As TV makers struggle to trigger replacement cycles, Wide Color Gamut (WCG) and High Dynamic Range (HDR) and their notable picture quality improvements are the next growth drivers for the industry. Various technologies are competing to deliver those features. In the short and mid-term, the best-positioned ones are OLED and the well-established, dominant, LCD technology supercharged with narrow-band phosphor LEDs or quantum dot (QD) color converters in the backlight unit.

Quantum Dots enable drastic enhancements of display color gamut. They do so with high efficiency, giving display makers headroom to increase brightness, contrast and gamut without increasing power consumption. Their most common implementation is as color conversion films located in the LCD backlight unit. QDs in this form are drop-in solutions that can be easily deployed on all sizes of displays without any process change or capital expenditure (CapEx) required by display makers. QDs therefore enable the LCD industry to boost the performance of its products without major investment. This contrasts with OLEDs, which require building multibillion-dollar dedicated fabs.

However QDs don’t solve some LCD shortcomings. They still lag in terms of response times, black levels, viewing angles. Also, LCDs can’t deliver pixel-level dimming, the strongest selling point for OLED displays. In the future, QDs could substitute for LCD color filters. Unlike films, this configuration requires some process changes in LCD manufacturing. However it would double the display efficiency, further improve color gamut and provide viewing angles similar to OLED. In the longer term, Electroluminescent QDs (EL-QD) could deliver OLED-like characteristics and performance, with improved brightness and stability.

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QDs will take advantage of this window of opportunity to capture the lion’s share of the WCG TV market. Rapidly improving performance and decreasing cost enables adoption to spread into mid-range, sub-$1000 models. Display makers will use QDs to keep extracting more value from existing LCD manufacturing. For the long term however, many are hedging their bets and looking at both RGB printed OLED and EL-QDs. In the mid-term, QD Color Filter (QDCF) configurations represent an attractive opportunity to close the gap with OLED in term of viewing angles and widen it in term of gamut and efficiency. QDCF however requires some LCD manufacturing process changes. Although moderate compared to a new OLED fab, not every LCD maker will want to commit the required CapEx or even develop the technology.

Narrowband phosphors deliver performance close to QDs at much lower cost. The performance gap, however, is widening as QDs keep improving and the cost gap decreases. Phosphors will therefore lose market share in the premium segments, but overall volumes will grow significantly thanks to increasing penetration in mid-range products. We also expect narrowband phosphors to be the dominant solution for smaller WCG LCD displays.

In the longer term, both OLED and QD-enhanced LCD could face competition from new, disruptive technologies such as electroluminescent QDs or even microLEDs, which could drive a potential paradigm shift in self-emissive display technology. Other technological innovations could also disrupt the QD market. For example commercialization of a narrow-band green phosphor could eliminate the performance gap between phosphors and QD films and enable a more cost-effective solution.

In 2017, demand for QDs is dominated by Samsung. After the demise of pioneer QD-Vision, whose intellectual property was acquired by Samsung in 2016, Nanosys and Hansol are the only QD manufacturers supplying high volumes in 2017. This could change rapidly however as many more TV makers adopt QDs.

Nanoco and its new film partner Wah Hong seem closer than ever to scoring a design win. Quantum Materials in the US and NS Materials in Japan are other credible outsiders. In the fast-growing Chinese display industry, local QD maker Najing Tech is partnering with key manufacturers, accelerating the development of QD films and EL-QD and preparing to ramp up manufacturing.

Many more companies are investing at various levels of the supply chain to get their share of the material, film or barrier opportunities. 2016 saw a major IP battle between Nanosys and QD Vision. As new companies attempt to get their share of the pie, we expect established leaders to become increasingly aggressive in leveraging IP to block new entrants.

On the environmental front, cadmium (Cd)-free QDs dominate the market. Combined with the upcoming availability of fully RoHS compliant solutions such as Nanosys’ Hyperion or possibly hybrid green QD/narrowband red phosphors (PSF), this has prompted the European Commission not to renew a Restriction of Hazardous Substances (RoHS) Directive exemption that temporarily allowed higher cadmium content (a decision that should be ratified by the Parliament later this year). Cd-free solutions will therefore keep dominating the market, but will coexist with Cd-based yet RoHS compliant solutions. Most manufacturers, however, will stay away from any Cd-containing compositions.
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