From smart systems research to value creation: the success stories to follow

Newcomer on the display market, Qualcomm promises a revolution with its Mirasol display, the first MEMS display, halfway between the LCD and e-ink.

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Most of today's mobile electronic devices use an LCD display. On the plus side, LCDs offer a color display for static pictures and an interface for movies, sometimes at a very high resolution; on the down side, LCD displays require a backlight to function, and they also consume a lot of energy, which is a problem for a battery-powered device. Another weakness is that LCD displays are difficult to read outdoor in direct sunlight.

Several years ago, the E-ink technology was introduced for use mainly in eBook readers. E-ink is a bi-stable technology, so it consumes less energy and offers a contrast high enough for use in sunlight. However, the graphic performance of the E-ink is poor, and color and video are not available yet.

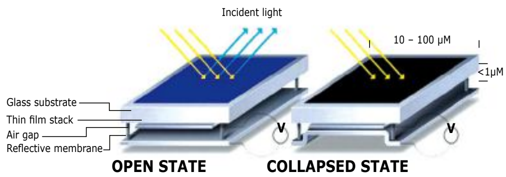
The Qualcomm Mirasol® offers another solution for portable display, and its characteristics place it between the LCD and E-ink technologies. The Mirasol® display is based on a reflective technology called IMOD (Interferometric Modulation), which has MEMS structures at its core. Each pixel contains reflecting micro-membranes. The technology is bi-stable, meaning it is very low power and highly reflective. The display can be seen in direct sunlight and eye strain is lower than LCD, though similar to E-ink; but with color images and a high refresh rate (30 FPS video), Mirasol® offers more possibilities than the E-Ink technology.

System Plus Consulting has studied the Kyobo eReader, the first eBook with a Mirasol® display. It features a 5.7-inch display with a definition XGA (1024 x 768 pixels, 223 ppi), and has a battery life between 1 - 2 weeks. Also, the Kyobo eReader integrates a backlight system for night reading. The electronic is on two boards, and the main IC uses a 1 GHz Qualcomm Snapdragon processor -- but the presence of a Xilinx FPGA and a Microchip microcontroller suggests that the electronic is not as integrated as it is in mobile phones. Completing the electronic is an internal Flash memory of 4GB, and WLAN. Eight drivers (22.8 mm² = 20.9mm x 1.09mm) are bonded to the Mirasol® display glass, and four Flex connect the display to the electronic. The absence of TFT on the screen increases the need for drivers and flex.

Main electronic board.
(Courtesy of System Plus Consulting)

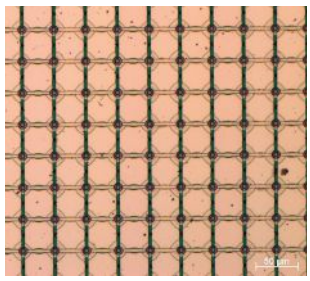
Technology analysis

The interferometric effect is generated by the variable thickness between the movable mirrors and the stationary glass panel.



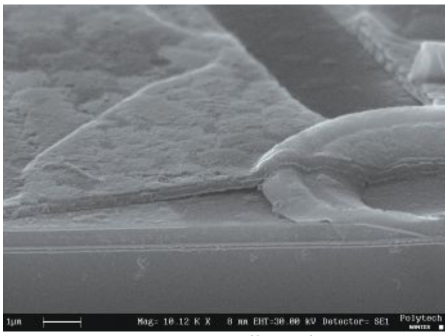
(Courtesy of Qualcomm)

Each pixel is a micro MEMS of 38µm x 38µm. The air gap thickness is controlled by a voltage between two electrodes. The display reflects the exterior light. 1 color = 1 air gap thickness. One pixel is specified for one color, while the other colors generate destructive interference in the pixel. To make three colors, three thicknesses are necessary. The air gaps are manufactured thanks to a sacrificial layer principle. Three vanadium layers (with three different thicknesses) are deposited before the manufacturing of the reflective membranes and etched at the end of the process, sacrificial oxide. The thickness of the reflective membrane is a function of the gap thickness to allow the same actuation voltage for collapsing the reflective membrane with three different gap sizes.



Pixels matrix.
(Courtesy of System Plus Consulting)

The following picture shows a cross-section of one mirror and its support:

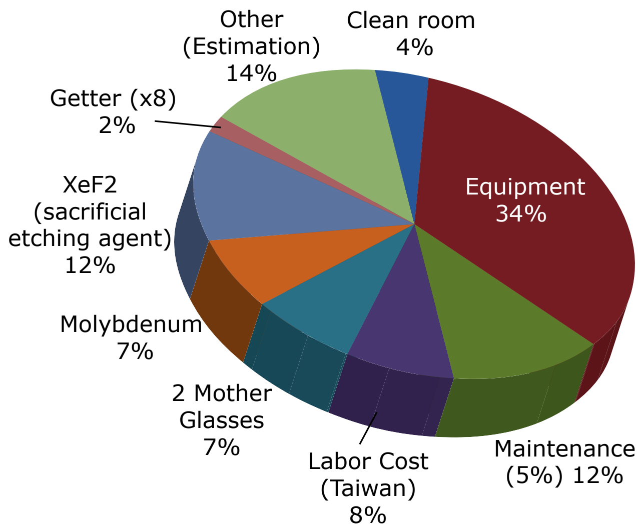


Mirasol® pixel Cross Section.
(Courtesy of System Plus Consulting)

Supply chain and cost structure

The Mirasol® displays represent the first MEMS-manufactured LCD technology. Today the display is assembled in an old 4G LCD plant by Foxlink, Qualcomm's production partner. The plant has had some problems delivering enough screens, and the yield is disappointing; but in 2010, Qualcomm invested $1 billion to build a dedicated plant for the Mirasol® display. This new plant should deliver its first screen in mid-2012. It is a 4.5G mother glass factory (730mm x 920mm) in Hsinchu, Taiwan. The capacity of this new plant is 50,000 mother glasses per month, and we estimate there are thirty 5.7" displays on a mother glass of 4.5G.

Display Mirasol manufacturing cost 600,000 displays per month



Display cost breakdown.
(Courtesy of System Plus Consulting)

Today, the manufacturing cost is high due to low yield and low production volume, but we suppose that Qualcomm is testing the market before reaching good yields and high-volume production with the new fab unit. The simulated cost at medium term should be more competitive with the actual cost of LCD and E-ink displays.

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