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REPORT ON INTERFEROMETRIC MODULATOR (IMOD)

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ABSTRACT

Interferometric Modulator (IMOD)is a display technology. It uses the interference of light for display. It is a light modulator that has an electrical switch. It can both emit light to appear colorful and absorb light to appear black. It is also called Mirasol. It creates various colors by using the interference principle. It uses the interference of the reflected light to show different colors. It uses very little power and can also be seen in sunlight. The Interferometric Modulator (IMOD) is an electrically switched light modulator comprising a micro-machined cavity that is switched on and off using driver ICs similar to those used to address LCDs. An IMOD based reflective flat panel display can comprise hundreds of thousands of individually addressable IMOD elements. IMOD displays represent one of the largest examples of a **micro electro mechanical systems** (MEMS) based device.

1. INTRODUCTION

Wireless communications are an essential and continuously expanding part of modern life. Smart phones presents a number of challenging requirements on the display module, such as low power consumption, video quality speed, and viewability in a broad range of lighting conditions. The IMOD displays minimize eye strain, and their wide viewing cones are free of the inversion effects that plague polarization-based displays. Qualcomm's new media FLO technology will enable user to watch high performance video on portable device and applications such as this need a display offering superior viewability and less power consumption. The Qualcomm's IMOD display technology will overcome all above mentioned requirements. IMOD is a set of image processing, modeling and display programs used for tomographic reconstruction and for 3D reconstruction of EM serial sections and optical sections. The package contains tools for assembling and aligning data within multiple types and sizes of image stacks, viewing 3-D data from any orientation, and modeling and display of the image files. IMOD was developed primarily by David Mastronarde, Rick Gaudette, Sue Held, Jim Kremer, Quanren Xiong, Suraj Khochare, and John Heumann at the University of Colorado.

2. NEED OF IMOD

There have been several electronic devices that are made. These electronic devices need technologies that help them stay charged so that less power is drained and also lesser electricity is needed to power it. The display technologies also needed a way by which they could have a lesser strain on the eyes. Keeping all this in mind, the Interferometric Modulator Technology was developed to solve all such problems.

3. WORKING PRINCIPLE

The basic elements of an IMOD-based display are microscopic devices that act essentially as mirrors that can be switched on or off individually. Each of these elements reflects only one exact wavelength of light, such as a specific hue of red, green or blue, when turned on, and absorbs light (appears black) when off.[2] Elements are organised into a rectangular array in order to produce a display screen.

An array of elements that all reflect the same color when turned on produces a monochromatic display, for example black and red (in this example using IMOD elements that reflect red light when "on"). As each element reflects only a certain amount of light, grouping several elements of the same color together as subpixels allows different brightness levels for a pixel based on how many elements are reflective at a particular time.

Multiple color displays are created by using subpixels, each designed to reflect a specific different color. Multiple elements of each color are generally used to both give more combinations of displayable color (by mixing the reflected colors) and to balance the overall brightness of the pixel.

4. BASIC STRUCTURE OF IMOD PIXEL

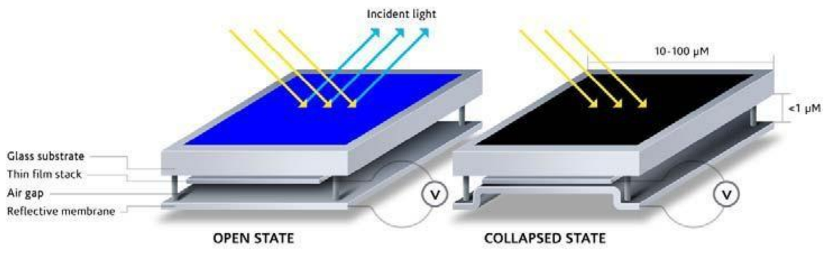

Fig 1: Basic Structure of an IMOD Pixel

A pixel in an IMOD-based display consists of one or more subpixels that are individual microscopic interferometric cavities similar in operation to Fabry–Pérot interferometers (etalons), and the scales in butterfly wings. While a simple etalon consists of two half-silvered mirrors, an IMOD comprises a reflective membrane which can move in relation to a semi-transparent thin film stack.[5] With an air gap defined within this cavity, the IMOD behaves like an optically resonant structure whose reflected color is determined by the size of the airgap.

Figure 1 illustrates the basic structure of an IMOD pixel. The pixel consists of a glass substrate which is coated with thin films. Beneath the glass is a reflective conductive membrane which is separated from the glass by a thin air gap. When a voltage is applied to the membrane and the thin films on the glass, the membrane experiences electrostatic attraction and is drawn towards the glass. This state is called the collapsed state and the pixel appears black as the light entering is shifted to the UV spectrum. The application of a lower voltage level returns the membrane to the original position, called the open state. In this state the pixel appears bright and colored. This color is generated by interference of light, a process which is much more efficient than using color filters. Figure 4 illustrates the superior efficiency of the mirasol display when compared to color filter-based reflective displays.

4.1 TECHNOLOGY USED IN IMOD

- **Glass substrate:** This is a substrate made of glass. Each pixel in an interferometric modulator is coated with this substance. This is a substrate displaying transparent properties.

- **Reflective membrane:** This is a thin membrane that uses the property of reflection for image construction. The reflective membrane is placed beneath the glass substrate. This membrane is a conductor of electricity.

- **Stack:** This is semi-transparent in nature and does not absorb or reflect all the light. It is made up of a thin film.

- **Air gap:** Various colors on the screen are a result of varying air gap present. The gap is present between the glass substrate and the reflective membrane. Due to the application of voltage, there is an increase or decrease in the air gap that results in the formation of various colored pixels.

5. COMPARISONS OF IMOD WITH OTHER DISPLAYS

- **IMOD Technology vs. LCD: -** A mirasol display’s relative simplicity, low power usage and outdoor viewing characteristics make it a compelling replacement for LCDs. In the initial stages the mirasol display will compete primarily with monochromatic (MSTN) and color super twisted nematic (CSTN) displays, used in portable devices. First brought to light in 1968, LCD technology has rapidly gained a foothold in the display market. Continuous improvements to the chemical mixtures and display-drive electronics, as well as optical films, have overcome the initial problems of the STN-based displays, namely low contrast and low resolution. While scientists continue to work on reducing the power requirements and improving the sunlight readability of the STN and TFT type LCDs, limitations inherent in the technology are making it difficult to achieve meaningful improvements.

- Qualcomm’s mirasol displays are considerably less complex than LCDs. As described in the previous part, the IMOD element in a mirasol display is bistable and the display can therefore maintain a given image without the need for continuous power. Bistability also leads to a significant amount of power savings when compared to an LCD, which has to be continuously driven as many as 60 times a second in order to prevent the display from losing the image. In addition to the power savings, the mirasol display provides a better viewing experience when compared to the LCD.

- **IMOD Technology vs. OLED:-** Since IMOD components in mirasol displays can be built on a subset of FPD fab lines, the mirasol display’s manufacturing costs are expected to ramp quickly downward as volume increases. OLEDs, on the other hand, require completely new fab facilities.

- Perhaps the mirasol display's greatest advantage over OLEDs, especially in the battery powered, small-screen arena is that in order to be visible, the OLED must be powered continuously. OLEDs, then, typically consume around 200mW, compared to 10s of microwatts for mirasol displays without supplemental lighting (display in hold state showing static image).

- OLEDs offer several advantages over LCDs. However, the technology has not gained a major foothold for several reason. The cons will be discussed on the next page while the pros will be reviewed here. The basic OLED cell structure is comprised of a stack of thin organic layers that are sandwiched between a transparent anode and a metallic cathode. When a current passes between the cathode and anode, the organic compounds emit light the obvious advantage is that OLEDs are like tiny light bulbs, so they don't need a backlight or any other external light source. They're less than one-third the bulk of a typical color LCD and about half the thickness of most black-and-white LCDs. The viewing angle is also wider, about 160 degrees. OLEDs also switch faster than LCD elements, producing a smoother animation. Once initial investments in new facilities are recouped, OLEDs can potentially compete at an equal or lower cost than incumbent LCDs.

- **IMOD Technology vs. EPD:-** Electrophoretic (EPD) displays use the concept of electrophoresis, which is the movement of an electrically charged object under the influence of an electric field, in order to display information. The charged object is typically a tiny ball the diameter of a human hair. It is typically black on one side and white on the other, or it can be tiny apsules filled with charged white particles suspended in colored oil. The application of an electric field changes the orientation of these objects, thereby making the display pixel appear black or white when viewed with reflected light. This technology has been successfully implemented by several companies and displays using this technology offer a comparable level of readability, wide viewing angle and stability as an IMOD-based display. However, these displays are currently not capable of offering full colour at a high level of reflectivity. In order to display colour it is necessary to use colour filters, which results in a major drop in display brightness and readability. Switching speeds are also much slower than those of an IMOD element used in mirasol displays. A transition from black to white requires a state change in which a physical object has to move through a viscous fluid. Because of this naturally slow process, an electrophoretic display is typically very slow to update (on the order of 500 milliseconds or slower), making it unsuitable for video applications.

- **IMOD Technology vs. ChLCD :-** Cholesteric LCDs (ChLCDs) are based on a type of liquid-crystal which has a very tightly wound spiral structure, with a pitch on the order of the wavelength of light. This material has the unique ability to reflect light of certain wavelengths (depending on the pitch) and as a result appear colored. When an electric field is applied to the material, it can be switched into a state where the spiral structure is broken and, as a result, the material appears translucent. If a display similar to a reflective STN display is constructed using this material, the rear substrate does not need to be reflective. In fact, it can be tinted black so that when the material appears translucent, the viewer actually sees a black pixel. Displays constructed as such have the ability to produce a bichrome image. In order to produce full-color displays, these displays are usually stacked one on top of the other, with each display producing red, green or blue.

6. ADVANTAGES AND APPLICATIONS

ADVANTAGES:

- Industry compatibility
- speed
- Readability
- Less power consumption
- Consistent contrast quality
- Smoother animation
- Faster video response

APPLICATIONS:

- MP3 player
- Cell phone secondary and main displays
- Portable Bluetooth accessories
- Handheld / wrist-worn GPS devices
- Industrial applications
- Gaming devices
- Digital TV and DVD players
- Medical imaging
- Automotive navigation
- Digital camera and camcorder screen

7. SUMMARY

- IMOD display technology is developing rapidly, and is expected to soon become dominant in displays for low-power, portable applications like e-readers, remote equipment for military applications, and perhaps in products aimed at third world countries such as OLPC. The advantages of IMOD displays are that they require very little power, feature excellent viewability even in bright sunlight, high readability, robust functionality, technical flexibility and mechanical durability.

- Qualcomm's experience in the mobile phone industry, in addition to consumer research, has shown us that consumers will continue to demand and quickly adopt mobile products with an Always-On display, smooth video response, sunlight viewability and extended battery life. Qualcomm's mirasol display will not only replace existing technologies, it will transform the industry by changing user expectations and behavior. Its distinct advantages over LCDs, transmissive technologies and OLEDs emissive technologies, coupled with Qualcomm's commitment to be a major player in portable displays, makes the mirasol display a serious contender in the display space.

- For manufacturers of displays and products that use them, mirasol displays present an Attractive, low-risk alternative to advanced LCD, OLED and EPD display technologies. Because mirasol displays conform to interconnect standards for most of today's small display applications, it can be designed efficiently into future products

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