SURFACE CONDUCTION ELECTRON EMITTER DISPLAY (SED)

SEMINAR REPORT

Submitted by

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In partial fulfillment for the award of the degree

Of

BACHELOR OF TECHNOLOGY

In

COMPUTER SCIENCE ENGINEERING

DIVISION OF COMPUTER SCIENCE ENGINEERING

SCHOOL OF ENGINEERING

COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY

COCHIN- 682 022

SEPTEMBER 2008

DIVISION OF COMPUTER SCIENCE ENGINEERING

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COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY

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Certificate

Certified that this is a bona fide record of the seminar work entitled

"SURFACE CONDUCTION ELECTRON EMITTER DISPLAY"

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Of the VII[th] semester, Computer science Engineering in the year 2008 in partial fulfillment of the requirements to the award of degree of Bachelor of technology in **Computer Science Engineering** of Cochin University of Science and Technology.

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Seminar Guide

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Head of the Department

Date:

ACKNOWLEDGEMENT

At the outset, I thank the lord almighty for the grace, strength and hope to make our endeavor a success. I express my deep felt gratitude to **Dr. DAVID PETER** Head Of the Division Computer Science Engineering, School of Engineering for her constant encouragement.

I am profoundly grateful to **Dr. DAVID PETER ,** Lecturer, Division of Computer Science, my mentor and seminar guide for her valuable Guidance support, suggestions and encouragement.

Further more i would like to thank all others especially my parents and numerous friends. This seminar report would not have been a success without the inspiration, valuable suggestions and moral support from them through out its course.

MANU .VIJAY

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ABSTRACT

Surface conduction Electron emitter Display (SED)

The SED technology has been developing since 1987. The flat panel display technology that employs surface conduction electron emitters for every individual display pixel can be referred to as the Surface-conduction Electron-emitter Display (SED). Though the technology differs, the basic theory that the emitted electrons can excite a phosphor coating on the display panel seems to be the bottom line for both the SED display technology and the traditional cathode ray tube (CRT) televisions.

The main advantage of SED's compared with LCD's and CRT's is that it can provide with a best mix of both the technologies. The SED can combine the slim form factor of LCD's with the superior contrast ratios, exceptional response time and can give the better picture quality of the CRT's. The SED's also provides with more brightness, color performance, viewing angles and also consumes very less power. Canon and Toshiba are the two major companies working on SED's. The technology is still developing and we can expect further breakthrough on the research.

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1. INTRODUCTION

1.1 Surface conduction Electron emitter Display (SED)

The SED technology has been developing since 1987. The flat panel display technology that employs surface conduction electron emitters for every individual display pixel can be referred to as the Surface-conduction Electron-emitter Display (SED). Though the technology differs, the basic theory that the emitted electrons can excite a phosphor coating on the display panel seems to be the bottom line for both the SED display technology and the traditional cathode ray tube (CRT) televisions.

When bombarded by moderate voltages (tens of volts), the electrons tunnel across a thin slit in the surface conduction electron emitter apparatus. Some of these electrons are then scattered at the receiving pole and are accelerated towards the display surface, between the display panel and the surface conduction electron emitter apparatus, by a large voltage gradient (tens of kV) as these electrons pass the electric poles across the thin slit. These emitted electrons can then excite the phosphor coating on the display panel and the image follows.

The main advantage of SED's compared with LCD's and CRT's is that it can provide with a best mix of both the technologies. The SED can combine the slim form factor of LCD's with the superior contrast ratios, exceptional response time and can give the better picture quality of the CRT's. The SED's also provides with more brightness, color performance, viewing angles and also consumes very less power (***Fig.1.1(a)***). More over, the SED's do not require a deflection system for the electron beam, which has in turn helped the manufacturer to create a display design, that is only few inches thick but still light enough to be hung from the wall (***Fig.1.1(b)***). All the above properties has consequently helped the manufacturer to enlarge the size of the display panel just by increasing the number of electron emitters relative to the necessary number of pixels required. Canon and Toshiba are the two major companies working on SED's. The technology is still developing and we can expect further breakthrough on the research.

Fig.1.11 Flat display:

Fig.1.12 Slim display:

1.2. PROBLEM DEFINITION

The only constant that we can count on is change. Nowhere is this more accurate than with display technologies. All manufactures are trying to reduce their manufacturing cost profiles by introducing new techniques. **SED** technology, or surface conduction electron-emitter displays, that has been shown at selected shows for the last few years by the recently disbanded joint venture between Canon and Toshiba.

CRTs are typically as wide as they are deep. CRTs can have image challenges around the far edges of the picture tube. But their thickness is much more.

Plasma TV shows close to black colour, gray levels actually showing up. This means they are actually dark gray – not black. Plasma has been getting better in this regard but still has a way to go to match as CRT. The pixels in a Plasma panel are inherently digital devices that have only two states, on and off. A Plasma produces gradations of light intensity by changing the rate at which each pixel produces its own series of very-short, equal-intensity flashes.

LCD latency has been a problem with television pictures with an actual 16ms speed needed in order to keep up with a 60Hz screen update. Also, due to LCD's highly directional light, it has a limited angle of view and tends to become too dim to view off axis, which can limit seating arrangements. LCD generally suffers from the same black level issues and solarization, otherwise known as false contouring, that Plasma does.

2. HISTORY

Canon began SED research in 1986 and, in 2004, **Toshiba** and **Canon** announced a joint development agreement originally targeting commercial production of SEDs by the end of 2005. The 2005 target was not met, and several new targets since then have also slipped by. This failure to meet mass-production deadlines goes as far back as 1999, when Canon first told investors of its intentions to immediately begin mass-producing the technology. The lack of tangible progress has worried many investors and has prompted many critics. One critic called SED "the best display technology you've ever seen that may be stillborn". During the 2006 Consumer electronics show in Las Vegas, Nevada. Toshiba showed working prototypes of SEDs to attendees and indicated expected availability in mid-to-late 2006. Toshiba and Canon again delayed their plan to sell the television sets to the fourth quarter of 2007. At the 2007 Consumer Electronics Show, no SED displays were to be found on the show floor. This led many analysts to speculate that the technology would never reach the consumer market.

In October 2006, Toshiba's president announced the company plans to begin full production of 55-inch SED TVs in July 2007 at its recently built SED volume-production facility in Himeji. In December 2006, Toshiba President and Chief Executive Atsutoshi Nishida said Toshiba is on track to mass-produce SED TV sets in cooperation with Canon by 2008. He said the company plans to start small-output production in the fall of 2007, but they do not expect SED displays to become a commodity and will not release the technology to the consumer market because of its expected high price, reserving it solely for professional broadcasting applications.

The formation of SED Inc. in 2004 was certainly an acknowledgement by Canon that, no matter how good their engineering and technical prowess, they would have a difficult time manufacturing and mass-marketing this technology on their own.

While CES 2005 was the moment for SED to prove its technology was alive and kicking, CEATAC 2005 and CES 2006 showed that SED Inc. could make multiple versions of that same 36-inch display with repeatable image quality and consistency. Hopefully we will see a Canon SED TV display at both CEATEC in Japan starting

September 30th and CES2009 in Las Vegas next January. Canon has a reissue patent covering SED TV technology. United States Patent RE40, 062 was reissued February 12, 2008. It apparently has some modifications from previous SED TV patents. This may be the beginning of Canon's attempt to produce SED panels without using the Nano-Proprietary patented technology.

3. WORKING

3.1 CREATING THE PICTURE

SED is a display device includes an electron-emitting device which is a laminate of an insulating layer and a pair of opposing electrodes formed on a planar substrate. A portion of the insulating layer is between the electrodes and contains fine particles of an electron emitting substance, that portion acting as an electron emitting region. Electrons are emitted from the electron emission region by applying a voltage to the electrodes, thereby stimulating a phosphorous to emit light (***Fig.3.1***).

An SED-TV creates a picture in much the same way. It's essentially a flat-panel television that uses millions of CRTs instead of one electron gun. These miniature CRTs are called **Surface Conducting Electron emitters (SCEs)**. A set has three SCEs for every pixel -- one each for Red, Green and Blue. A widescreen, high-definition set can have more than 6 million SCEs.

An SED-TV has millions of these SCEs arranged in a **matrix**, and each one controls the Red, Green or Blue aspect of one pixel of the picture. Rather than directing electrons to create the image one row at a time, the matrix activates all the SCEs needed to create the picture virtually simultaneously (***Fig.3.1(b)***).

As with a CRT set, the inside of an SED-TV is a vacuum. All of the SCEs are on one side of the vacuum, and the phosphor-coated screen is on the other. The screen has a positive electrical charge, so it attracts the electrons from the SCEs. When bombarded by moderate voltages (tens of volts), the electrons tunnel across a thin slit in the surface conduction electron emitter apparatus. Some of these electrons are then scattered at the receiving pole and are accelerated towards the display surface, between the display panel and the surface conduction electron emitter apparatus, by a large voltage gradient (tens of kV) as these electrons pass the electric poles across the thin slit. These emitted electrons can then excite the phosphor coating on the display panel and the image follows.

When they reach the screen, the electrons pass through a very thin layer of aluminum. They hit the phosphors, which then emit red, green or blue light. Our eyes and brain combine these glowing dots to create a picture (***Fig.3.1(c)***).

Any part of the screen that's not used to create pixels is black, which gives the picture better contrast. There's also a color filter between the phosphors and the glass to improve color accuracy and cut down on reflected light.

To tie it all together, when the SED-TV receives a signal, it:

A. Decodes the signal

B. Decides what to do with the red, green and blue aspect of each pixel

C. Activates the necessary SCEs, which generate electrons that fly through the vacuum to the screen

When the electrons hit the phosphors, those pixels glow, and your brain combines them to form a cohesive picture. The pictures change at a rate that allows you to perceive them as moving.

This process happens almost instantaneously, and the set can create a picture sixty times per second. Unlike a CRT, it doesn't have to interlace the picture by painting only every other line. It creates the entire picture every time.

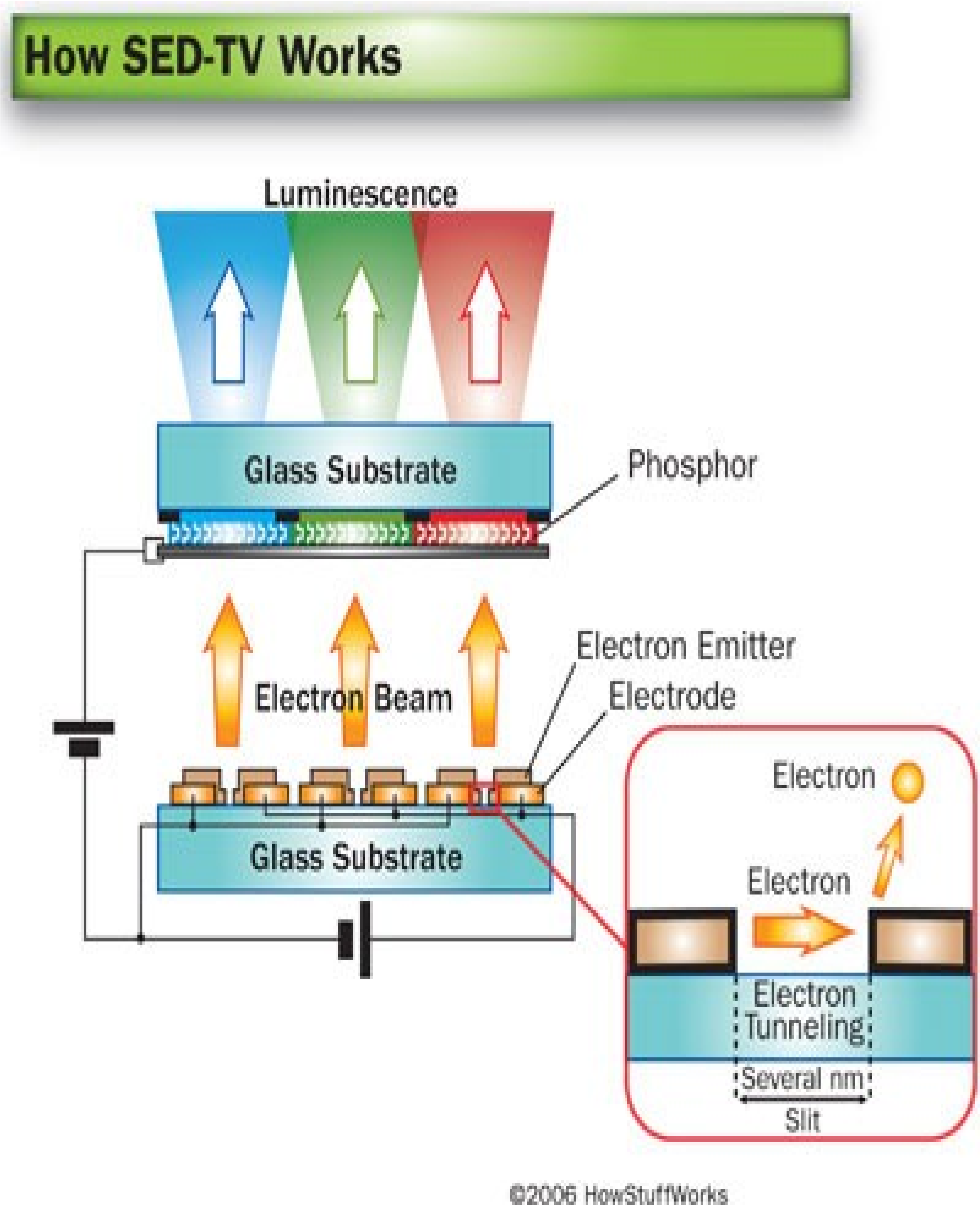

Fig 3.11 SED working:

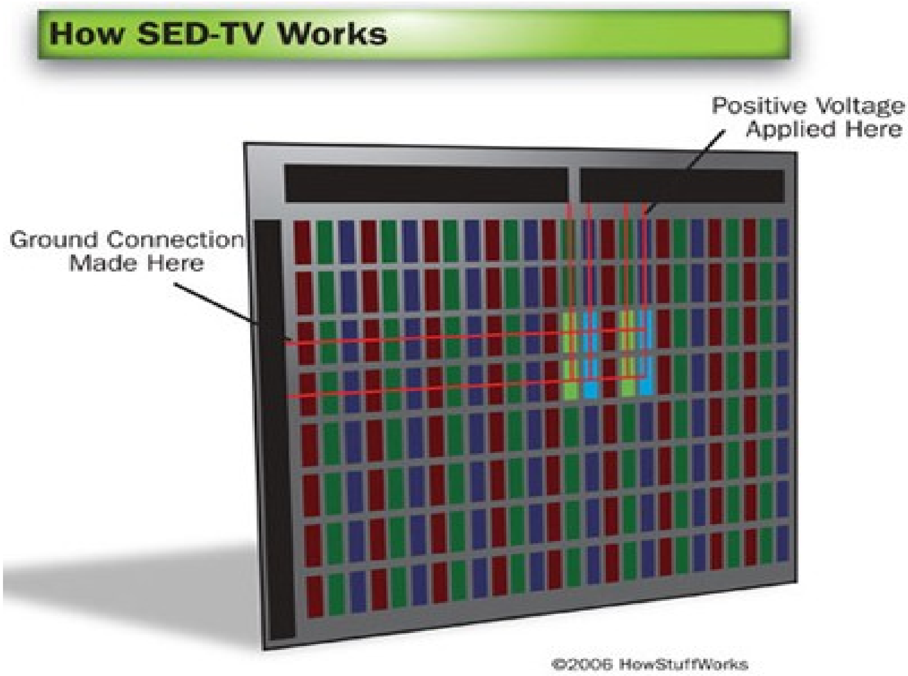

Fig 3.12 internal connections:

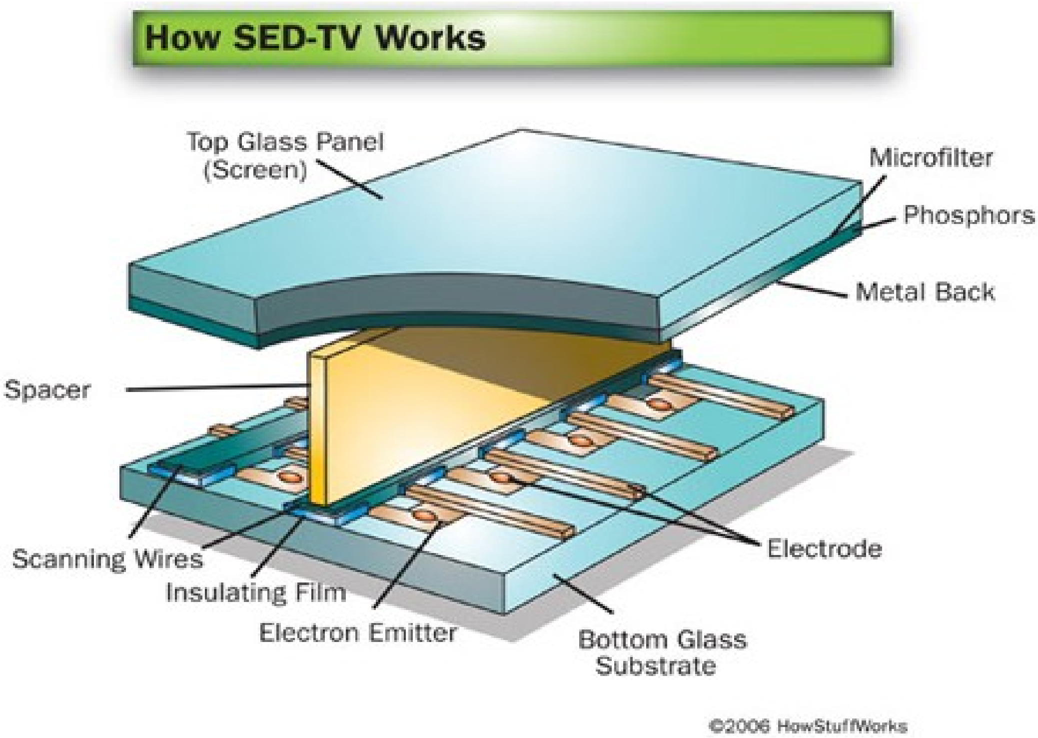

Fig. 3.13 Internal structure:

3.2 FABRICATION OF NANO GAPS

Nanogaps are the electron guns of SED.A nanometer scale gap (nanogap) structure in palladium strip fabricated by hydrogen absorption under high-pressure treatment. It is found that the edge roughness of the nanogap improves the electron emission characteristics. The electron emission current is dependent upon the angle of inclination of surface. Hydrogen plasma treatment is used to increase the edge roughness of the nanogap and thereby dramatically improve the electron emission characteristics. For the nanogap with a separation of 90 nm, the turn-on voltage significantly reduces from 60 to 20 V after the hydrogen plasma treatment.

4. COMPARISON

This is a comparison of various properties of different display technologies

DISPLAY TECHNOLOGY	Screen shape	Largest known diagonal in *In*	180° Viewing Angle	Typical use	Usable in bright room
CRT	Spherical curve or Flat	42	YES	Computer monitor , TV	YES
LCD	FLAT	108	NO	COMPUTER TV	NO
PLASMA	FLAT	42	NO	TV	YES
SED	FLAT	55	YES	COMPUTER TV	YES

Table 1.1 Comparison of various properties of different display technologies.

5. ADVANTAGES

SEDs promise the same advantages over LCDs and Plasmas as CRTs are delivering today plus they will also be thin and much larger than CRTs.

5.1 SED TV Compared to CRT

SED is flat. A traditional CRT has one electron gun that scans side to side and from top to bottom by being deflected by an electromagnet or "yoke". This has meant that the gun has had to be set back far enough to target the complete screen area and, well, it starts to get ridiculously large and heavy around 36". CRTs are typically as wide as they are deep. They need to be built like this or else the screen would need to be curved too severely for viewing. Not so with SED, where you supposedly get all the advantages of a CRT display but need only a few inches of thickness to do it in. Screen size can be made as large as the manufacturer dares. Also, CRTs can have image challenges around the far edges of the picture tube, which is a non-issue for SED.

5.2 SED TV Compared to Plasma TV

Compared to Plasma the future looks black indeed. As in someone wearing a black suit and you actually being able to tell it's a black suit with all those tricky, close to black, gray levels actually showing up. This has been a major source of distraction for this writer for most display technologies other than CRT. Watching the all-pervasive low-key (dark) lighting in movies, it can be hard to tell what you're actually looking at without the shadow detail being viewable. Think Blade Runner or Alien.

SED's black detail should be better, as Plasma cells must be left partially on in order to reduce latency. This means they are actually dark gray – not black. Plasma has been getting better in this regard but still has a way to go to match a CRT. Hopefully, SED will solve this and it's likely to. Also, SED is expected to use only half the power that a Plasma does at a given screen size although this will vary depending on screen content.

5.3 SED TV Compared to LCD

LCDs have had a couple of challenges in creating great pictures but they are getting better. Firstly, latency has been a problem with television pictures with an actual 16ms speed needed in order to keep up with a **60Hz** screen update. There is no motion blur in SED. LCDs still suffer from motion blur of fast-moving scenes such as most sports.

Also, due to LCD's highly directional light, it has a limited angle of view and tends to become too dim to view off axis, which can limit seating arrangements. This will not be an issue for SED's self illuminated phosphors.

Full dynamic contrast range. LCDs only show about **6-bits** of contrast--shades of gray at the same time. Thus outdoor scenes in bright light always block up the blacks and bleach out the whites. SED shows the Peak brightness. The fixed backlight brightness is as bright as any part of a scene can get. Yet CRTs (and SEDs) can produce peak brightness much brighter (over a small area and for a short time). this adds "sparkle" and liveliness to a scene.

However, LCD does have the advantage of not being susceptible to burn-in which any device using phosphors will, including SED.

SED is likely to use about two-thirds the power of a similarly sized LCD. Finally, LCD generally suffers from the same black level issues and solarization, otherwise known as false contouring, that plasma does. SED does not.

6. DISADVANTAGES

As with any phosphor-based technology, SED may also be susceptible to screen burn-in. This was a constant problem for people using CRT television monitors for security camera systems. Early plasmas also had this problem, but with phosphor development, the problem has largely been reduced.

7. FEATURES

1. **Contrast ratio 50,000:1.** Toshiba's final versions of SEDs will have a contrast ratio of **100,000:1.**
2. **Response time 0.2 milliseconds.**
3. **Brightness of 450 cd/m^2.**
4. **180º Viewing angle.**
5. **Viewable in Bright room.**
6. **It can be used in Mobile device display.**
7. **Low power consumption.**
8. **Longer life expectancy.**

8. CONCLUSION

SED will be the next generation display technology in the near by future. Hopefully we will see a Canon SED TV display at both CEATEC in Japan starting September 30th and CES2009 in Las Vegas next January.

Reissue patent covering SED TV technology may be the beginning of Canon's attempt to produce SED panels without using the Nano-Proprietary patented technology.

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