



Field Emission Displays

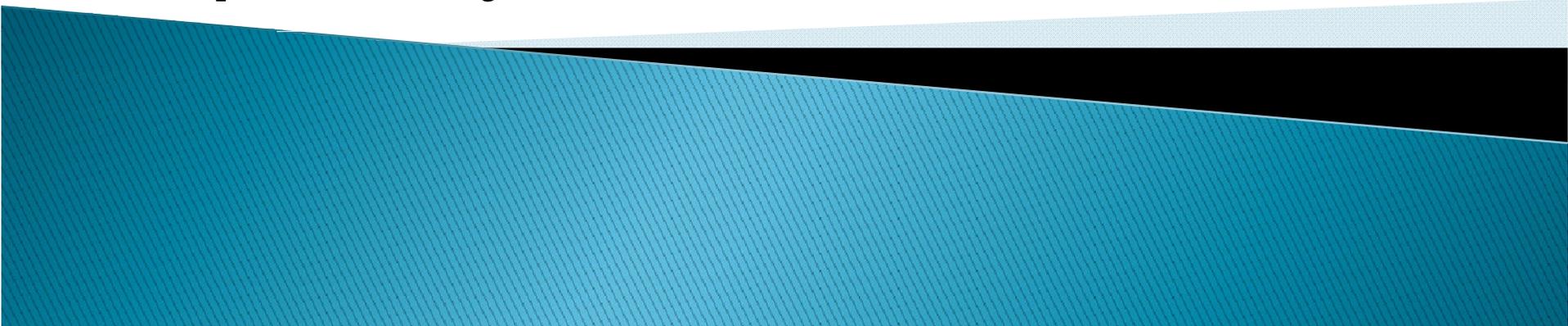


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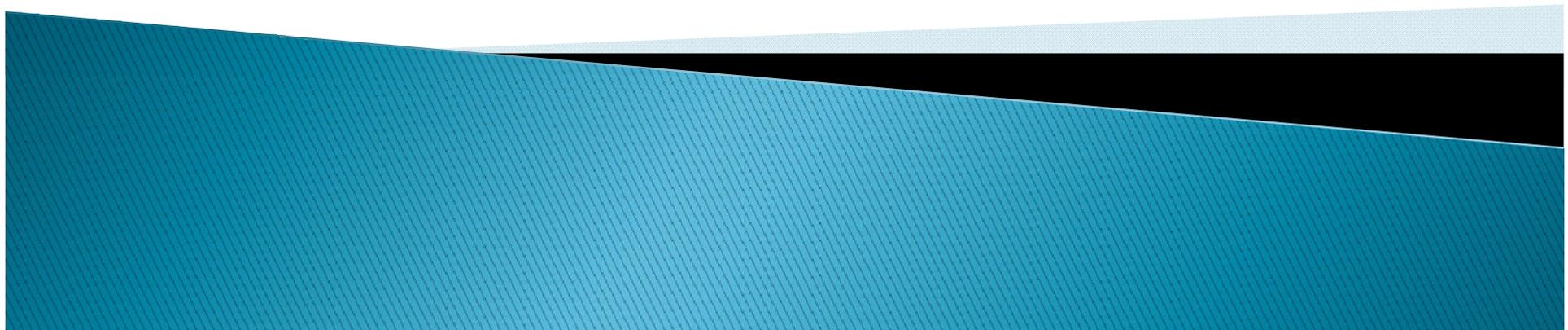
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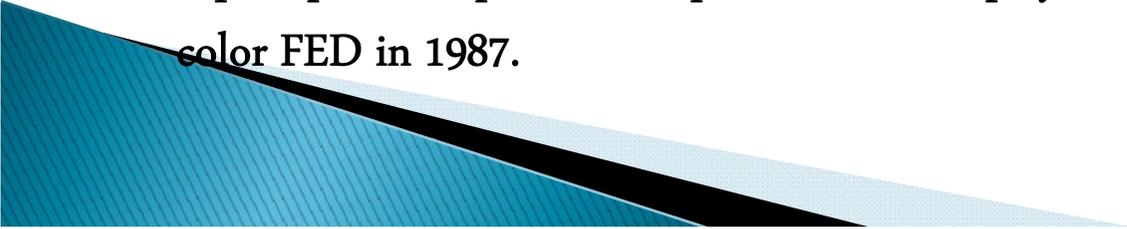
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Introduction

(FED) A type of flat panel display in which field emitting cathodes bombard a phosphor coating causing it to emit light. A field emission display use a large array of fine metal tips or carbon nanotubes (which are the most efficient electron emitters known), to emit electrons through a process known as field emission. Many of these are behind each phosphor dot so FEDs do not display dead pixels like LCDs.



History

- ▶ In 1968, **Charles A. "Capp" Spindt** at the **Stanford Research Institute** (now called SRI International) had the idea of fabricating a flat display using microscopic molybdenum cones singly or in field emission array (FEA).
 - ▶ This development was the enabling technology the concept for using FEA's in a matrix addressed display (FED) conceived by the SRI team of which Capp was a member, and patented by Crost, Shoulders and Zinn in 1970 (US Patent 3,500,102).
 - ▶ However SRI was unable to obtain funding for developing this concept in the decades of the seventies and early eighties, and the initiative for developing the technology moved to the *Laboratoire d'Electronique de Technologie et de l'Informatique (LETI), a research arm of the French Atomic Energy Commission*, in Grenoble. LETI picked up on the technology and publicly demonstrated an operating display in 1985.
 - ▶ The SRI team were finally funded by Boeing and Commtech International (a venture capital partnership) to develop a full color display and were able to demonstrate the first color FED in 1987.
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FED Technology

The FED screen mainly contains three parts:

1. Phosphorous plate, acts as anode.
2. A field emission cathode using a thin carbon sheet as an edge emitter.
3. FED packaging, including sealing and vacuum processing.



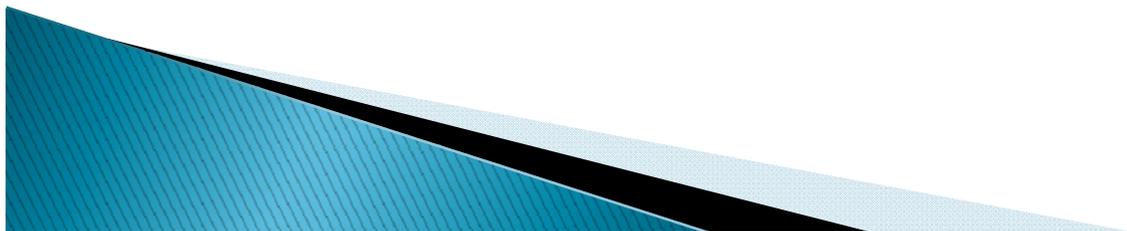
1. phosphor

- ▶ Phosphors are the screens in which the images are displayed
- ▶ In the display technology the phosphor screens act as anode, which receives the electrons emitted from the cathode
- ▶ The phosphors are made up of layers of three primary colours - green, red and blue



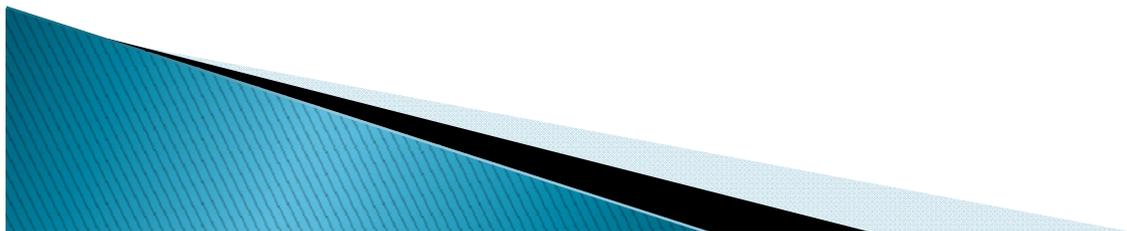
Ways of Anode working

- ▶ Low voltage anode
- ▶ High voltage anode



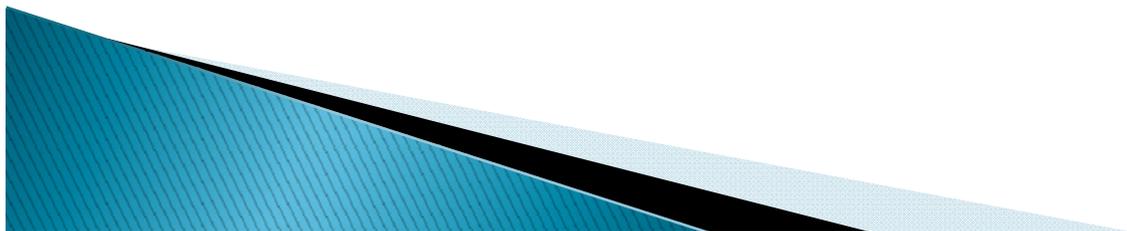
Low Voltage Anode

- ▶ In this method the entire screen is individually painted in each of the three primary colours, one at a time.
- ▶ As each of the colours are painted separately only that colour phosphor is grounded, so that all the electrons can strike that particular colour
- ▶ This prevents any of the electrons to strike accidentally the other colours present in the screen.



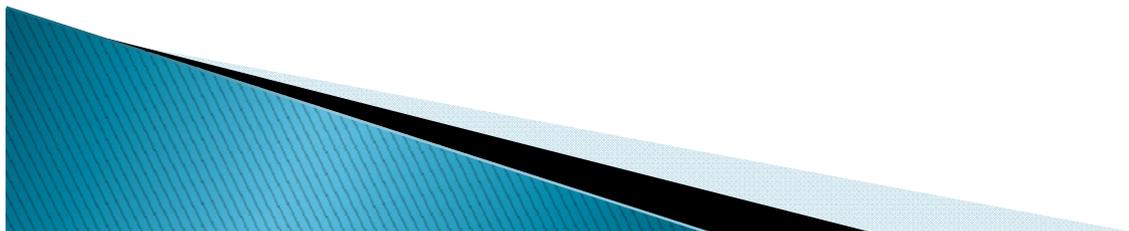
High Voltage Anode

- ▶ In the high voltage approach the emission from micro tip radiate in a roughly 60° cone
- ▶ When these tips are very close to anode, the spread to emitted stream of electron is small enough to result in a spot size of nearly 0.33mm diameter
- ▶ When the anode voltage is increased further greater phosphor efficiency is required and also the distance between anode and cathode should be increased to prevent arcing

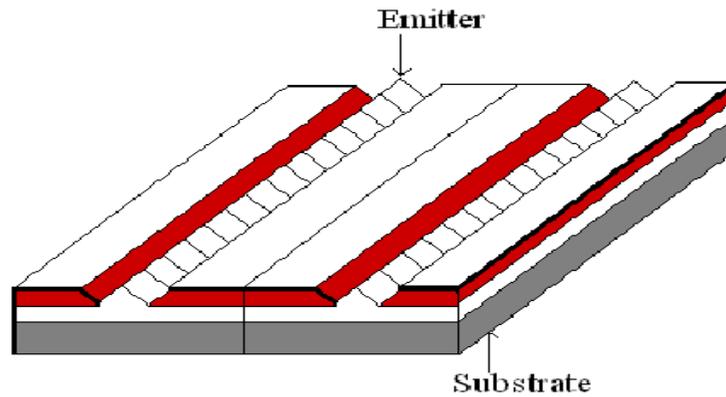


2. Field Emission Cathode

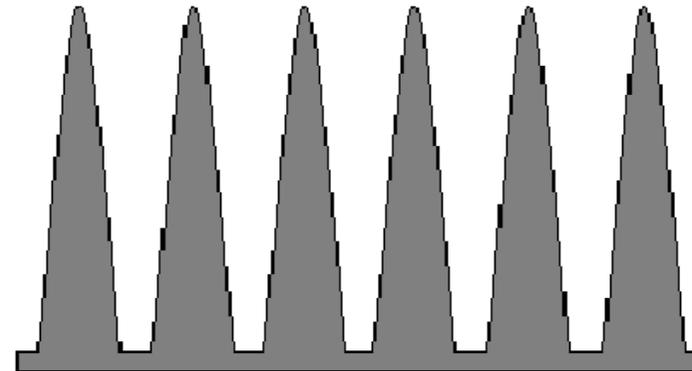
- ▶ In the field emission display screen the cathode are electron guns which emit electrons
- ▶ Electron guns are called micro tips



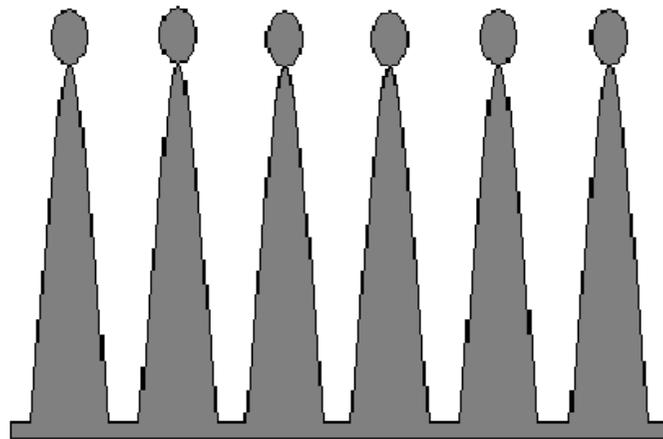
Micro tips types



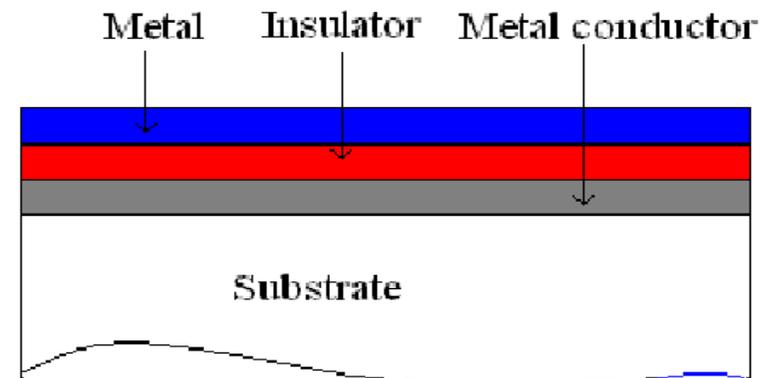
Wedge Type Emitter Using Silicon



Emitters Are Formed By Silicon Tips With Continuous Coating Of Diamond Particles



Single-Crystal Diamond Particle On Silicon Tip Can Act As a Good Emitter



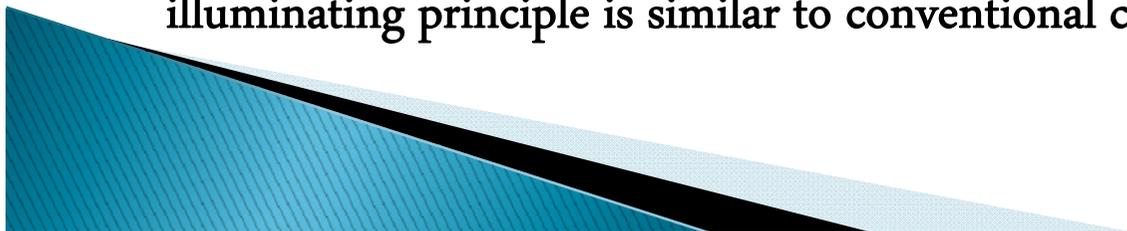
Metal-insulator-semiconductor type planar emitter

Working Principle

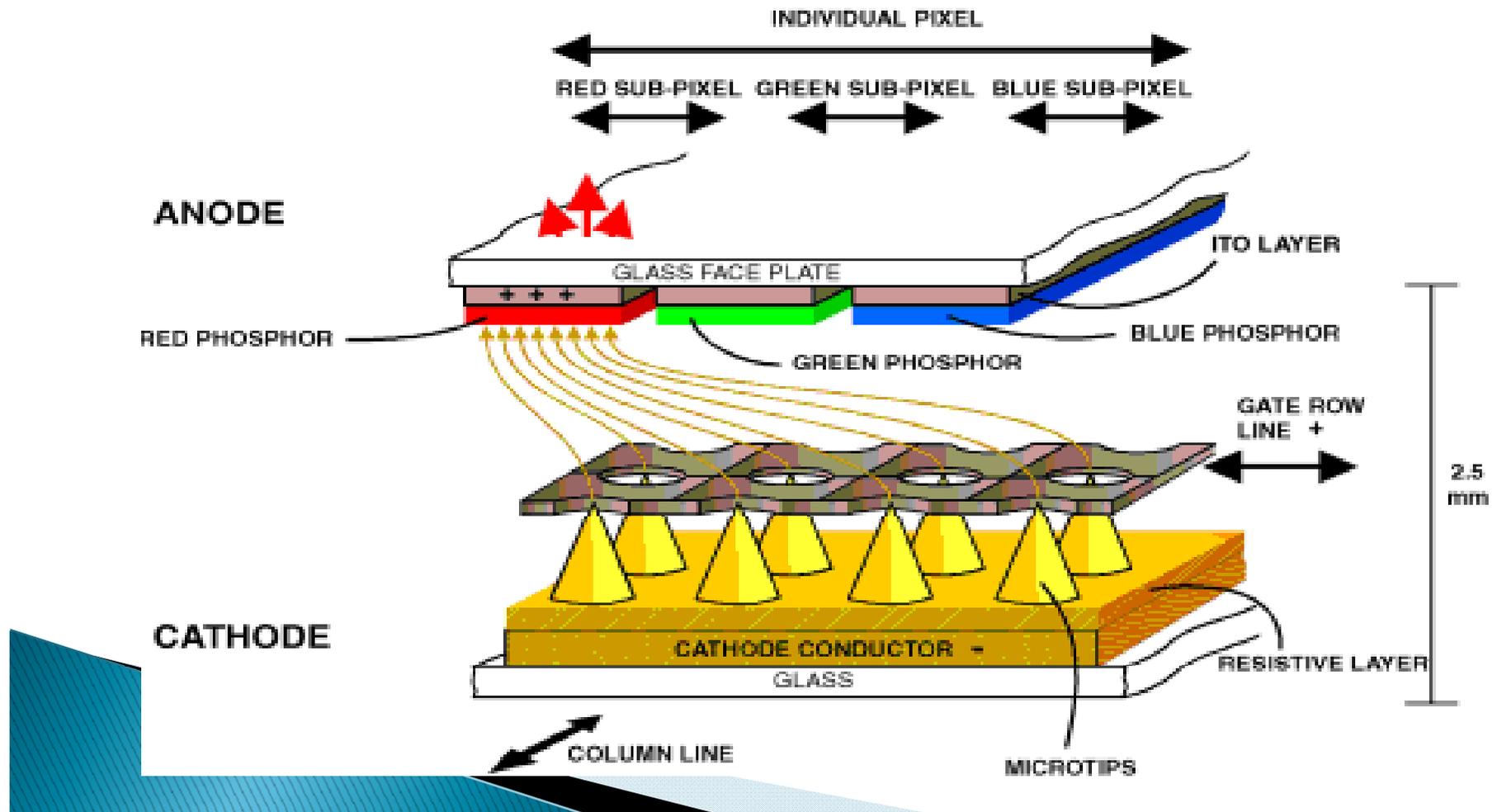
FED is consisted mainly with 2 pieces of glass substrate, and there are spacers between them. The space in between is vacuum. The front plate is called anode plate.

On the anode plate, there are electrodes and phosphors that are illuminating by electrons impacting. The rear plate is cathode plate consisted of electrodes and field emission array (FEA) formed by large number of emitters that emitting electrons in accordance with field emission principles.

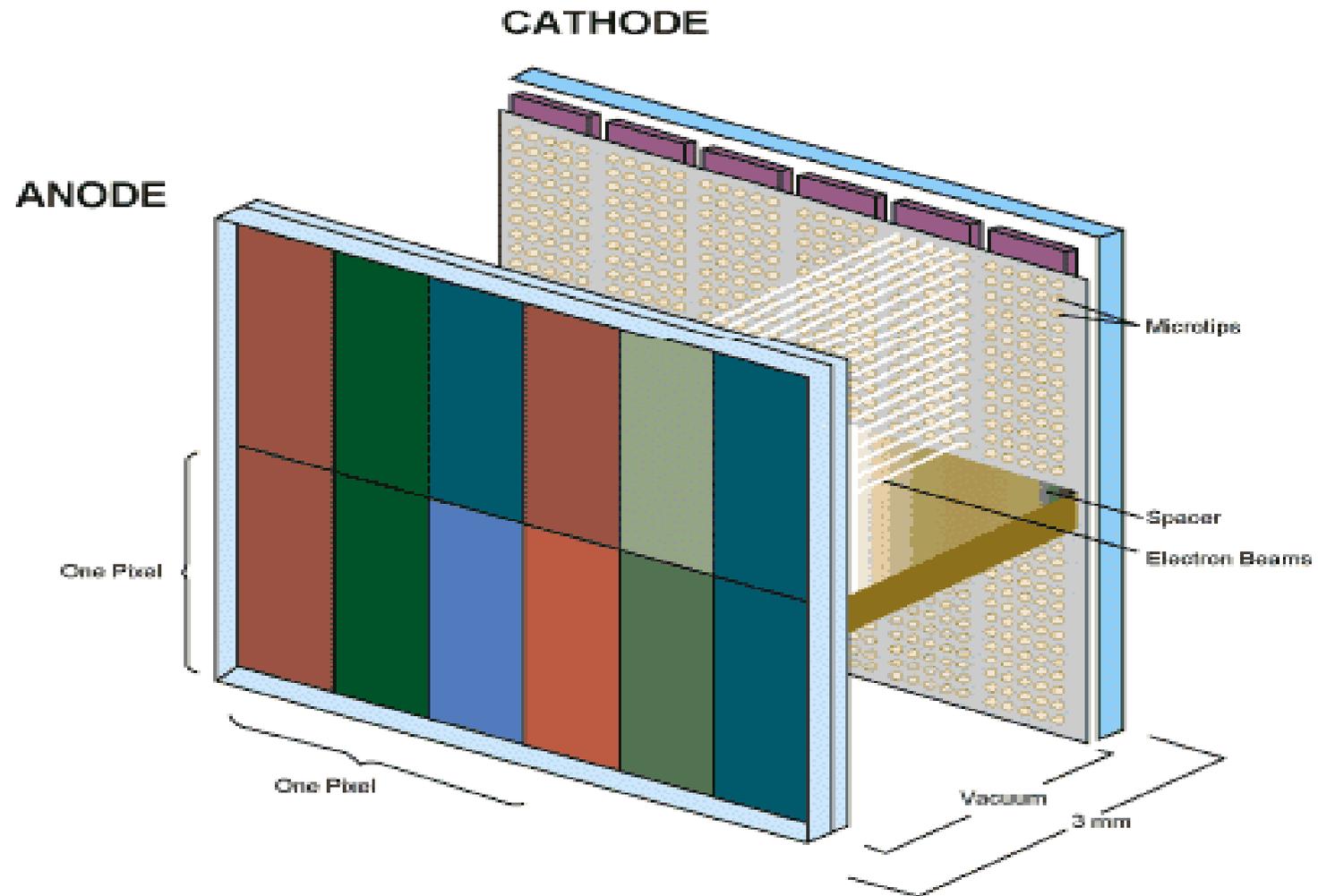
The operating principle is that cathode emits electrons on the basis of the field emission principle and electrons are accelerated by electric field to impact fluorescent layer at anode plate and excite phosphors to illuminate. This illuminating principle is similar to conventional cathode ray tube (CRT).



Field Emission Display



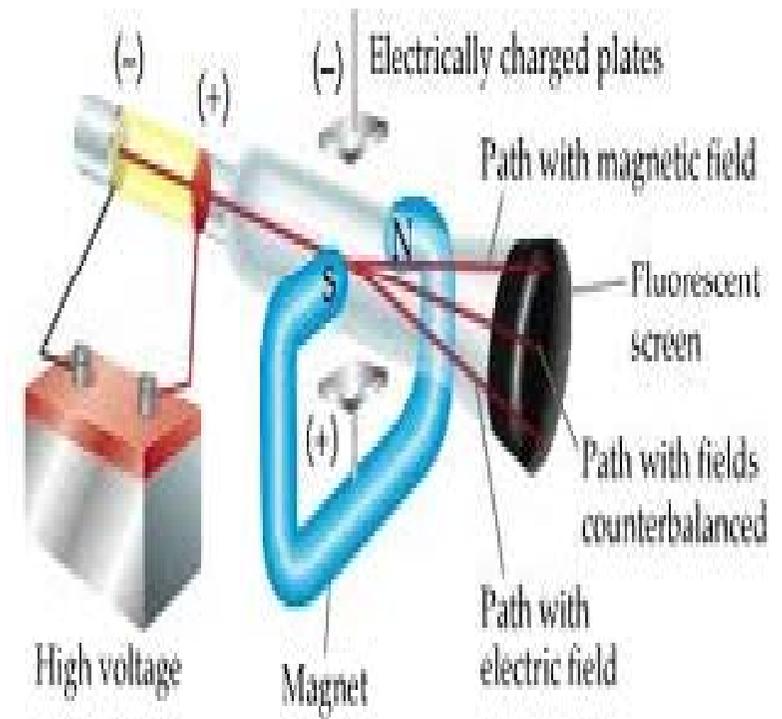
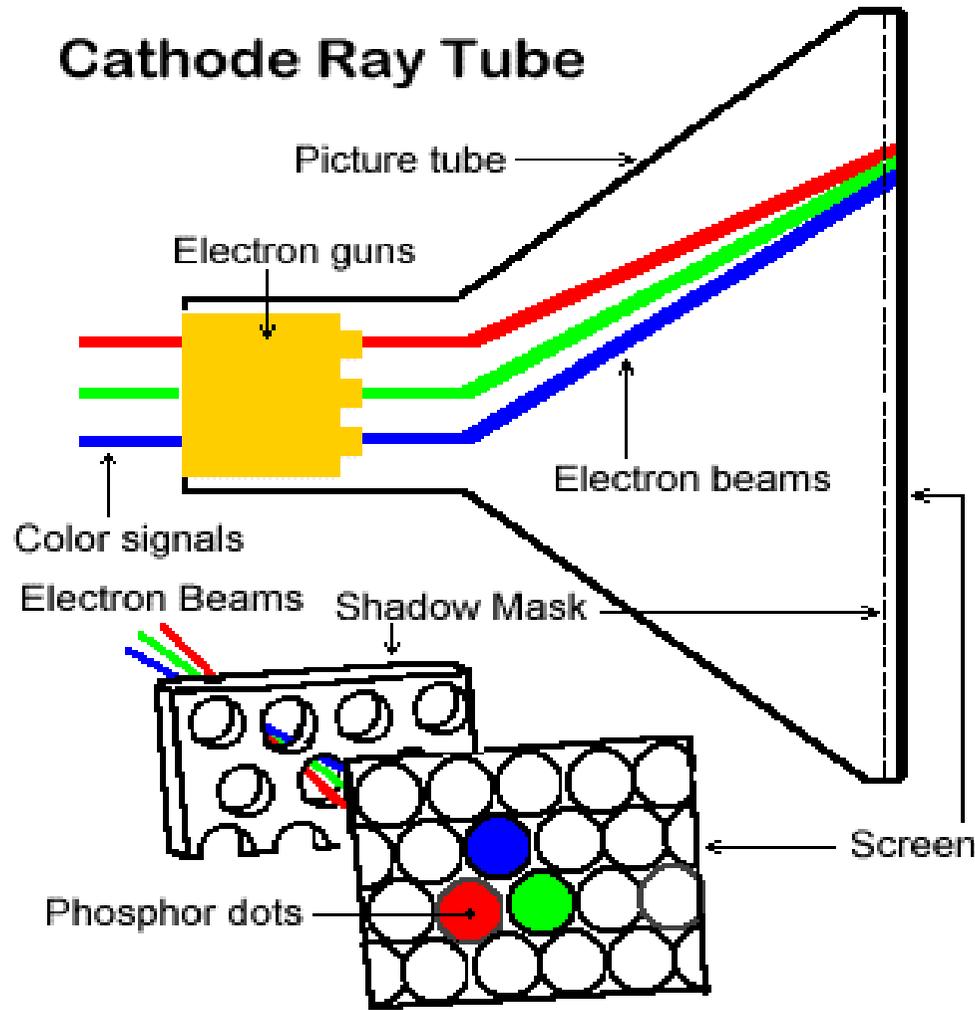
3. FED packaging



Difference between CRT and FED

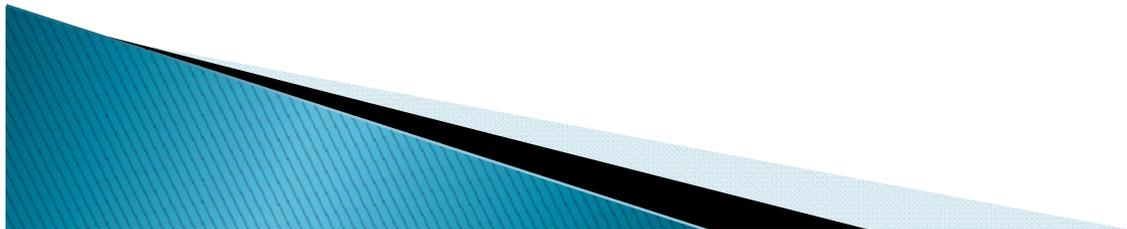
- A field emission display is similar to a cathode ray tube but difference between them is the electron releasing way of cathodes. CRT is hot electron generated by heating the cathode electron gun and deviation of electron is controlled by electromagnetic field to scan fixed location on fluorescent screen.
 - While field emission display cathode is formed with large number of emitter, which is virtually unnumbered micro electron gun. When electrons are emitted by field emission principle, they will be accelerated directly by electric field to hit on the corresponding pixels formed by phosphor.
 - Therefore, Field Emission Display can maintain the image quality of CRT and reduce the bulky size of it and making it thinner and lighter.
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Cathode Ray Tube



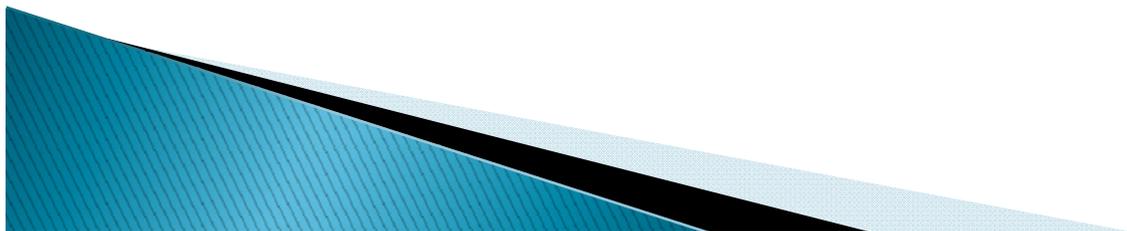
FED Characteristics

- ▶ Brightness
- ▶ Speed
- ▶ Compact and lightweight
- ▶ Display size
- ▶ Low driving voltage
- ▶ Wider viewing angle
- ▶ High illumination
- ▶ Wide temperature extremes
- ▶ Colour Quality



Challenges: Technical Problems

- Vacuum tubes require maintenance.
- Current FEDs often suffer from variation in screen brightness across the display, and also within each pixel.
- The tips couldn't survive under severe conditions of arcing (i.e. electrical discharge) due to the small gaps everywhere in FED prototypes.
- Another big problem for the FED concept is the cathode driver. For big screen applications, such as HDTV, it is difficult (if not impossible) to build a feasible high voltage.

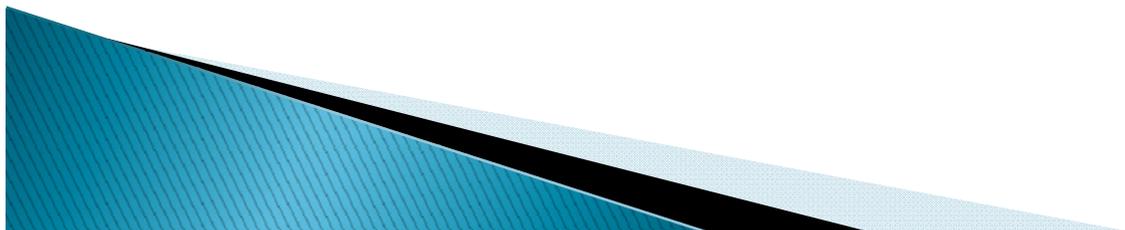


Comparisons between Technologies

	CRT (Cathode Ray Tube)	LCD (Liquid Crystal Display)	PDP (Plasma Display Panel)	OLED (Light Emitting Diode)	FED (Field Emission Display)
Brightness (Cd/m ²)	500	500	1500	1300	300
Contrast	100:1	5000:1	10000:1	1000000:1	100000:1
Viewing Angle (°)	175	170	178	178	178
Response Time (s)	50μ	8m	8m	10μ	20n
Power consumption (W/in)	11	5	8	2	0.2
Weight (kg/in)	1.8	0.6	0.6	0.4	0.1

Applications

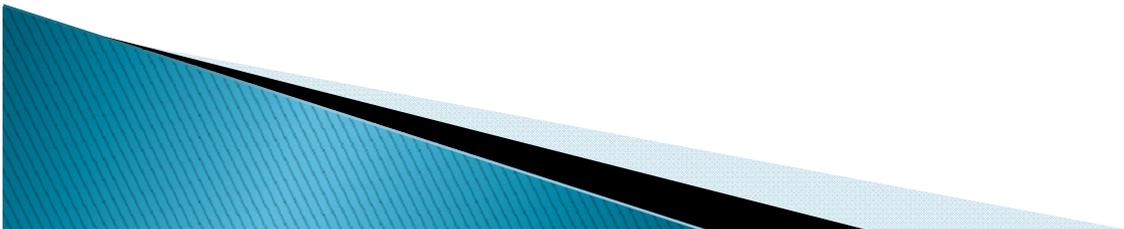
- ▶ Sonograms
- ▶ X-ray imaging
- ▶ Heart-rate monitors
- ▶ Laptop computers
- ▶ Hang-on-the-wall televisions
- ▶ Big screen and PC monitors
- ▶ High-definition TV



Companies Researching FED

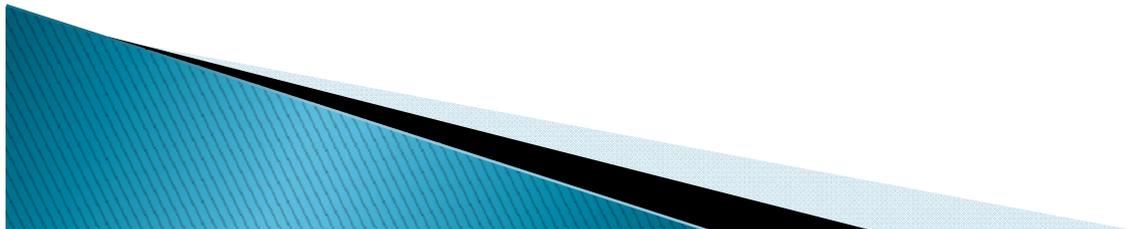
Sony promises Spindt-type FED display in 2009

Samsung is researching CNTs, Applied Nanotech Inc. have made a 25" display



Conclusion

- ▶ CRT technology has already reached its technological and marketing limits and will likely be replaced in 10 years.
- ▶ The modern world needs substances that are small in size.
- ▶ This shows that the cathode ray tube do not have much to do anything in the market in future. And it would die already, if Field Emission Display (FED) technology or any other displays would bring anything to the market.



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Thank you

