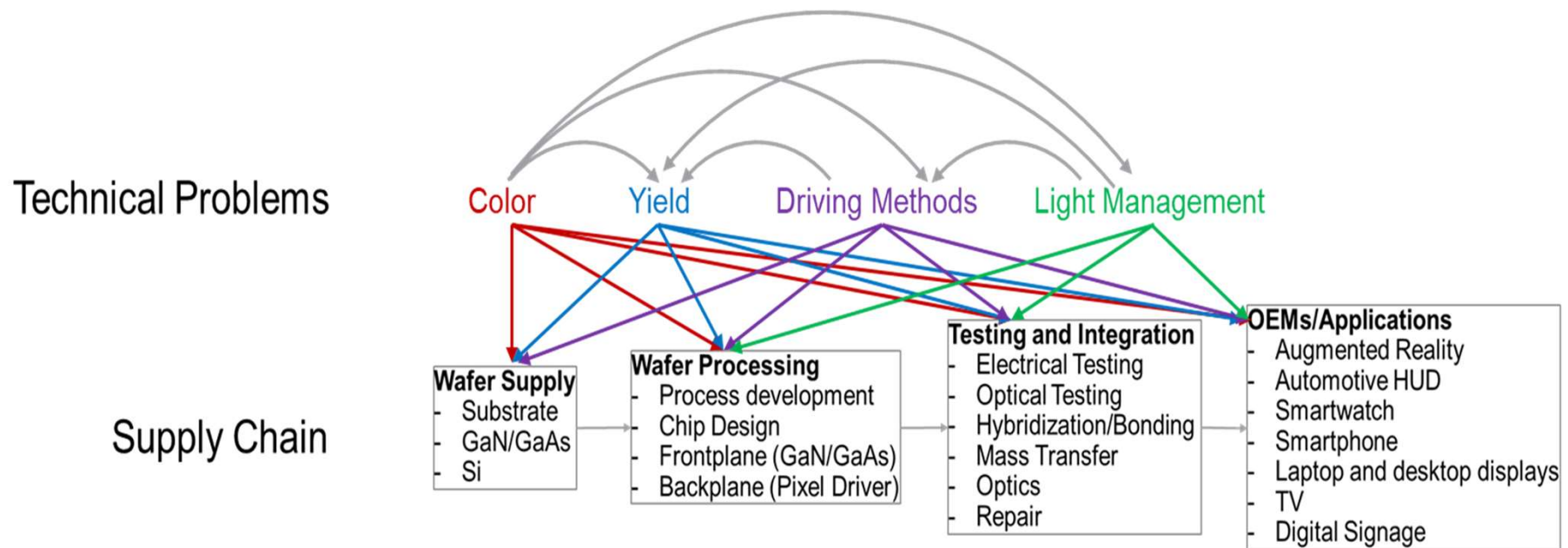
- **Frontplane:** LED epi wafer that is pixelated and ready to bond to the backplane.
- **Backplane:** CMOS wafer that has pixel driving and image processing functionality that is ready to bond to the frontplane.

Remaining issues:

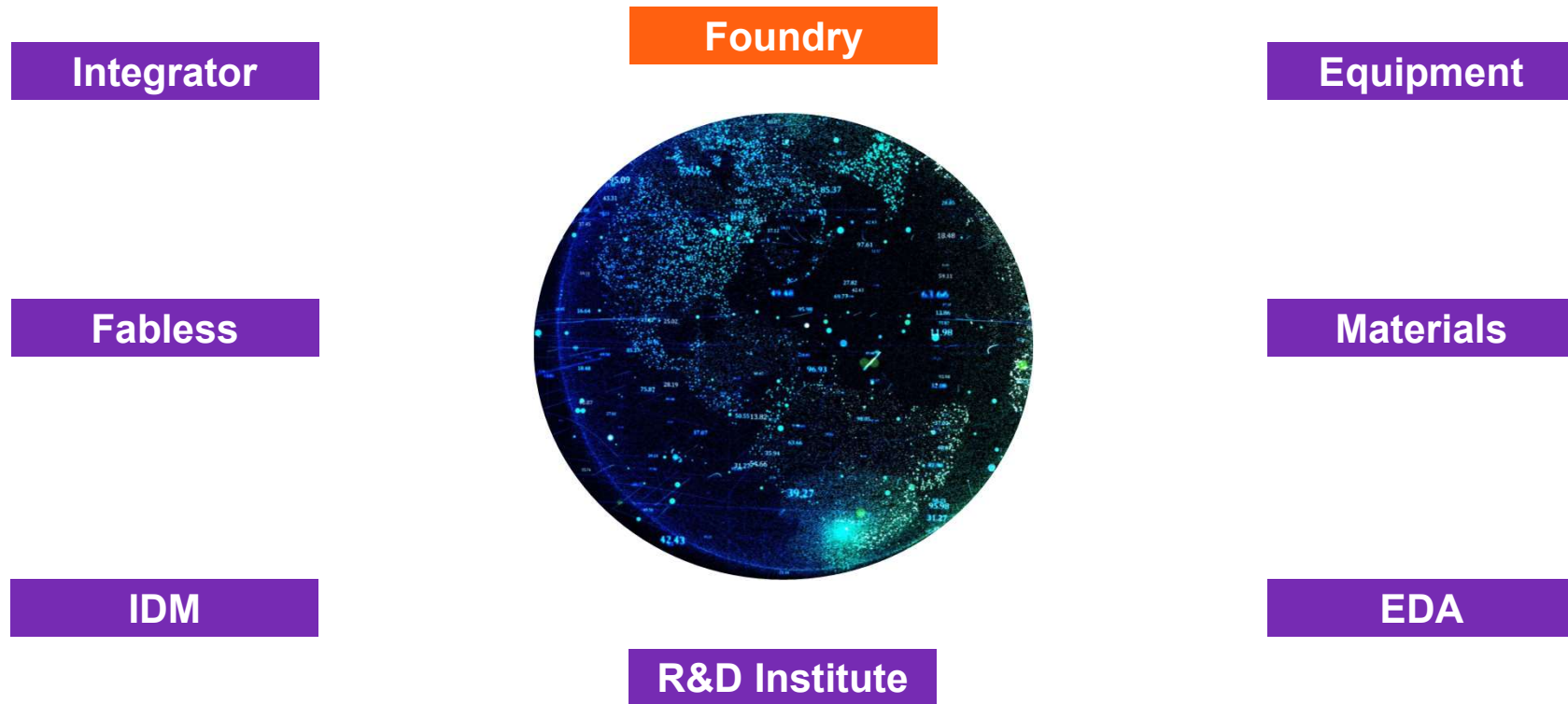
- Integration: Frontplane to backplane integration approach and interfaces.
- Color: Multiple approaches from optically combined monochrome displays to full color wafers.
- Pixel Pitch and Efficiency: AR demands $<5\mu\text{m}$ pixel pitch to satisfy angular resolution. Smaller pixel pitch reduces pixel efficiency.

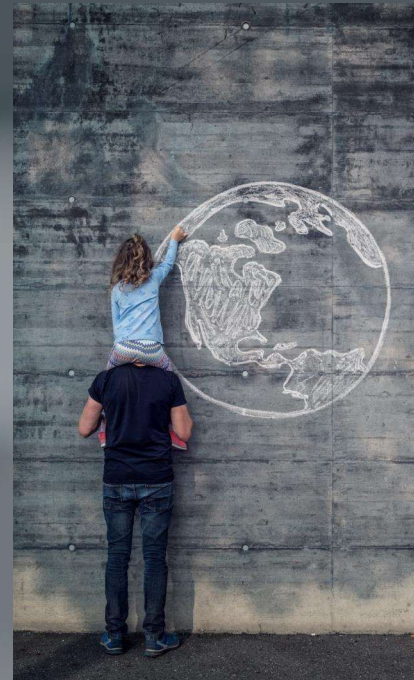
Solutions require optimizations in frontplane and backplane simultaneously.

MicroLED display are making progress, but challenges remain



Let's start to build the future together





Thank You



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