

The Trend and Opportunity of AMOLED Technology

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ABSTRACT

OLED has proven its value as the next generation of display technology, with advantages such as self-emitting light, high brightness and contrast, ultra-thin size, a large viewing angle, a large operating temperature range, and flexible display. The trend and opportunity of AMOLED technology are reviewed in this talk, and also the progress made by Visionox.

1 INTRODUCTION

In the first section of the report, the development of consumer electronics was reviewed, especially the mobile phone and its corresponding display panel. The conclusion is that AMOLED is still the most suitable option for mobile display applications.

The second part of the talk discusses about several evolution trends of the AMOLED display technology up to now, the first of which is from conventional curved screen to notched screen and finally towards all-curved display. This effort devotes to achieve higher and higher screen-to-body ratio, and to provide impression of boundless display to the customers.

Yet another important hot topic we can observe right now is the rush towards foldable and/or rollable display. This technology helps reduce the footprint of a mobile electronic device, whereas providing an expanded display area. As a further step beyond curved display, the foldable AMOLED screen raises more challenges not only to the display manufacturer, but also to the up-stream material vendors and down-stream system integrator. Therefore, a successful product could only be realized by a subtle balance between performance, reliability and the corresponding applications.

The last but not least progress is about fully integrated, "smart" display with diversified sensors, including fingerprint sensor, camera and microphone under screen, etc. Each of these integrated device leads to complicated trade-off between multiple features. Taking camera-under-display for example, the imaging quality of the camera depends on lower resolution pixel, simplified circuit and highly-transparent OLED materials, all of which sacrifice the image rendering quality of the display. More effort is still required to overcome these challenges and to achieve satisfying overall performance.

The third and last part of the talk introduces Visionox as one of the major suppliers of AMOLED display panel in the world. The history and current capability of Visionox are revealed in this section, including the miscellaneous

flexible AMOLED devices and systems developed in-house. The talk concludes to the belief of the company, that ubiquitous display will interconnect all electronics and their users, and vision of the company, that is to expand the worldviews and to improve the enjoyment of human vision.

2 Evolution of Mobile Display

The Evolution of Information Carriers was developed rapidly in several parts, for example, consumer product development, Energy evolution and display technologies. The display technic has been developed from CRT, LCD and AMOLED. We believe that the future display shall be everywhere, and we name it "Ubiquitous Display".

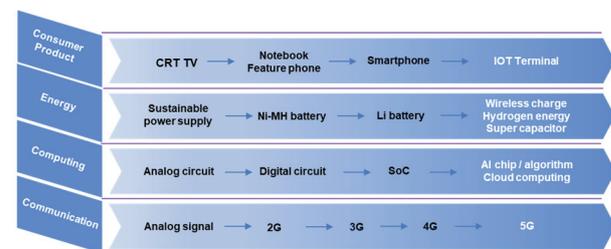


Fig. 1 Evolution of Information Carriers

The evolution of mobile phones have some common features: portability, which needs the display to be thinner and lighter; interaction efficiency, which means more colorful, higher screen-to-body ratio, higher PPI; function integration, that the mobile phone call should be multi-functional for game, music, photograph, audio record, navigation, flashlight and so on.

The evolution of mobile phones have brought very high requirement for the display, which accelerates the display maker to fabricate variable screen, as we all know about the full screen display, curved, foldable, rollable shape.

Among the various display technologies, AMOLED is best suitable to meet these high-standard requirements. The self-emissive properties lead to the very thin display to achieve curve and flexibility. And also AMOLED display could be transparent, so it could be integrated with various sensors and detectors.

3 Challenges and Opportunities for AMOLED Technology

For the curved display, The AMOLED display has been changed from 2D, 3D curved, 90° curved, and to

all curved, whose screen-to-body ratio could be 100%. The challenge inside includes material, lamination & pad-bending process, panel design & optical simulation and stress management & simulation.

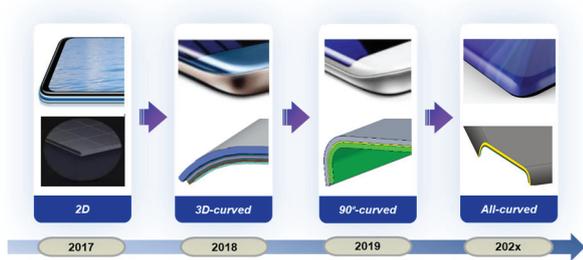


Fig. 2 Towards All-Curved AMOLED Display

For the foldable display, Samsung, Huawei, Xiaomi and Royole all present the foldable phones with different folding type. The challenge lies in the thinner cover window film, using colorless PI (CPI) or ultra-thin glass (UTG), out-cell or on-cell TP with better flexibility, thinner and/or integrated circular POL, tough and strong layers to mitigate the stress, for higher fatigue-resistance and yield tolerance, thinner OCA with better shearing performance and many other aspects. From a comprehensive understanding, three parts should be carefully considered: foldable performance, impact resistance, surface robustness.

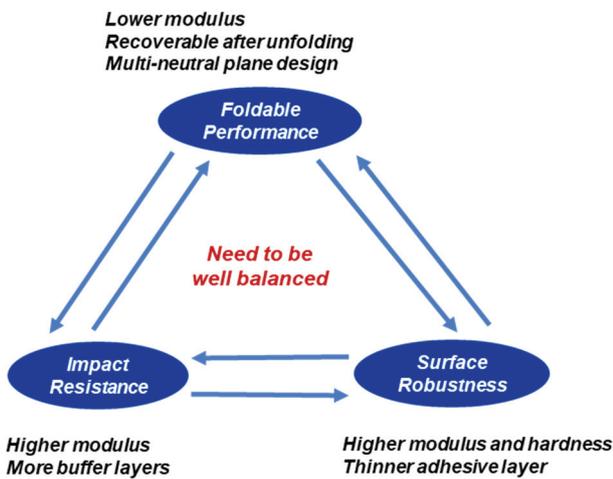


Fig. 3 Technical Challenge for foldable display

For the fully-integrated display, the display would be integrated with touch, haptic feedback, biometrics, microphone, screen phonation, camera, IR and so on. For the example, Fingerprint under display could be achieved by several solutions: lens, collimator, mapis, a-Si PIN sensor.

Solution	Lens	Collimator	Mapis	a-Si PIN Sensor
Schematic Diagram				
Resolution	~300PPI	~300PPI	> 500PPI	~250PPI
AMOLED Compatibility	FHD	FHD	QHD/FHD	QHD/FHD
Area of Sensor		~6mmx6mm / 8mmx8mm		~25mmx50mm
Brightness	600nit	600nit	350nit	600nit
Thickness	3.88mm	0.8mm	0.45mm	0.8mm

Fig. 4 Solutions for Fingerprint Under Display

For the 100% screen-to-body ratio, under display camera is an important technology. The challenge is on the agreement of high display quality and high photograph quality. However, they have the converse requirement for the panel fabrication. For example, the high PPI is demanded for good display quality but not for photograph quality, since the under display camera need the substrate to be transparent.

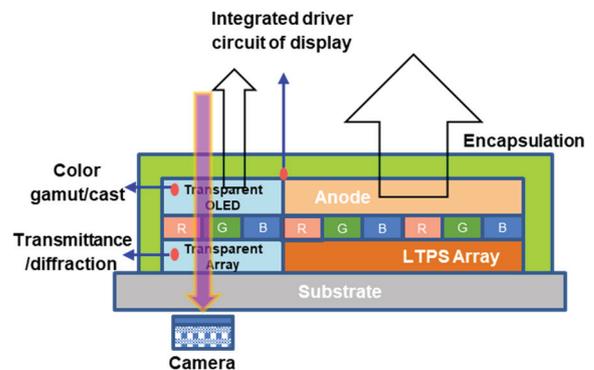


Fig. 5 Structure for Under Display Camera

4 Development of Visionox AMOLED Business

Visionox has founded for more than 23 years, with more than 7000 employees and 6000 patents. The company operates under a vision of "pushing boundaries to enhance the experience of vision" and a mission of "leading China's OLED industry through technological innovation." With over 20 years of experience in OLED technology, Visionox has become a globally leading enterprise in the OLED industry, covering R&D, production, and sales.

Focusing on new display technology, the Visionox R&D teams carry out research in cutting-edge technologies such as flexible OLED displays, as well as generic technologies, key technologies, and forward-looking technologies. At the same time, Visionox unites industry, education, research, politics, and finance to establish mechanisms for collaboration and promote scientific and technological progress. Visionox's R&D centers have established long-term cooperative relationships with many well-known universities in China and abroad. The centers include overseas experts and

