FLEXIBLE FLAT PANEL DISPLAY NOTEBOOK

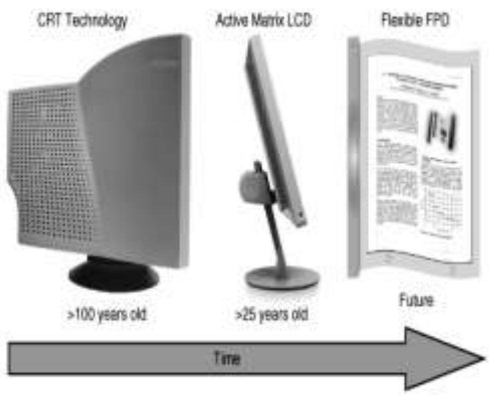
Shivam Tushar Verma[1], Rizwan Khan[2]

[1] *Department Of Computer Science, ABES Institute Of Technology Ghaziabad, (India)*

[2] *Assistant Professor Department Of Computer Science, ABES Institute Of Technology Ghaziabad, (India)*

ABSTRACT

Research on flat panel displays, which started in the 1960s, finally reached the commercialization stage in the form of large plasma display panels which are (PDPs) and liquid crystal displays (LCDs). This research will hopefully lead to FPDs with larger displays, higher picture quality, lower power consumption, and surely lower prices. A spin-off of this trend is the growing demand for enhanced picture quality broadcasting in media such as Hi-Vision (HDTV) and in data services. In the future, broadcasting, communications and personal computers will have fused together to form a common media by which interactive broadcasting and mobile reception via digital terrestrial broadcasting will be available in all most every area. The demand for ubiquitous and easy-to-use displays as human interfaces will also increase. All these interfaces will be a lightweight, flexible display that can be rolled up or folded. It might be possible for everyone to carry a large display device simply by rolling it up. While the dream of having a flexible display has a long history, roll-up and paper-like displays are now estimated to be commercially feasible by around 2016. It has also become apparent that the advent of flexible display systems will have a significant impact on the market and on the people, not only because of the ubiquitous and convenient systems that could be supported, but also of the potentials to provide unconventional visual effects that are not possible with conventional systems. Moreover, the manufacturing technology for these displays will likely to be of low-cost and environment friendly. Studies on these display systems and materials have just begun, and it is unwise to give definitive statements about such a display system. That said, however, the following pages describing the issues and prospects of flexible displays will definitely give the reader an overall Introduction to the present research



Evolution of display technology

Keywords: Flexible Display, Flexible Notebook, Flexible Copy, Paperless Technology, Plasma Display Panels, Flat Panel Display

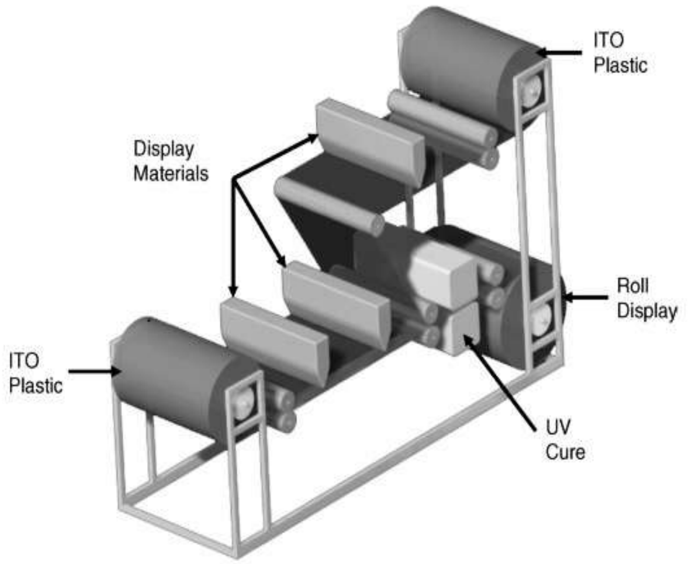
I. INTRODUCTION

There are many teachers in private school and they are allotted with 6 classes in which 40 students are present in each class and obviously they have to carry dozens of copies back to home to check them and carry them back again to return to students which I thought was very hectic and burdened work. When I used to see young school children carrying their text books and copies in their bags I felt pity for them because EVERY STANDARD IN SCHOOL comprises of 6 subjects and for each their associates a text book and a copy. Necessity is the mother of invention but actually the truth is scarcity is the grand mother of invention. I'm an engineering student and my role was to become the bridge between both the technology and the people because I heard "if people want what they can't have become the thing people want". So I decided to create something which can eliminate the use of bulky books and copies and started doing research and finally found an alternative which can revolutionize the way children can carry their books and copies in a single flexible flat panel display which would include the capability of handwriting recognition. Laptops and tablets eliminated the use of bulky computer but were they able to eliminate the bulky copies and textbooks for each subject which was far away from technology. Flexible flat panel display copies with dual sided touch screens, features of handwriting recognition, connectivity to internet, inbuilt memory could eliminate the use of papers, which could definitely save trees in an unimaginable form, use of pen and pencils would also save wood and chemicals for making ink, Bluetooth and Wi-Fi connectivity would allow teachers to check copies of hundreds of students by simply accessing documents from their flexible copies. Giving assignments would be as simple as sending mails AND MUCH MORE. The manufacturing of these flat panel displays is a dynamic and continuously evolving industry .Improvements in flat panel displays are made rapidly as technology improves and new discoveries are made by the scientists and engineers. The cathode ray tube (CRT) and active matrix liquid crystal display (LCD) recently celebrated their 100th and 25th anniversary, respectively. The arrival of these kinds of portable electronic devices has put an increasing premium on durable, lightweight and inexpensive display components. In past years, there has been significant research investment in the development of a flexible display technology. the evolution from the bulky CRT display to the thin active matrix LCD for desktop applications, and the much more anticipated paper-like flexible flat panel displays of the future. To enable a flexible flat panel display, a flexible substrate must be used to replace these conventional glass substrates, which can be either plastic or a thin glass.

Flexible flat panel display technologies offer many potential advantages over other displays, such as very thin profiles, lightweight and robust display systems, advance processing , the ability to flex, curve, conform, roll, and fold a display for extreme portability, high-throughput in manufacturing, wearable displays integrated with in garments and textiles, and ultimate engineering design freedom (e.g. odd-shaped displays)and etc…. have been potential advantages for the principal driving force behind much of the effort and resources dedicated towards the development of flexible flat panel display configurations. There are also many new compelling product categories enabled by the plastic display technology. An electronic newspaper, for example, could eventually update headlines throughout the day and can behave as virtual environment. If plastic displays on televisions and computers could become analogous to that of fabric or paper, they would no longer dominate our physical and aesthetic worlds. We could make them easily fade from sight when not in service. The textbooks and copies we use could simply be roll up into a pen that you could stick into your shirt pocket. Instead of adapting our aesthetic sensibilities to incorporate technology into our lives, technology would itself reflect our imagination and creativity. The broad definition of a flexible flat panel display is as:-A flat panel display constructed of thin (flexible) substrates that can be easily bent, flexed, conformed, or rolled to a radius of curvature of a few centimeters without losing functionality. Defining a flexible display is akin to defining modern art. Because of the diversity of the application space for flexible display technology is so vast, that it is so hard to propose an all-encompassing definition. The term ‘‘flexible display’’ means different things to different people. Flexible displays could be flexed once during their lifetime; for example, during manufacturing to create a permanently conformed display. For such a rollable display application, however, the display may be rolled and unrolled more than 200 times a day. The ability of flex in a display has fascinated researchers for many years, but only today they are being seriously considered for a number of applications and utilities but moving closer to the market place the primary reason for the increased interest is that many of the necessary enabling technologies for flexible displays are maturing to the extent where reasonable looking prototypes are being developed by many research and development organizations. The convergence and evolution of such technologies as flexible substrates, barrier layers, conducting layers, electro-optic materials, optical and functional thin film materials, and thin film transistors (TFTs) are making possible for these new flexible display concepts to take birth. Flexible display technology can potentially result in many compelling applications which can’t be satisfied by a rigid glass-based display. Also, there may be a temptation to believe flexible displays will replace glass-based displays for many other applications. While this is possible at this point ,but it will be very difficult for such flexible displays to compete solely on cost alone in the inexpensive and small display module market or in the high-end, high-performance market . For the time being, flexible displays will most likely enter the marketplace in a unique way where their positive attributes and features are clearly capitalized on. Flexible flat panel display technology constitutes an eclectic research field and potentially a very large industry in the future. It’s highly interdisciplinary range combines of basic principles from engineering, physics, chemistry, and manufacturing.

II. MANUFACTURING

Although it may be somewhat of an overstatement, the words ‘‘Holy Grail’’ are often used to describe the flat panel display community desire to achieve a commercialized flexible display technology. One reason why these words are often used is because flexible displays, in principle, are amendable to a roll-to-roll manufacturing process which would be a revolutionary change from current batch process manufacturing. Figure shows a simple conceptual illustration of a roll-to-roll manufacturing process where display materials are deposited on indium-tin-oxide (ITO) coated plastic substrates, processed, and rolled back up. As compared to a batch process, which handles only one component at a time, roll-to-roll processing represents a dramatic deviation from current manufacturing practices. If and when roll-to-roll manufacturing technology matures for display processing, it promises to reduce capital equipment costs, reduce display part costs, significantly increase throughput, and it may potentially eliminate component supply chain issues if all processes are performed with roll-to-roll techniques. Although batch processing can still be employed to manufacture flexible flat panel displays, many researchers and technologists believe that roll-to-roll manufacturing will ultimately be implemented .



A simple schematic diagram of a roll-to-roll manufacturing process

III. DUAL TOUCH SCREEN

A dual-touchscreen is a display setup which uses two screens, in which both of the screens could be touch-capable, to display both elements of graphical user interface and virtualized implementations of common input devices, including virtual keyboards. Usually, in a dual-touchscreen device, the most persistent GUI elements and functions are displayed on one, hand-accessible touchscreen alongside the virtual keyboard, while the other, more optically-centric display is used for those user interface elements which are either less or never accessed by user-generated behaviors. It uses the approach in which user-generated actions are initialized on the lower resistive touchscreen while the resulting graphical displays are executed in the upper screen. While taking touch screens to another level it will allow user to use both sides of flexible panel display.

IV. ENABLING TECHNOLOGIES

The technology of flexible flat panel display includes many new components and supporting technologies. Anticipating a new market opportunity, the display industry has been already developing display materials targeted specifically at flexible flat panel display requirements. These technologies are compatible and converge to enable a truly flexible display. The necessary technologies include robust flexible substrates, conducting plastic or glasses conducting oxides and/or conducting polymers, electro-optic and reflecting materials, inorganic and organic electronics. In addition, many processes must also be developed and optimized in concerned with the materials development, such as roll-to-roll manufacturing, coating technology, and printing. In reality, these components and processes cannot be optimized independently since a flexible display is a complex system of linked components that must be co-developed in order to function efficiently. Since the field is still racing towards commercialization at a rapid pace, it is not at all clear which technologies will win and ultimately become commercialized

V. IMPACT OF FLEXIBLE DISPLAYS

The move from the cathode ray tube (CRT) display to the Flexible paned displays is a major transition; electron beam scanning systems are rapidly being replaced with matrix displays. The main effects of this transition are a significant space saving that makes large wall- mountable TV screens or bulky text books and copies to be practically in easily mobility, as in the case of the laptop computer. A flexible display system is expected to have a significant impact that is beyond that of conventional flat panel display systems. That impact is detailed below.

5.1 Ubiquitous Convenient System

The weight of a normal science text book would be approximately 1000 g apart from that carrying six such books and adding on the notebooks weight the complete bag weight could vary from 7-8 kgs. This is such an equal order of magnitude of a conventional wall-mounted LCD, or CRT display. Its volume would be at least three orders of magnitude smaller than that of a CRT display. It will be able to be rolled up or folded, transported anywhere, and operated indoors or outside. These characteristics will drastically diversify carrying bulky text book styles and promote the distribution of the contents.

5.2 Fusion Of Medias

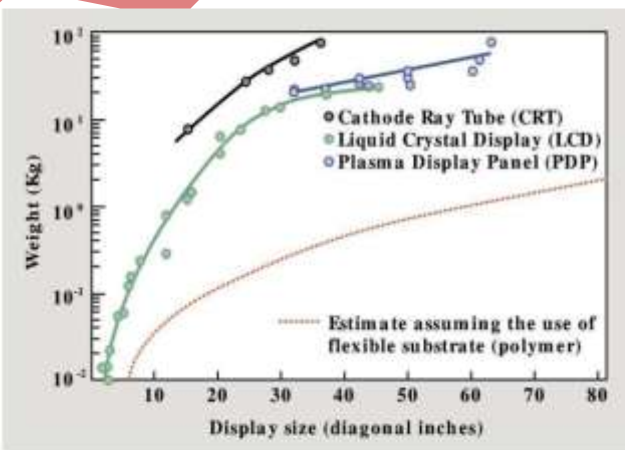
A display device with writing capabilities is an essential piece of hardware for a variety of media, including broadcasting, communications, and personal computers. Accordingly, if a display device possesses paper-like properties, electric media and paper media will fuse to diversify viewing styles. Moreover, if a flexible display is equipped with an information storage function, e.g. teachers personal notes and slides, it will open up an array of application possibilities.

5.3 Visual Effects Of Curved Display

Some movie theaters have curved screens and there are subjective evaluation results showing that a slightly curved display (a concave surface as viewed by an observer) is Preferable to a flat display. Some research used simulation methods which also supports the idea that a curved display presents a stronger sensation of reality. A curved display attains a larger viewing angle, which could lead to an enhanced sensation of reality even with a small display device. Since there have been no systematic or extensive experiments conducted using a direct-view-type display, it is also anticipated that a flexible display system will serve as a research tool for such visual effects. The capability of displaying images on a surface with an arbitrary degree of curvature will contribute to a wide range of applications in the medical, transportation, and educational fields, among others.

5.4 Low-Energy, Low-Cost Manufacturing Technology

The current system employs a manufacturing process that requires temperatures of 400 to 500 during the screen-printing, firing, and vacuum-sealing steps. Present Liquid crystal displays, which use amorphous silicon thin film transistor (a-Si TFT) for driving, must be fabricated at high temperature. The present technology also uses up a lot of raw materials, e.g., a massive amount of glass substrate. On the other hand, flexible displays using a plastic substrate which can be manufactured at near ambient temperature, and very little raw material is used up for the approximately 0.2-mm-thick substrate. The flexibility of the plastic substrate and display material will enable space-saving production through rolling technology such as roll up and roll over. Beyond the benefits in lower costs, these fabrication technologies would be environment friendly.



Relationship between display weight and screen size

VI. TYPES OF DISPLAY SYSTEMS

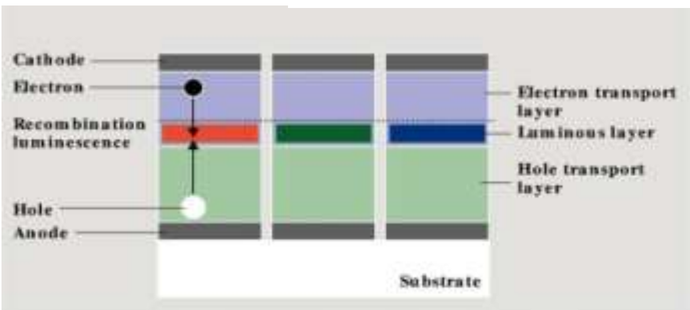
6.1 Electroluminescent (El) Systems

A typical example of this system is organic EL devices. Enthusiastic development followed, with devices initially employing low-molecular-number materials (a single molecule with several dozen to several hundreds of atoms in it). These early materials were very hard- to-bend and thus were not suitable in developing a flexible display. Recently though, they have been used in cellular phone displays. Flexible high-molecular-number materials soon caught up in sophistication, and today there is little characteristic difference between these materials. Energy is input to cause molecules in the luminous layer to reach a high energy state when electrons and holes (electron empty shells) are injected from the positive and negative electrodes are recombined in the luminous layer. The energy is emitted in the form of light when the state returns to the normal, stable one. A broad range of trials are made on these materials and on device structures for them. Their quick response (1 ms or less) and self-emissive characteristic are promising features for high- quality moving-image displays Both low molecular number and high molecular number systems face significant challenges in attaining sufficient luminous efficiency (reduced power consumption), device life, and economy.

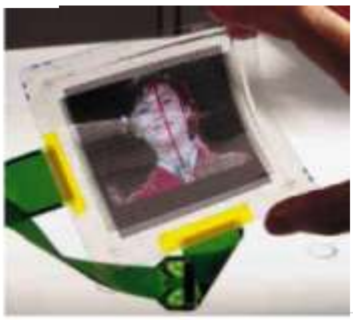
6.2 Liquid Crystal (LC) Systems

Several LC materials have been developed. E.g. Optical writing cholestric liquid crystal, when an electric field is applied perpendicular to the substrate. When no electric field is applied, a structure appears in which the molecules are aligned such that their long axes to rotate about the substrate perpendicular, this allows selective reflection of light at a wavelength corresponding to the pitch of the rotation (interference reflection). A low applied electric field causes the rotating axes to turn 90 degrees, allowing light to be transmitted .This orientation is maintained even after the electric field ceases. A higher electric field will align the long axes uniformly in the direction of the electric field, further improving the optical transmittance .The structure changes to a planar one after the electric field is removed. An image can be displayed by controlling these three orientation states. This scheme has the drawback of a high drive voltage. Another scheme is one that sandwiches ordinary super- twisted nematic (STN) liquid crystal between plastic substrates. Unfortunately this scheme has a slow response of several dozen micro seconds. to overcome this problem, a high- molecular-number liquid crystal material was developed that connects ferroelectric liquid crystal (FLC) with a side chain of monopolymer. The high-speed FLC is then sandwiched between plastic substrates. These systems can be used only for a binary gray-scale display. Contrary to these, a new liquid crystal material (liquid crystal film) with both high-speed response and gray-scale display capability has been developed. This flexible material is composed of the polymer network and the ferroelectric liquid crystal.

Flexible LC display



Basic structure and display principle of organic EL



Flexible organic EL display

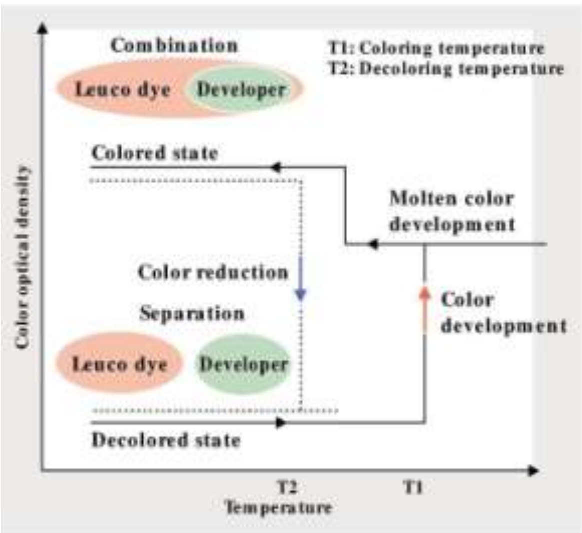
6.3 Moving Particle Systems

This is an electrophoretic image display system. EPID has recently become a lively topic after the advent of new materials. A typical example is the microcapsule structure, which uses pigment particle sealed in polymer micro-capsules. The pigment particles are positively or negatively charged according to its color, to obtain enough contrast to operate as a reflective-type device, these particles are moved closer to the front substrate or to the rear substrate by applying an external electrical field. A color device can be constructed by using either colored particles or colored fluid. Systems which move colored particles horizontally near a substrate surface or rotate spheres include the twist ball system and the toner system. Another recent development is a display in which polymer powder can be traveled rapidly under the electric field. This system is said to have a high-speed response to complement the electrophoretic image display's general merits of high contrast and good image retention.

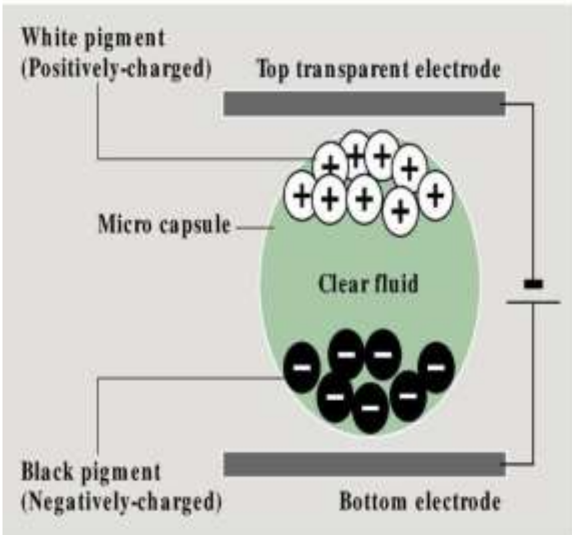
6.4 Electrochemical And Thermal Change Systems

This system is exploited by electrode position displays .silver ions are electrodeposited onto an electrode from an electrolyte solution under an applied voltage to reflect outside light. A recent device shows a high reflectivity (73%) at a low voltage. Electro chromic displays worked by exploiting electrochemical oxidation-reduction to produce an optical absorption spectrum change in a material. A recent prototype display based on viologen had a slow response, indicating the difficulties of creating moving image displays with this method. A wide range of thermal image rewriting systems has also been pursued. A typical scheme is one that controls color response by the temperature of leuco dye which is employed in thermal recording: it is colorless by itself, but responds to a developer at a high temperature. The developed color can be diminished when it is returned to a certain lower temperature, with the developer separating from the dye. This scheme can attain high-contrast images with good image retention performance, yet its slow response makes it difficult to display moving images

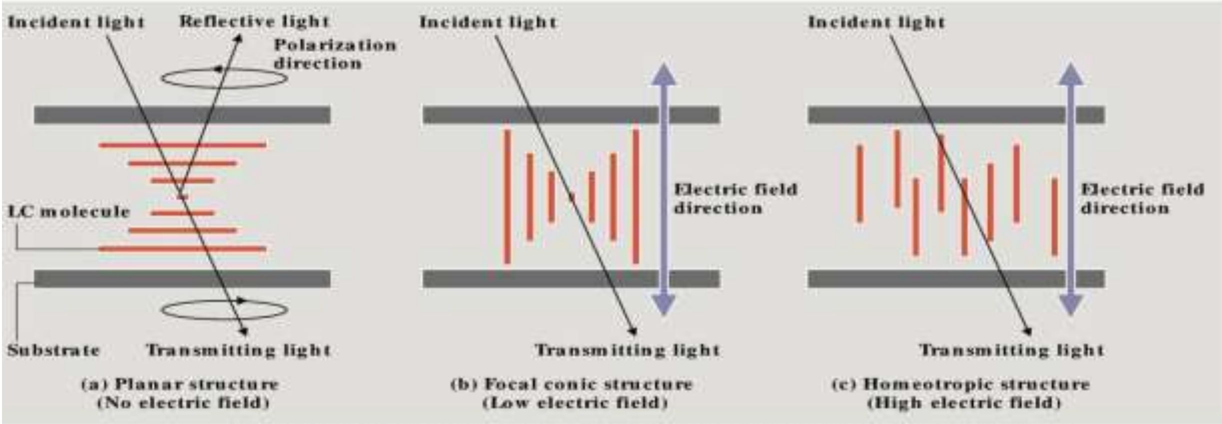
.



Leuco dye color development/ reduction reaction



Basic structure and display principle of microcapsule electrophoretic image display



Molecular orientation change by applying electric field and display principle of Cholestric LC

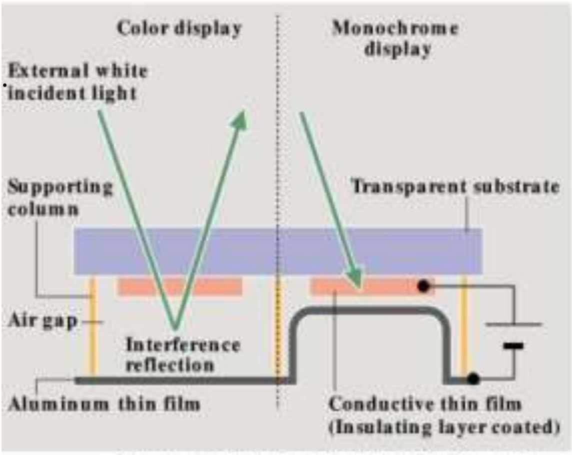
6.5 Mechanical External Light Modulation Systems

Micro-electromechanical systems use semiconductor fine processing technology to form mechanical rather than electrical components. The digital micro-mirror device is one of MEMS for a projection display and has already made it to the market. A DMD is manufactured with micron-sized square micro-movable mirrors corresponding to pixel dots, modulating incident light by tilting the mirrors for each pixel dot. Similar to this is research on a reflective display that modulates external light using a mechanical device. It consists of a conductive thin film over a glass substrate, with a variable- form thin metal film (aluminum) underneath this conductive thin film, separated by an air gap between them. Both the thin film and metal film are coated with an insulating layer. For this setup, the device reflects light at a wavelength determined by the interference based on the gap. When a voltage is applied between the thin film and metal film, an electrostatic force causes the metal film to cave in the side of the conductive thin film. At this moment, the device absorbs light. The current technology can make a dot size approximately 30 m square. Color displays with RGB dots of differing air gap sizes have been test manufactured. They have a response of several microseconds, which is adequate for displaying moving images. Other mechanical systems include one that moves a micro-cantilever closer or farther from an electrode by using voltage to obtain contrast. This is a promising system for constructing large displays with high contrast and good image retention. While the mechanical modulation system, which combines these Micro -precision mechanisms and electrostatic drive devices, does not have adequate flexibility at this stage, the potential for improvement remains because new materials and structures are actively sought in many research fields.

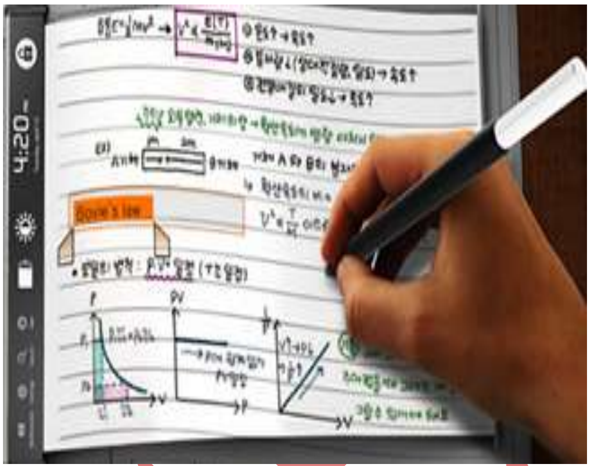
VII. HANDWRITING RECOGNITION

All versions of the windows operating systems since vista have natively supported advanced handwriting recognition, including via a digital stylus. The windows handwriting recognition routines constantly analyze the user's handwriting to improve performance. Handwriting recognition is also supported in many applications such as Microsoft OneNote, and windows journal. some arm powered tablets, such as the galaxy note 10, also support a stylus and support handwriting recognition. Wacom and n-trig digital pens provide very, ≈2500 dpi resolution for handwriting, exceeding the resolution of capacitive touch screens by more than a factor of 10. These pens also support pressure sensitivity, allowing for "variable-width stroke-based" characters, such as

Chinese/Japanese/Korean writing, due to their built-in capability of "pressure sensing". Pressure is also used in digital art applications such as Autodesk sketchbook



Structure and display principle of MEMS optical interference reflective display



VIII. PROSPECTS FOR A FLEXIBLE DISPLAY SYSTEM

As mentioned above, there are a diverse range of display systems and materials for flexible display. A flexible display will require nearly the same performance level as that of ordinary FPDs. Reaching this goal will thus entail breakthroughs in reducing power consumption, a thorough investigation of human factors, and new materials. Above all, the picture quality of flexible screens has to be increased.

8.1 Enhanced Picture Quality

Unlike conventional electronic paper, which has mainly been studied with an eye to developing still-picture displays, a flexible copy must have a high-speed response and gray-scale capability. The organic EL, liquid crystal film, and mechanical modulation systems are promising in this regard. The organic EL device is especially promising because it is the only self-emissive device. Liquid crystal film can use backlighting, obviating the need for external light. On the other hand, reflective systems, such as the electrophoretic and electrochemical/thermal systems and the mechanical modulation scheme, cannot be viewed in dim conditions without an external light and require high reflectivity. In their favor, these schemes have high image retention Performance, whereas organic EL and liquid crystal film devices require a memory function, namely active-drive TFTs, to retain large images of sufficient quality.

8.2 Power Consumption Reduction

Larger FPDs are being constructed, and future increases in their numbers and operating time will present a significant burden on our energy supplies. Every effort needs to be made to suppress the display's power consumption. This need is especially evident in the case of flexible displays for outdoor applications and an alternates of laptops and palm tops , since these will be battery-operated. Liquid crystal, electrophoretic, electrochemical/thermal response, and mechanical modulation are low power consumption systems, attaining highly efficient light emission is still a problem for organic EL devices. Laboratories have succeeded in realizing higher efficiency light emission by using phosphorescence, which bears the promise of reduced power consumption.

8.3 Human Factors

It is said that the replacement of paper media with electronic media will have diverse impacts in relation to human factors, such as ease of viewing and reading .A study that showed that an objective assessment of work performance when information was presented using various electronic displays or as hard-copy on paper showed no significant difference, yet the subjective assessments from the test subjects indicated that subjects felt that information on paper was easier to see and caused less fatigue. One factor that is considered to have caused this result was the larger degree of freedom for posture while viewing the information on paper. Thus, it seems that a flexible display may have greater ease of viewing and less fatigue compared with an ordinary stationary display, since it can be viewed with different postures. The effect in this regard is not yet clear, as no operational flexible display has been constructed, but the issue will become significant as we move into a paperless world.

IX. CONCLUSION

The recent development of many components and supporting technologies for flexible flat panel display applications, such as substrates, conducting layers, barrier layers, electro-optic materials, thin film transistor technologies, and manufacturing processes, is accelerating the flexible flat panel display concept towards the marketplace. Very impressive flexible flat panel display prototypes have been manufactured by several display groups around the world, which continues to drive interest and development in the field .A flexible display has the potential to significantly reduce the use of paper, in addition to providing ubiquitous broadcasting services as an easy-to-use digital media. In the aspect of hardware, the fact that it can be manufactured with a low-temperature, space-saving process, making it an energy-saving, resource-saving device, matches well with future environmental protection goals. Organic material also promises new functions and performance improvements for conventional inorganic material devices. The market for laptops & touchpads alone is estimated to reach 30 trillion $ by 2016. Therefore, the fact that a flexible display will have various applications will likely have an extensive impact, not only on broadcasting and broadcasting technology, but also on the entire electronics and education industry. The development of organic EL and liquid crystal film for such a diverse range of purposes will require numerous breakthroughs in efficiency and device lifetime, the construction of new device structures, and transistor improvements. Research on flexible displays at the Science & Technical Research Laboratories will embrace the challenge of pioneering new flexible devices based on organic materials.

REFERENCES

[1] Gregory P. Crawford, Flexible Flat Panel Display Technology, John Wiley & Sons, Ltd 2005

[2] Fumio SATO, Director, Display and Optical Devices, Research on Flexible Display Systems, Broadcast Technology No. 21, winter 2005 NHK STRL

[3] Dual-touchscreen from Wikipedia, the free encyclopedia