

Microdisplay Technical Report for XR Devices

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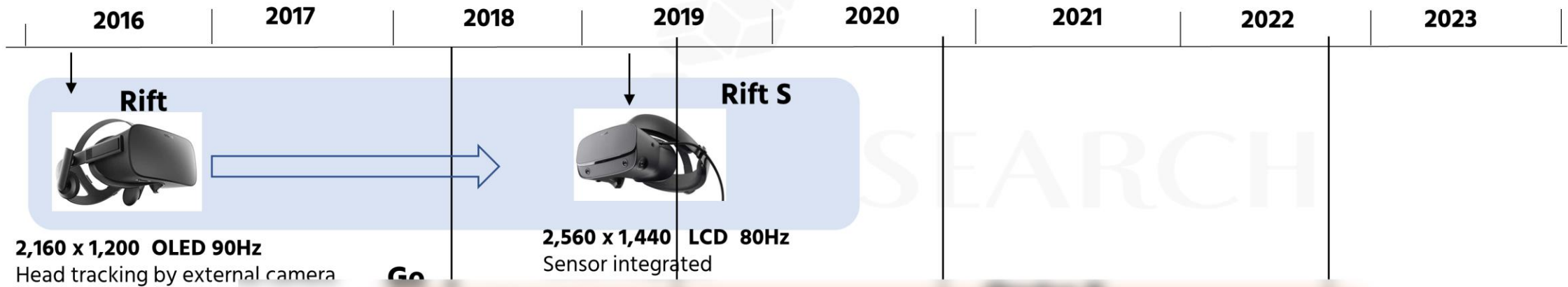
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1. XR industry trends

1.4 XR Key Player Trends

■ Oculus

- Oculus, under Meta, initially used OLED as a display, but has recently been using LCD, prioritizing higher resolution.
- Oculus Quest 2 (currently Meta Quest 2) has two displays with high definition resolution of 1,832 x 1,920 each. Quest Pro, announced in October 2022, further improved image quality by applying miniLED backlight and QD film. For our next product, we are developing a thinner and lighter headset using Holocake Lens.



2. XR product analysis

2.2 Specification analysis of XR products launched in the first half of 2023

■ AR device

Company	INNO	Oveede	Cellico	LetinAR	Maxlogic	Maxlogic	RealWear	Rokid	Camfire
Product name	Air2								
Type	Glasses								
Optics Ocularity FoV (°): D H V	Waveguide binocular 26								
Display Resolution Brightness (nits) Hz	Micro-OLED 640x480 60								
Tracking type	6DoF inside-out								
Weight (g)									
Power connection	Standalone								
Price (\$)	550								
Nation	China								

FoV- D: diagonal, H: horizontal, V: vertical

4. Analysis of microdisplay technology trends and issues

4.3 Microdisplay technology comparison for VR/MR

- Apple's MR Vision Pro, released in June 23, uses two 1.41" 4K *****, demonstrating product performance that conventional LCoS cannot demonstrate.
- To cope with the miniaturization and high resolution of VR/MR in the future, ***** are needed, attracting attention to the development of RGB patterning technology with high aperture ratio.

Comparison of key microdisplay technologies for VR/MR

Specification	Meta Quest Pro	Apple Vision Pro	Required Spec.
Display Type	Micro-OLED	Micro-OLED	Micro-OLED
Size	1.1"	1.41"	1.1"
Refresh Rate	90Hz	120Hz	120Hz
Pixel Density	~1000 PPI	~1000 PPI	~1000 PPI
Display Resolution (Each.)	~1920x1080	~2160x1440	~2160x1440
Total Pixels (Both Displays)	~4,000,000	~6,000,000	~6,000,000
Launch	2021	2023	2023

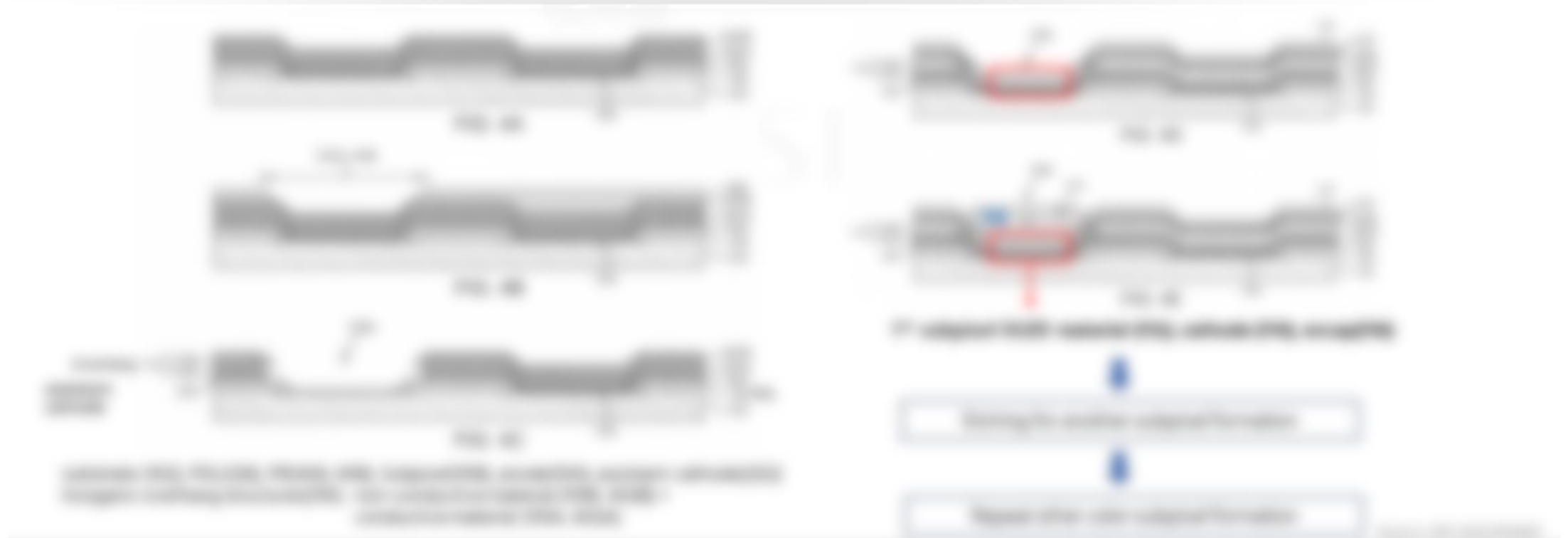
Source: UBI Research DB

5. Micro-OLED major technology development status

5.2 Photolitho OLED Development Status by Panel Company

- FMM-less color patterning technology from Applied Materials is a key technology that encapsulates each sub-pixel to prevent damage to the light emitting layer during photopatterning processes such as JDI and Visionox (EX: WO 2022/050983).
- *****installed on the PDL, and damage to the OLED material during the subsequent etching/strip process can be prevented through *****.

Applied Materials' FMM-less color patterning technology

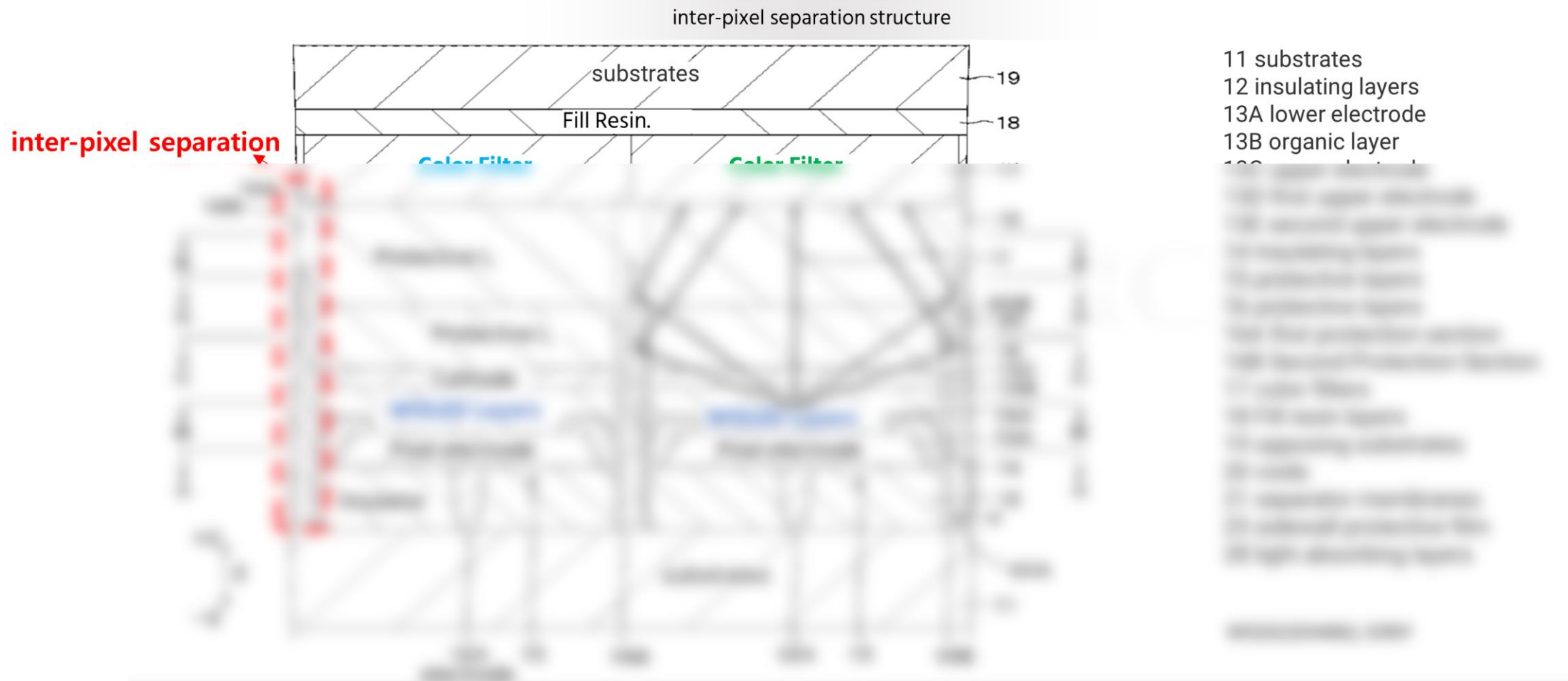


5. Micro-OLED major technology development status

5.5 Micro-OLED device structure

■ Sony - White OLED + CF device development trend


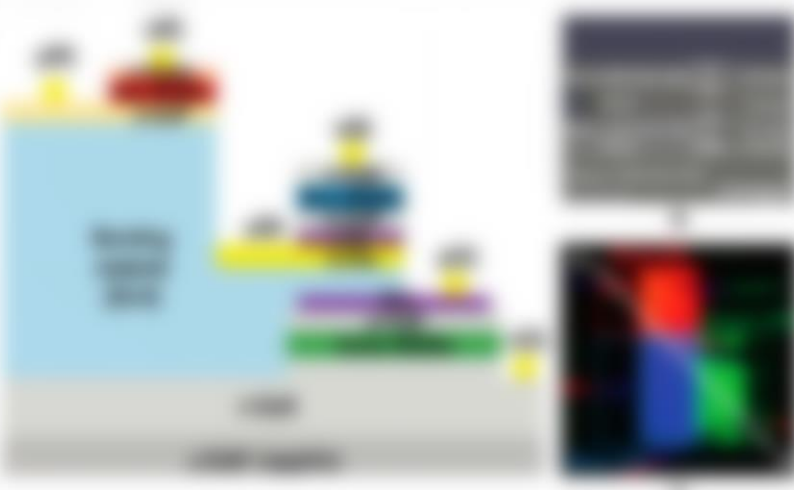

- Sony introduced an inter-pixel separation structure to prevent light leakage between adjacent pixels of high-resolution Micro-OLED.



7. Micro-LED major technology development status

7.3 Micro-LED Display Color Technology

- It is difficult to achieve 4000PPI level resolution with mass transfer & flip chip bonding colorization technology applied to medium to large sized Micro-LED displays.
- Microdisplay for MR set without screen door effect requires more than 3500~4000 PPI, and the main colorization process for InGaN/GaN RGB-based Micro-LED Display is developing the following monolithic integration technologies.

Wafer Scale Monolithic Integration method	Monolithic Multi-Color Integration Technology	Monolithic vertical stacking
 <p>Diagram illustrating the Wafer Scale Monolithic Integration method. It shows a wafer with multiple color subpixels (red, green, blue) integrated on a single substrate. The diagram includes a 3D view of the wafer and a 2D cross-section showing the subpixels.</p>	 <p>Diagram illustrating the Monolithic Multi-Color Integration Technology. It shows a cross-section of a multi-layered structure with different colors (red, green, blue) stacked vertically. The diagram includes a 3D view of the structure and a 2D cross-section showing the layers.</p>	 <p>Diagram illustrating the Monolithic vertical stacking method. It shows a cross-section of a structure with multiple layers of subpixels (red, green, blue) stacked vertically. The diagram includes a 3D view of the structure and a 2D cross-section showing the layers.</p>

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