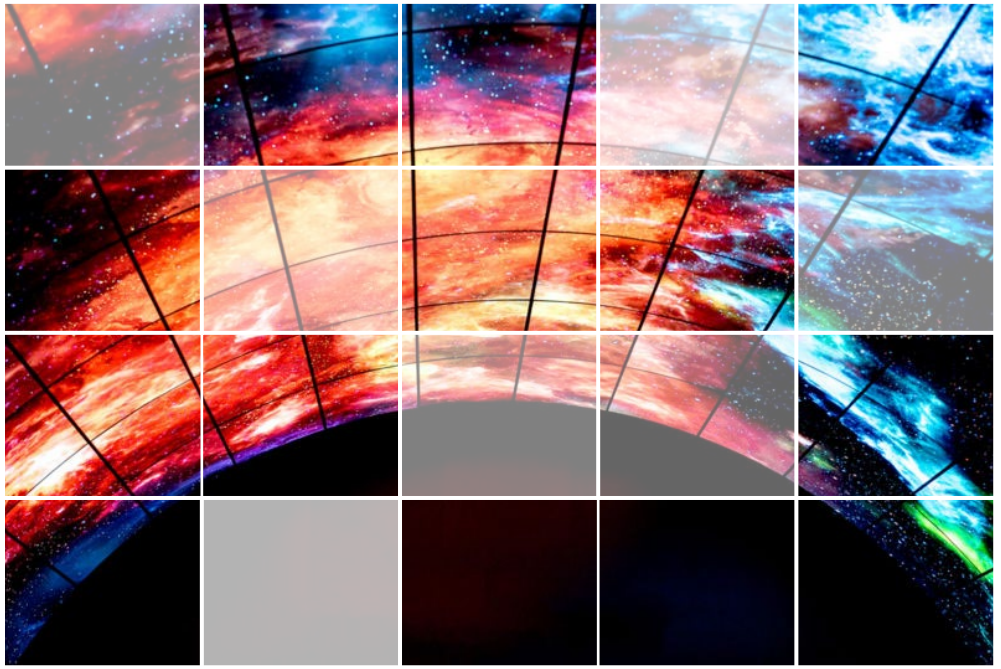
An Introduction to the OLED Industry



2021.8

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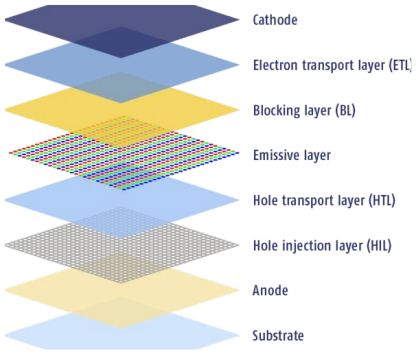
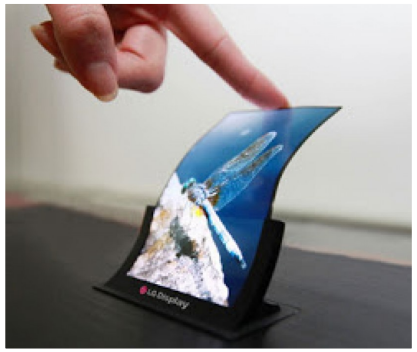


Introduction to OLED displays



OLED Market Overview

Key Market Trends

RAYSTAR
SAMSUNG DISPLAY
Pioneer
LG Display

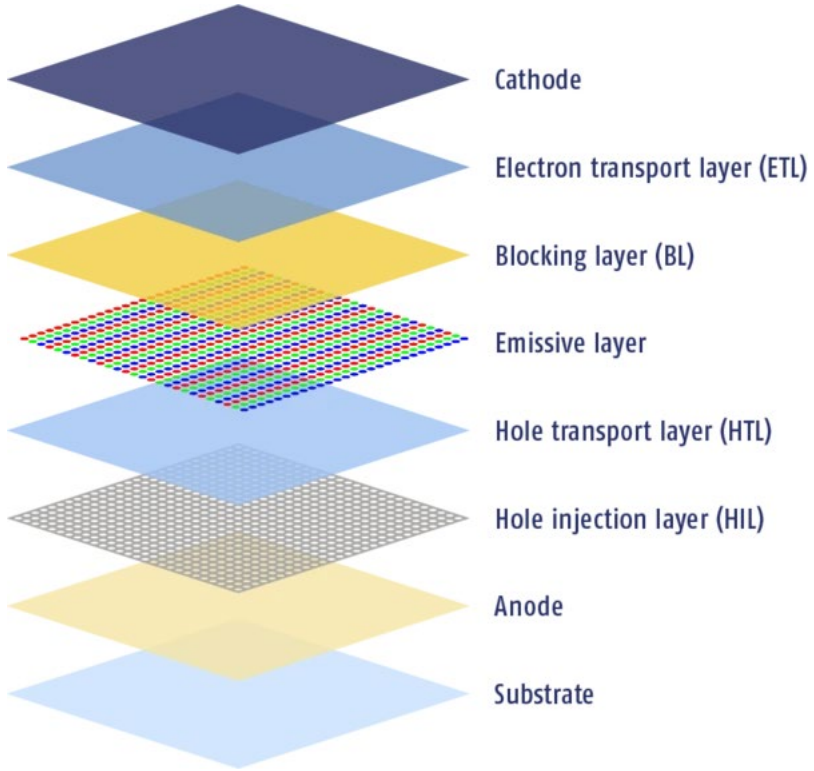
Major Players

Introduction to OLED displays

What is an OLED?

OLED (Organic Light Emitting Diodes) is a flat light emitting technology, made by placing a series of organic thin films between two conductors. When electrical current is applied, a bright light is emitted. OLEDs are emissive displays that do not require a backlight and so are thinner and more efficient than LCD displays (which do require a white backlight).

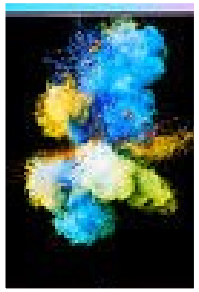
OLED displays are not just thin and efficient - they provide the best image quality ever and they can also be made transparent, flexible, foldable and even rollable and stretchable in the future.



Source: https://www.oled-info.com/

OLED vs LCD

An OLED display have the following advantages over an LCD display:



Improved image quality - better contrast, higher brightness, fuller viewing angle, a wider color range and much faster refresh rates.

Lower power consumption

Simpler design that enables ultra-thin, flexible, foldable and transparent displays

Better durability - OLEDs are very durable and can operate in a broader temperature range

AMOLED vs PMOLED

 AMOLED	 PMOLED
Passive-Matrix	Active-Matrix
Each row and line containing pixels within the display is controlled sequentially and one-by-one	Uses a thin-film transistor or TFT backplane to access and switch on or off the individual pixel directly; the TFT backplane contains a storage capacitor for maintaining active pixel sates
Limited in size and resolution	Can be made large, more efficient also more complicated
Lower lifetime due to the high voltage needed	Longer lifetime
Used in small devices or secondary displays	Used in smartphones, tablets and TVs

The future - flexible and transparent OLED displays

World of Possibilities:

- Curved OLED displays, placed on non-flat surfaces
- Wearable OLEDs
- Foldable OLEDs and rollable OLEDs which can be used to create new mobile devices
- Transparent OLEDs embedded in windows or car windshields

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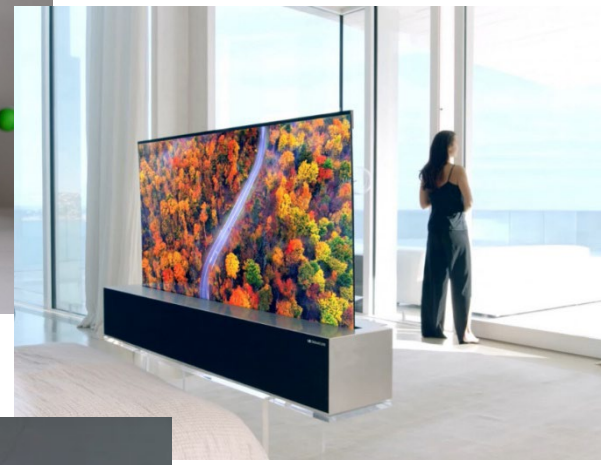
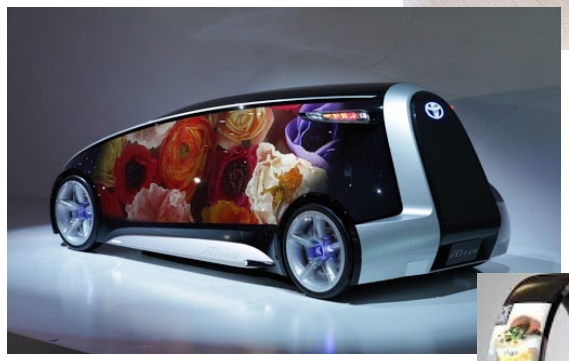
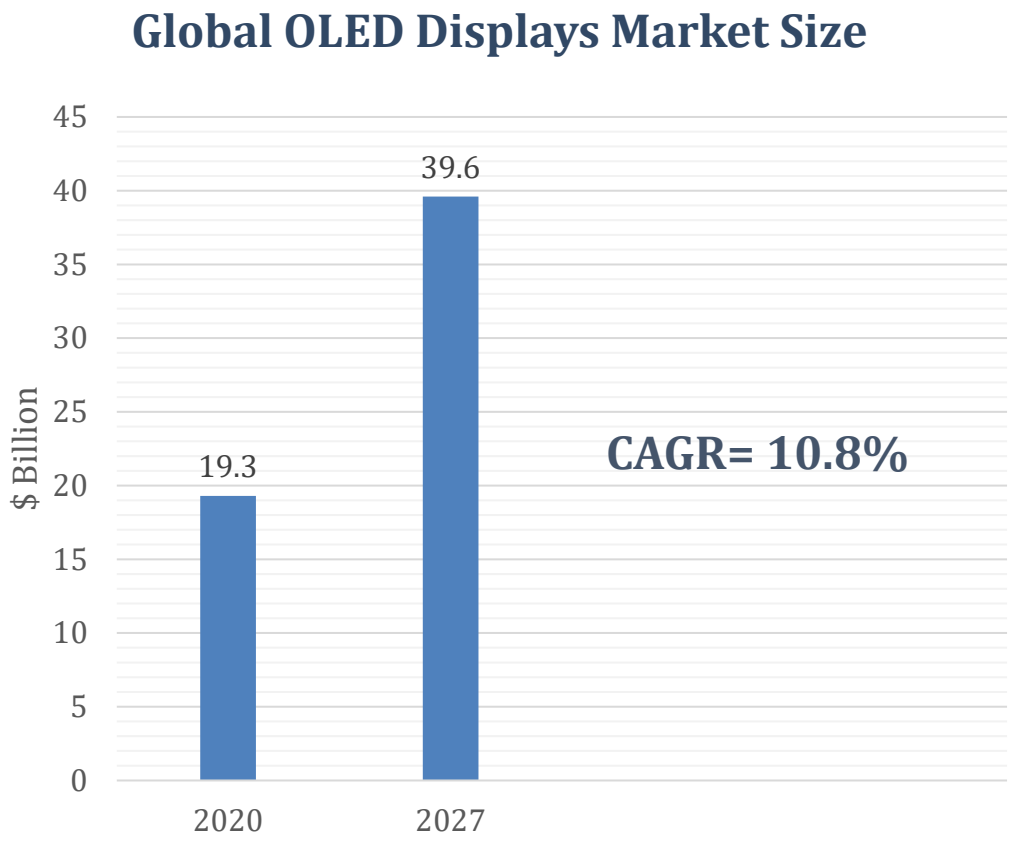




OLED Market Overview

Global OLED Displays Market

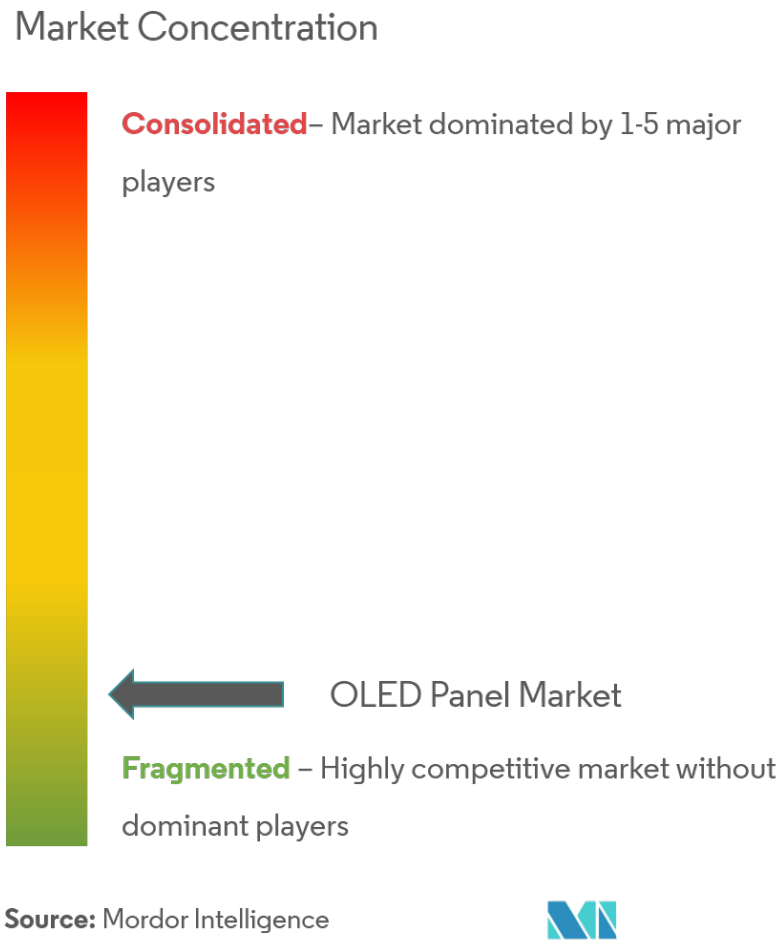


Source: ReportLinker <Global Organic Light Emitting Diode (OLED) Displays Industry>

- Global OLED Displays Market to Reach **$39.6 Billion** by 2027
- AMOLED segments is projected to record 11% CAGR and reach **US$34 Billion** by 2027
- China market is forecast to reach a projected market size of **US$8.5 Billion** by the year 2027 trailing a CAGR of 14.3% over the analysis period 2020 to 2027.
- Japan and Canada, each forecast to grow at 7.6% and 9.3% respectively over the 2020-2027 period. Within Europe, Germany is forecast to grow at approximately 8.5% CAGR.

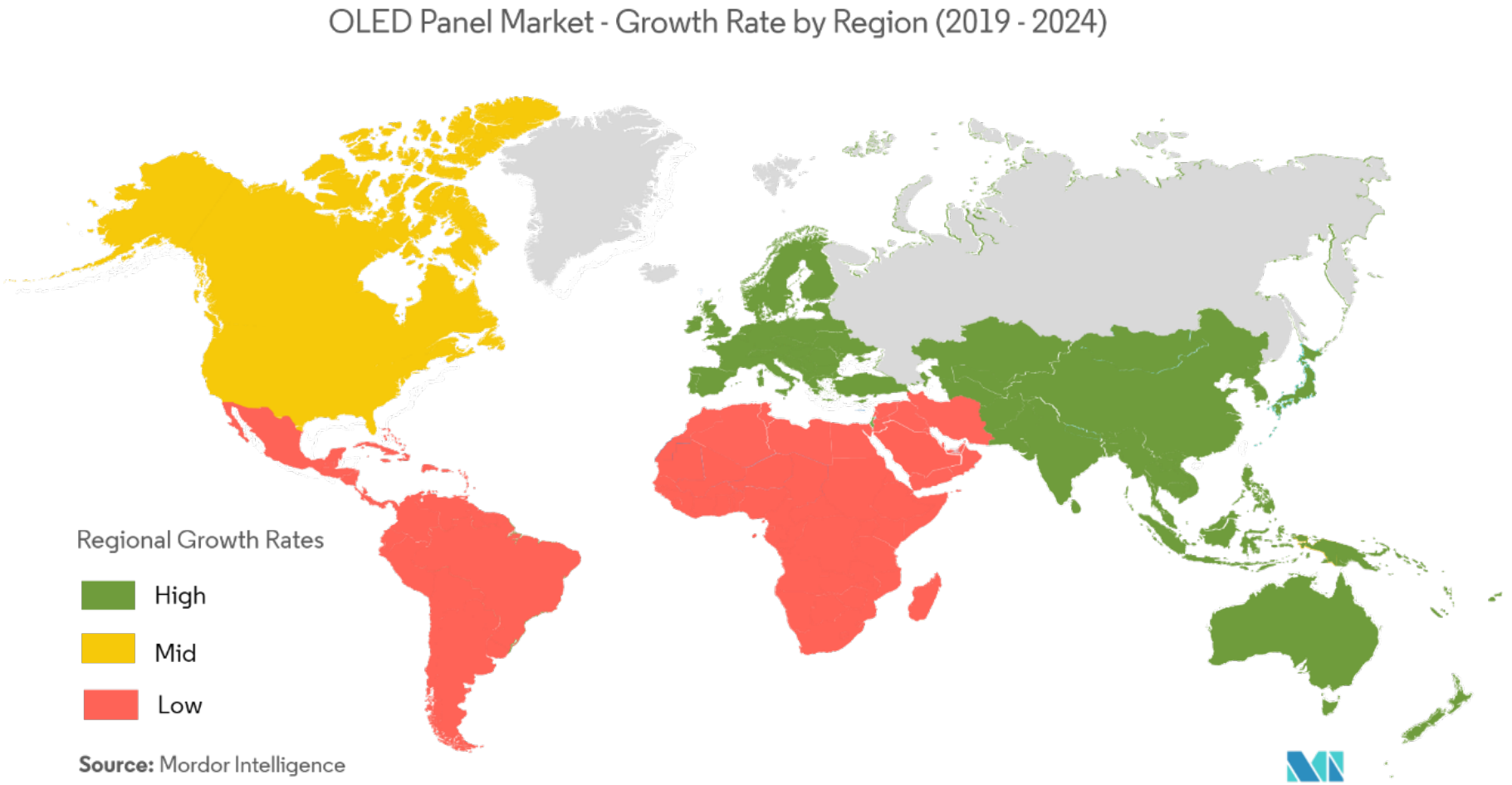
Market Segment

By Type	Flexible Rigid Transparent
By Display Address Scheme	PMOLED Display AMOLED Display
By Size	Small-sized OLED Panel Medium-sized OLED Panel Large-sized OLED Panel
By Product	Mobile and Tablet Television Automotive Wearable Other Products (Lighting Products, Healthcare, and Home Appliances)



Source: Mordor Intelligence

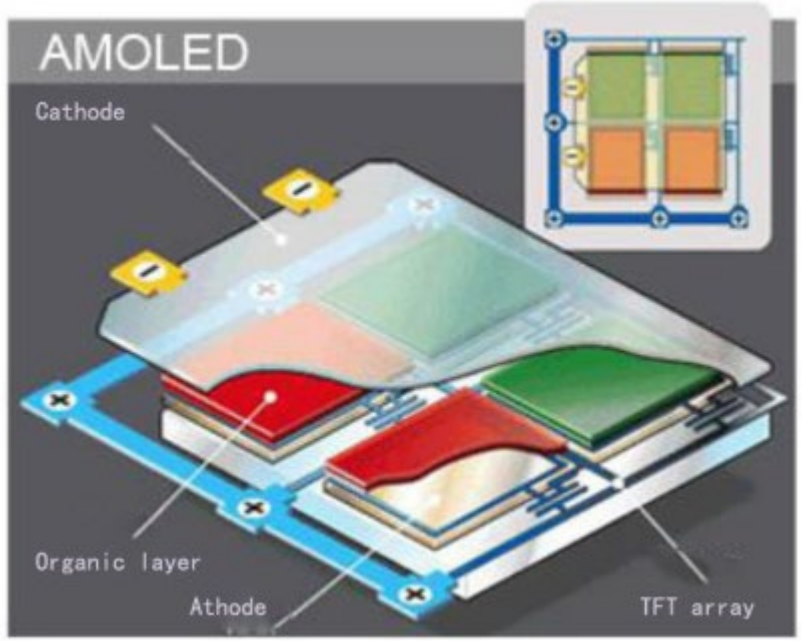
Market Segment



Key Market Trends

AMOLED Display in Smartphone and Tablet to Witness High Growth

- The OLED panel overshadows the traditional flat panel displays used in smartphones as it requires no additional backlighting, and it is emissive.
- Owing to the superior properties, such as less thickness and bright output, mobile manufacturers have been increasingly incorporating AMOLED panels in their product.
- An AMOLED uses an active-matrix TFT (thin-film transistor) array which contains a storage capacitors that maintains the line pixel states, and enables large size (and large resolution) displays.
- In its iPhone X, Apple employed flexible AMOLED alongside its super retina display technology, which led to the shift in the smartphone industry.

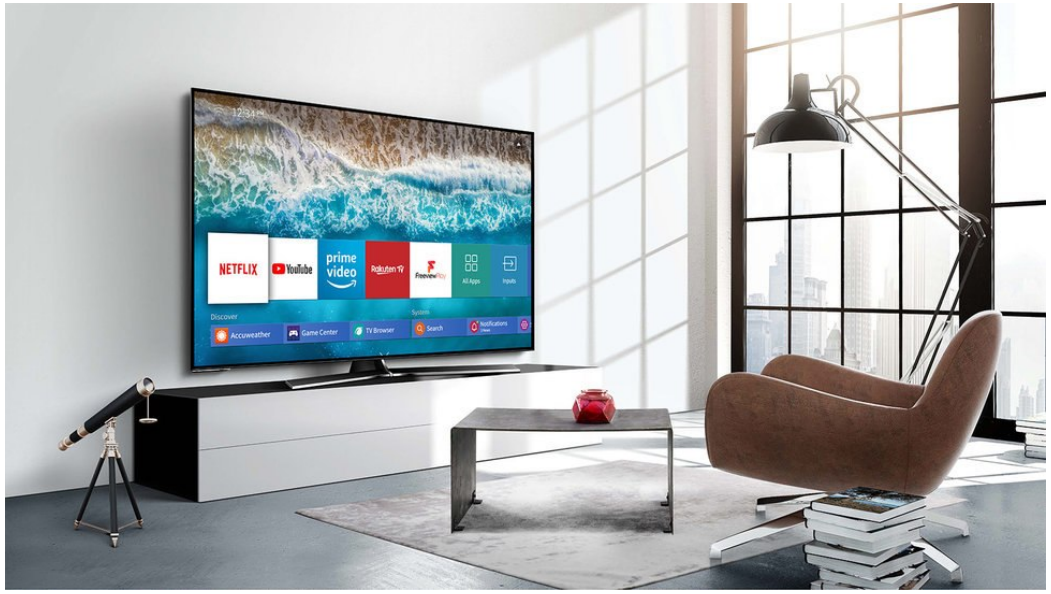


Asia-Pacific Occupies the Largest Market Share

- Asia-Pacific is the biggest market for OLED panels as most of the key players, including LG, and Samsung, have their manufacturing facilities in the region. Additionally, several TV manufacturers, signage display manufacturers, and other vendors have their headquarters in the APAC region.
- Companies in Asia supply their OLED panels to most of the major smartphone, TV & lighting manufacturers. The Asian smartphone market is witnessing a staggering growth, especially China being the smartphone giant that has dominated the industry for decades.

Increasing TV makers adopting OLED panels in premium TVs

Omdia estimates that over 22,000 units of large-area (at least 80-inch) OLED TVs will ship in 2021, up from 900 units in 2020. OLED TVs ranging from 70- to 79-inch will also hit a record sales volume of 325,700 units, up 70% from 2020 (which saw a 245% increase in 70- to 79-inch OLED sales).



Latest OLED TVs on the Market

LG C1 OLED TV

Sony Bravia XR A80J

Xiaomi Mi TV Master 77 OLED

Hisense A9G

Konka APHAEA V5

Skyworth W92

Panasonic JZ1500, JZ1000, JZ980

Philips 806/856 OLED TVs

Major Players

Major Players

Asia-Pacific

SAMSUNG DISPLAY

BOE

RAYSTAR

LG Display

TIANMA

INNOLUX 群創光電

SONY

Visionox

RiTEK

Futaba

EDO 和辉光电 EVERDISPLAY OPTRONICS

WS 智晶光電股份有限公司 WiseChip Semiconductor Inc.

EPSON EXCEED YOUR VISION

DLC DLC-Display Specialist

WINSTAR

Lumiotec

ROYOLE

AUO

North America

AcuityBrands.

UNIVERSAL DISPLAY CORPORATION™

OLEDWorks

Major Players

Company	Geographic Region	Focus Segment	Stock Information	Leading Technology	Website
Samsung Display Co. Ltd.	South Korea	Mobile Display, TV Display, PID, IT Display	Private	AMOLED, Curved	https://www.samsungdisplay.com/eng/index.jsp
LG Display Co., Ltd	South Korea	TV Display, Commercial Display, IT Display, Mobile Display, Automotive Display	NYSE: LPL KRX: 034220	WRGB, IPS	http://www.lgdisplay.com/eng/main
Sony Corporation	Japan	TV Display, Microdisplay	NYSE: SNE 6758:Tokyo	OLED Microdisplay	https://www.sony.net/
Futaba Corporation	Japan	Wearable, Activity Monitor, Instrument Panel, Water Heater, Commercial Mixer	6986:Tokyo	Flexible Film Display, Fixed Segment OLED Pattern Image	http://www.futaba.co.jp/en/index.html
Seiko Epson Corporation	Japan	Smart Glasses	6724:Tokyo	Silicon OLED Optical Engine Modules	https://global.epson.com/
Lumiotec	Japan	OLED lighting	Private	surface-luminescent OLED panels	http://www.lumiotec.com/en/index.html

Chart: Dragon Gate Investment Partners

Major Players

Company	Geographic Region	Focus Segment	Stock Information	Leading Technology	Website
BOE Technology Group Co., Ltd.	China	AMOLED Displays, Micro OLED display	000725.SZ	Flexible AMOLED Display	https://www.boe.com/en/
Tianma Microelectronics Co., Ltd.	China	AMOLED Displays	000050. SZ	On-cell TP AMOLED Solution	http://en.tianma.com/index.shtml
Visionox Co., Ltd.	China	AMOLED Displays	002387.SZ	"Bi-directional foldable single-axis display full module" products, 814PPI VR Display	http://www.visionox.com/
EverDisplay Optronics (EDO)	China	AMOLED Displays	688538.SS	AMOLED	
DLC Display Co., Limited	China	OLED Modules	Private		http://www.dlcdisplay.com/
Royole Corporation	China	fully flexible displays	Private	fully flexible display	https://www.royole.com/en

Chart: Dragon Gate Investment Partners

Major Players

Company	Geographic Region	Focus Segment	Stock Information	Leading Technology	Website
Raystar Optronics Inc.	Taiwan	OLED Graphic Display Module, OLED Character Display Module	Private	OLED display and module design	https://www.raystar-optronics.com/
Innolux Corporation	Taiwan	AMOLED and OLED Display	3481 TW	flexible OLED	http://www.innolux.com/pages/en/index_en.html
RITEK Corporation	Taiwan	small and medium-sized OLED	2349 TW	small and medium-sized OLED	https://www.ritek.com/
WiseChip Semiconductor Inc.	Taiwan	Bendable OLED, Round OLED, Touch OLED, Transparent OLED, Character OLED	Private	In Cell Touch PMOLED, Flexible and transparent PMOLED	https://www.wisechip.com.tw/en/
Winstar Display Co. Ltd	Taiwan	OLED Modules, Passive Matrix OLED, OLED Display Panel, OLED Dot Matrix Display	Private	PMOLED Modules	https://www.winstar.com.tw/
AU Optronics	Taiwan	AMOLED display	OTC: AUOTY	ink jet printing OLED technology	https://www.auo.com/en-global

Chart: Dragon Gate Investment Partners

Major Players

Company	Geographic Region	Focus Segment	Stock Information	Leading Technology	Website
Acuity Brands Lighting Inc.	United States	OLED Lighting	NYSE: AYI	Oled Luminaire With Panel-Integrated Drivers and Advanced Controls	https://www.acuitybrands.com/
Universal Display Corporation	United States	invention, research, development and commercialization of OLED technologies and materials	NASDAQ: OLED	UNIVERSAL OVJP® (Organic Vapor Jet Printing), UNIVERSALBARRIER® Thin-Film Encapsulation	https://oled.com/
OLEDWorks LLC.	United States	OLED lighting devices	Private	multi-stack OLED lighting	https://www.oledworks.com/

Chart: Dragon Gate Investment Partners

Recent Industry Updates- 2021

2021

July - IPValue acquires over 1,200 display related patents form Mitsubishi Electric

Yeolight shows new automotive OLED taillight prototypes

Nintendo announces Nintendo Switch OLED Model with a vibrant 7-inch OLED screen

June- Kopin developed a 35,000-nits green monochrome OLED microdisplay

LG starts shipping the 83-inch OLED C1, for $5,999 in the US

RSBG acquires 75% of inkjet system developer Notion Systems

May- LGD plans to increase production capacity at its Guangzhou OLED TV fab by July 2021

Korea launches a new project to develop 1,000 PPI Oxide TFTs for next-generation OLEDs

Source: oled-info.com

Recent Industry Updates- 2021

2021

April - Samsung Display starts producing OLED display modules at its Noida plant in India

DPI Labs install OLED TV displays on a VVIP Boeing 767

March- Solus Advanced Materials to build a $20.5 million OLED materials plant in China

Wise Road Capital acquires Magnachip for $1.4 billion

UDC and PPG to establish a new PHOLED production site in Ireland

February- LG Display to expand its Vietnamese OLED TV module factory in a $750 million investment

Everdisplay went public at the Shanghai Stock Exchange Star Market

January- trinamiX announces an under-the-OLED 3D imaging sensor

Source: oled-info.com

Recent Industry Updates- 2020

2020

January - Intel shows a foldable concept device with a 17.3-inch OLED display

January - Lenovo unveils a 13.3" foldable OLED laptop, to ship mid-2020

April - Merck acquires 700 OLED display patent families from Konica Minolta

April - Samsung Display to stop all LCD production by the end of 2020

June - TCL invests $187 million in JOLED, to jointly-develop OLED TV printing

June - Korea launches a national project to develop stretchable displays

June - Visionox launches the world's first OLED to support an under-the-display camera

July - LG Display starts to mass produce OLED TVs in Guangzhou

Source: oled-info.com

Recent Industry Updates- 2019

2019

July - LGD to invest a further $2.5 billion in its P10 OLED TV fab

August - Jilin OE Materials is building a $85 million OLED Material R&D center in China

August - Tianma to establish a 6-Gen flexible OLED fab in Xiamen, in a $6.8 billion investment

August - AUO demonstrates its first ink-jet printed OLED, a 17.3" 120Hz 4K display

September - BOE starts shipping its OLED microdisplays

September - Samsung re-launches the foldable OLED Galaxy Fold

October - Samsung formally announces its $10.8 billion QD-OLED TV investment

October - Wisechip launches the world's first Hyperfluoresence OLED display

December - BOE plans a new OLED microdisplay fab in a $470 million investment

Source: oled-info.com

Recent Industry Updates- 2019

2019

January - SDC announces new 15.6" UHD AMOLED displays for laptops

January - LGD launches the world's first rollable OLED TV

January - LGD launches a 88" 8K OLED TV

February - LGD launches the first phone with a CSO OLED

February - Samsung launch foldable OLED smartphones

April - RiTdisplay and Lumtec both start to produce OLED lighting panels

April - LG Display pulls out of the commercial OLED lighting market

May - TCL starts flexible OLED pilot production at its Wuhan CSoT fab

May - Lenovo demonstrates a foldable 13.3" Windows laptop

June - Oppo and Xiaomi show smartphone prototypes with under-the-OLED cameras

Source: oled-info.com

Thanks!

Thanks for reading Xuan's ***Manufacturing in Our Lives*** series, if you have any questions regarding the report, please contact xuan.luo@dgipl.com.

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