Presentation Material for K-JIST

Information Display Devices & Plasma Display

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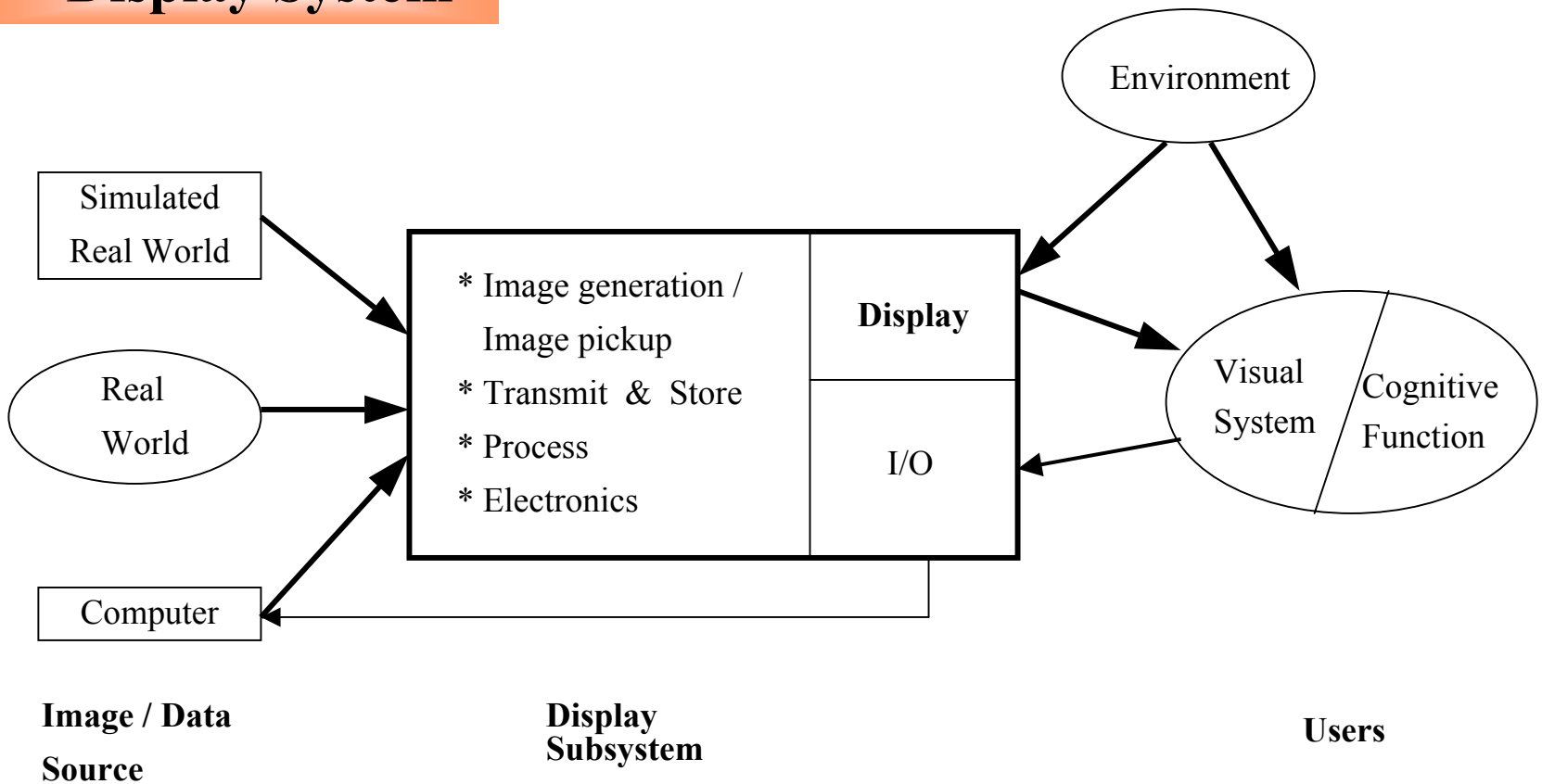
OUTLINES

1. Introduction
2. Information Display Devices
   - 2.1 TFT-LCD
   - 2.2 OLED
   - 2.3 PDP
   - 2.4 FED
3. Hot issues on Plasma Display
4. Summary

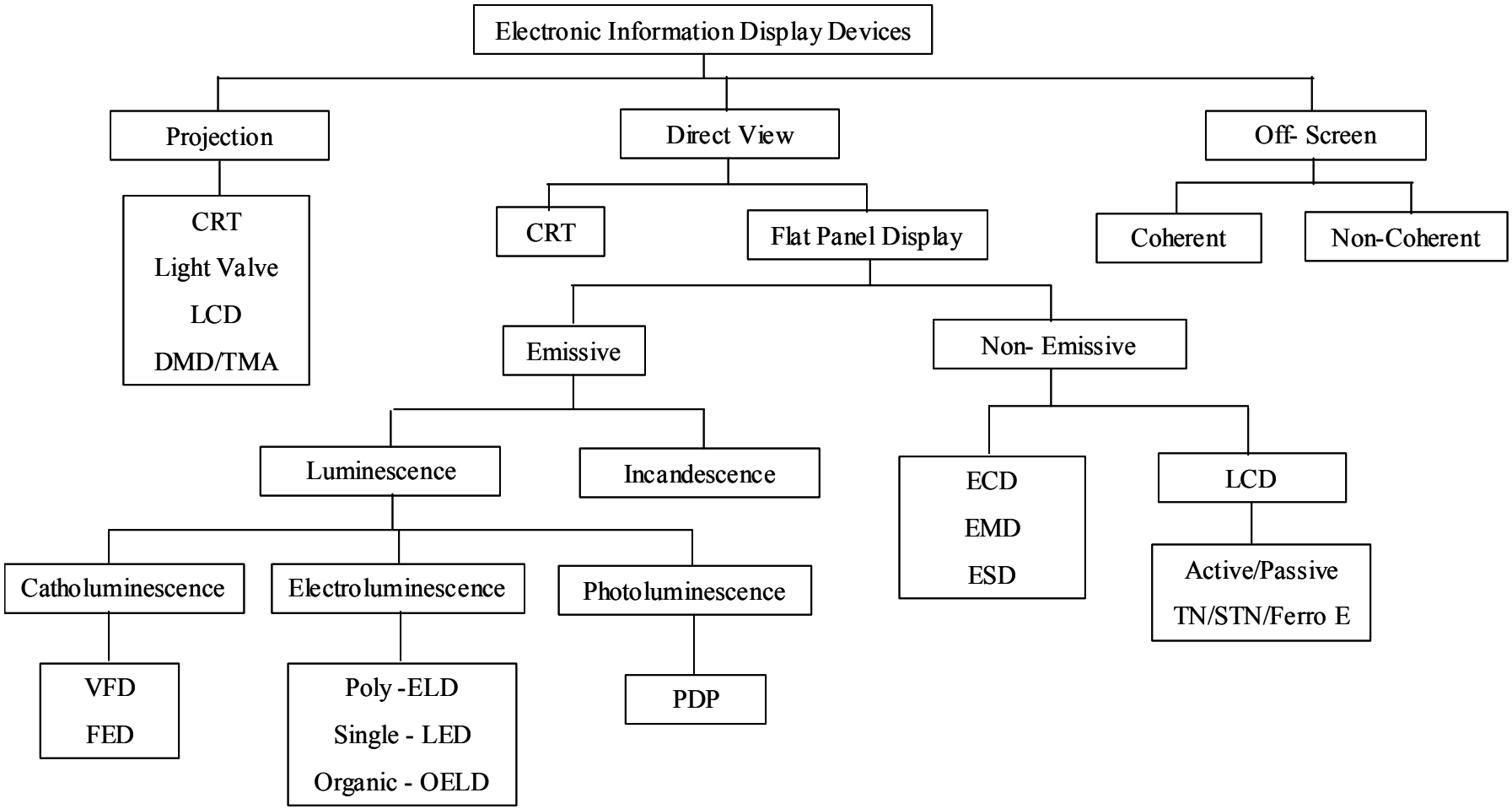
1. Introduction

□ Display System



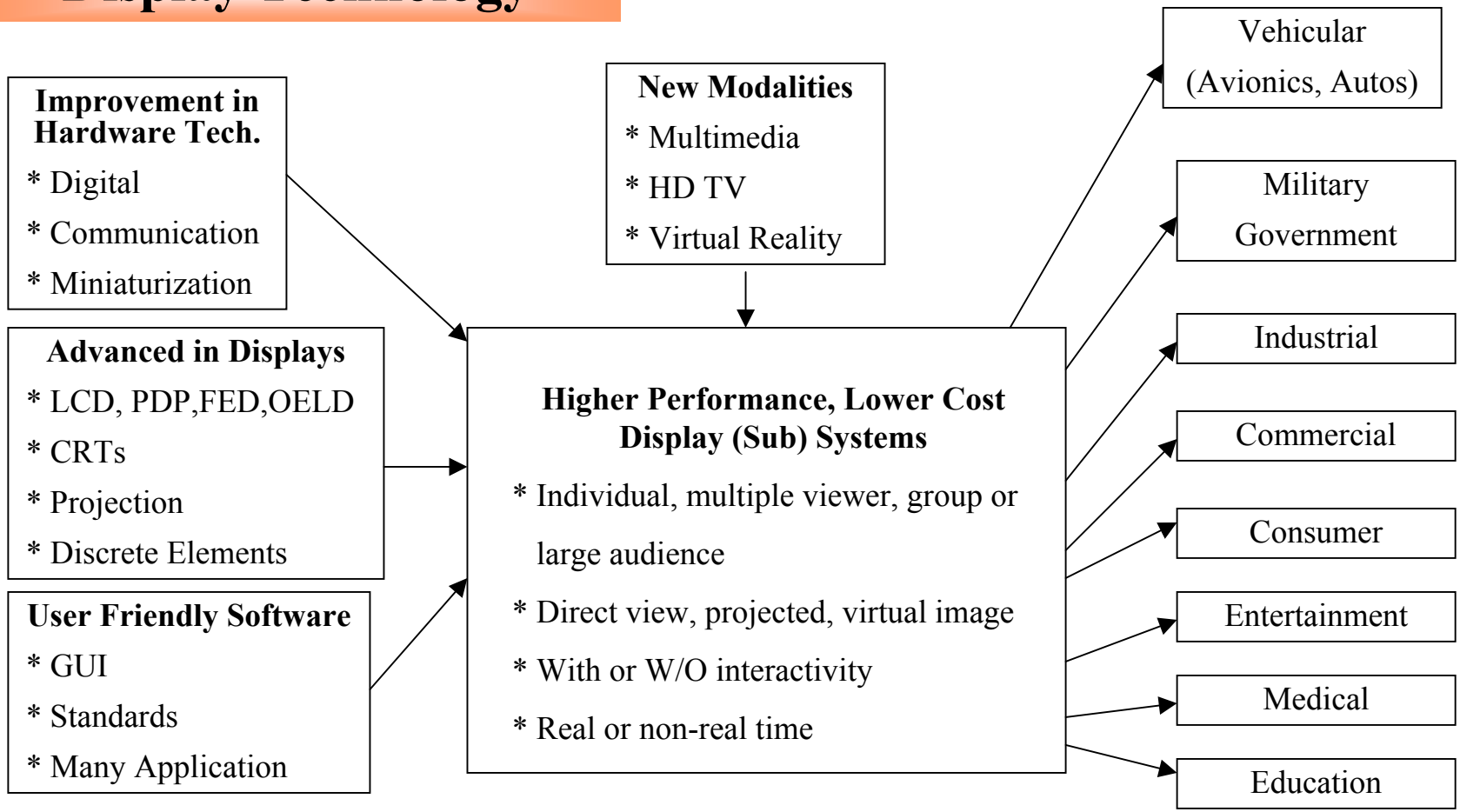
1. Introduction

□ Display Device Types



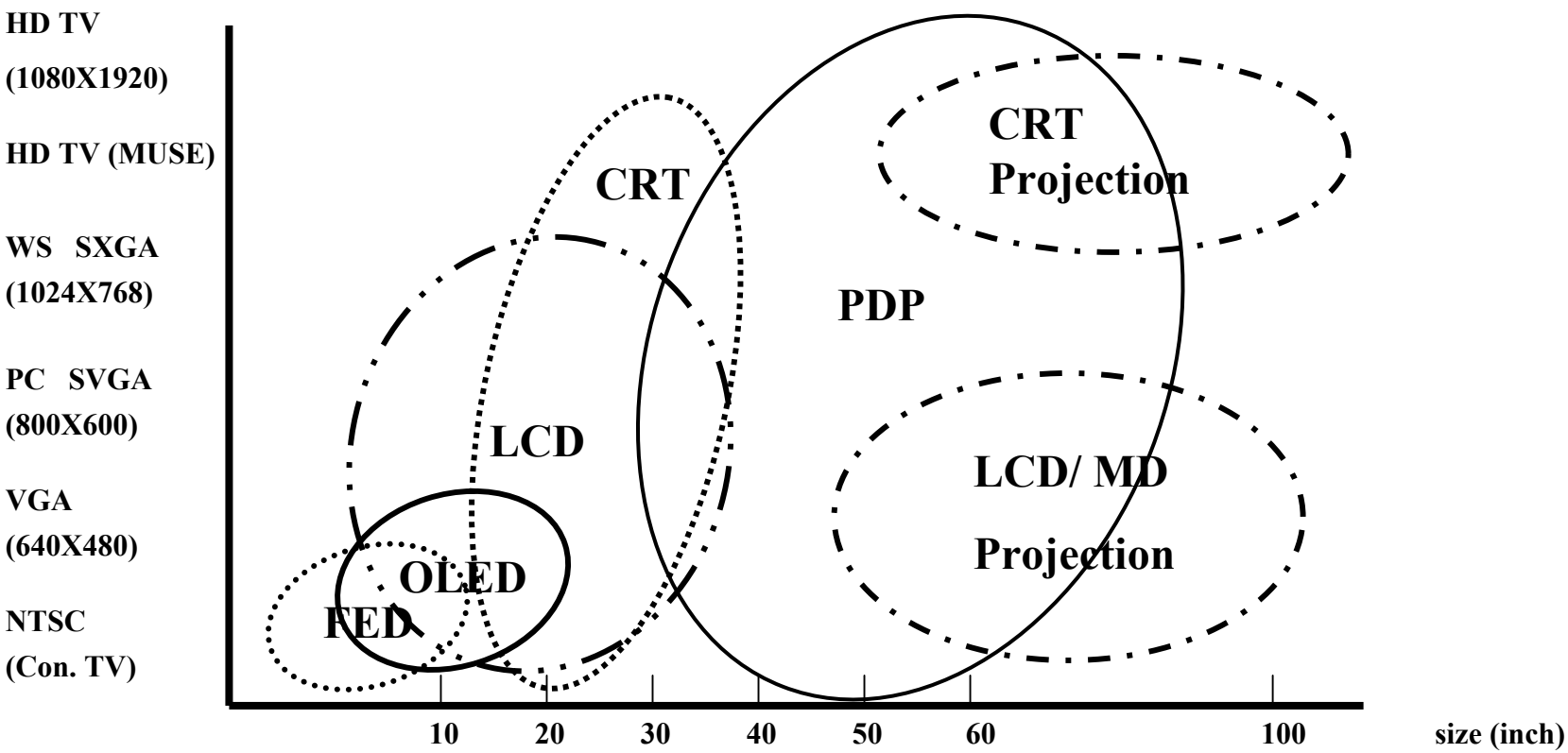
1. Introduction

□ Display Technology



1. Introduction

□ Display Screen Size



☐ Requirements for Information display devices

(1) High capability

(2) Easy handling

(3) High quality : No flickering, high contrast, high luminance, color purity.

(4) Digital device

(5) High resolution

(6) Interactive

(7) Long life time/High reliability

(8) Low cost

☐ Major Information display devices

Flat Panel Display

		Response time
Plasma Display Panel	Cathode glow from conducting gaseous discharge	15 μsec
Light Emitting Diode	Electron injection in a forward -biased p-n semiconductor junction	10 nsec
Vacuum Fluorescence	Electron bombardment of phosphor in hard vacuum under control of a grid	50 nsec
Electroluminescence	Electron conduction in polycrystalline(or Organic) phosphors due to high electric field	20 μsec
Flat Cathode Ray tube	Electron bombardment of phosphor in hard vacuum under control of a grid or cathode	50 nsec
Field Emission Display	Electron emission from cold cathode and bombardment of phosphor in hard vacuum	50 nsec
Liquid Crystal Display	Electrostatic rotation of organic compound which exhibit liquid crystallinity	10 msec

☐ Flat panel display & CRTs

Advantages of CRTs

(1) High quality

(2) Full Color

(3) Easy Driving

(4) Cheap

Disadvantage of CRTs

(a) Bulky

(b) High Voltage (> 1 KV)

(c) Magnetic interference

Technology trends for substituting CRTs

(a) No interference

(b) Large area(High Definition)/ Small area(Mobile)

(c) No high voltage

1. Introduction

☐ Next generation information display technology

* Mobile Communication

  - Full color moving image

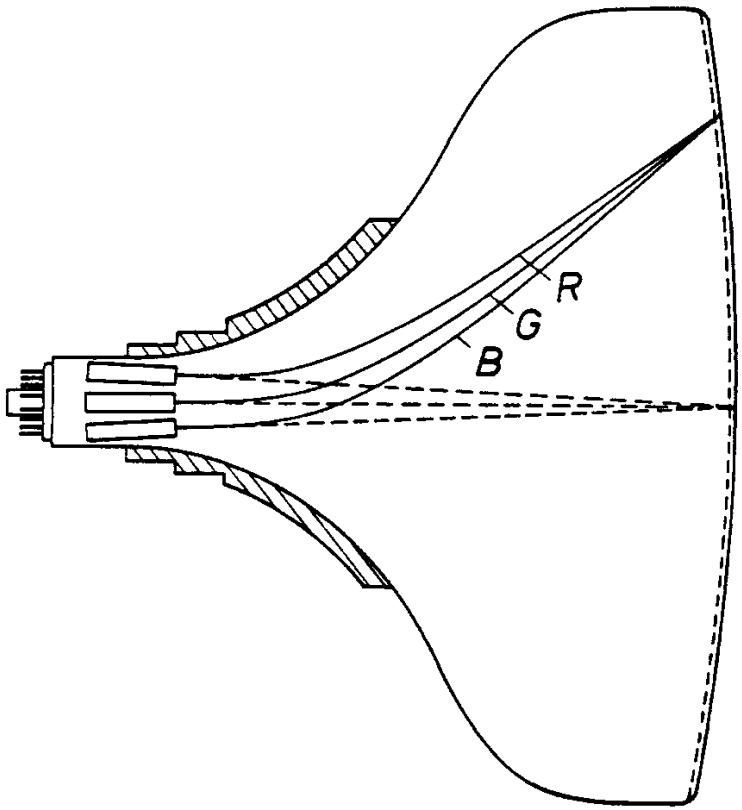
* High Definition

  - Picture quality like Photo.

* Real and 3D image

  - Large screen and no-glasses/off screen

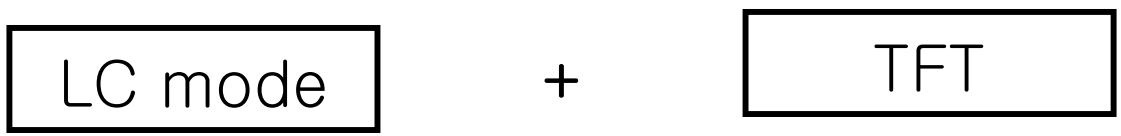
☐ Cathode Ray Tube(CRT)



- High Picture Quality
- Cheap
- 20 inch ~ 40 inch
- TV and business application

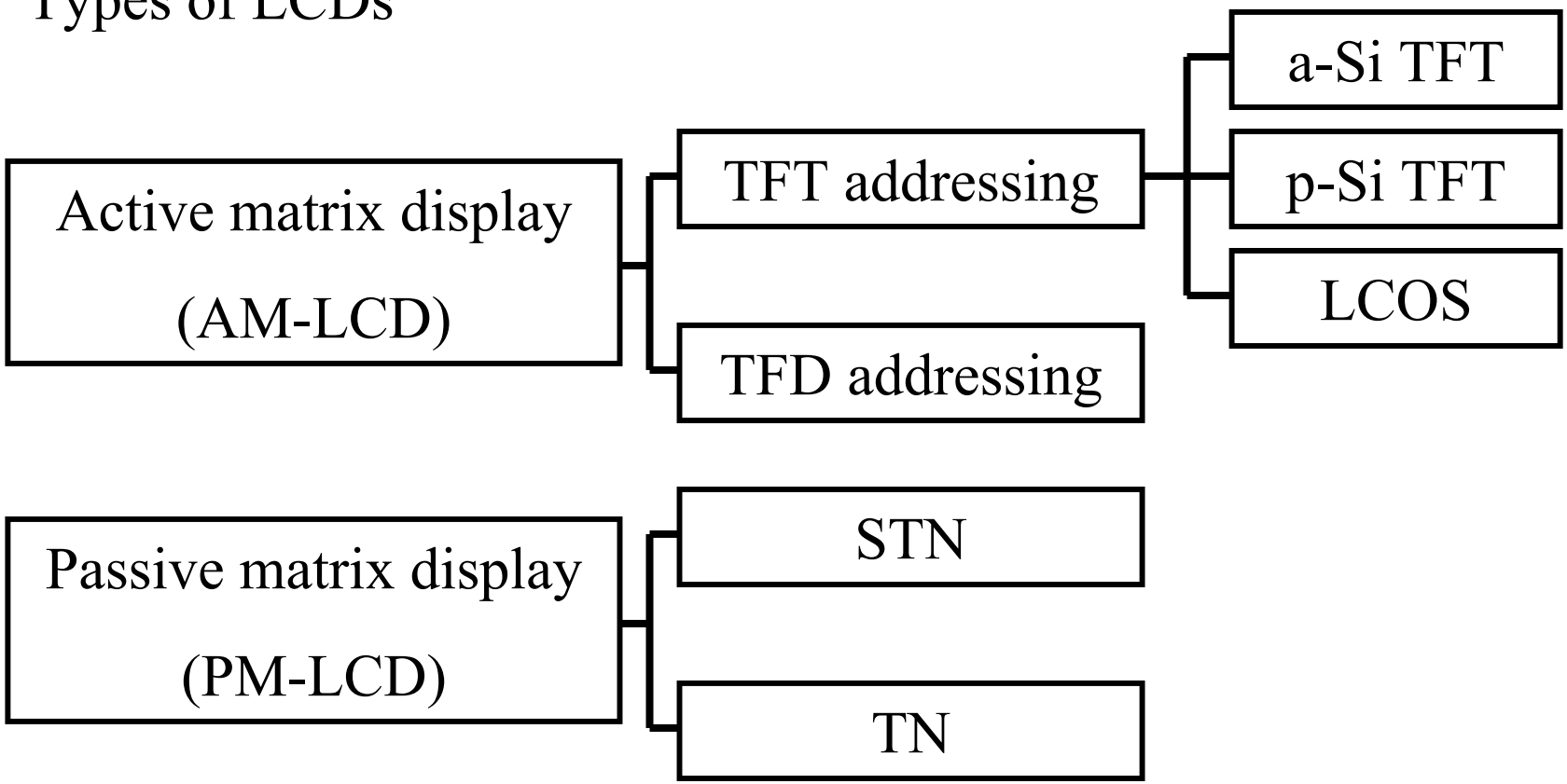
2.1 Thin Film Transistor Liquid Crystal Display(TFT-LCD)

Definition: Electronic display device utilizing electrostatic rotation of organic compound which exhibit liquid crystallinity



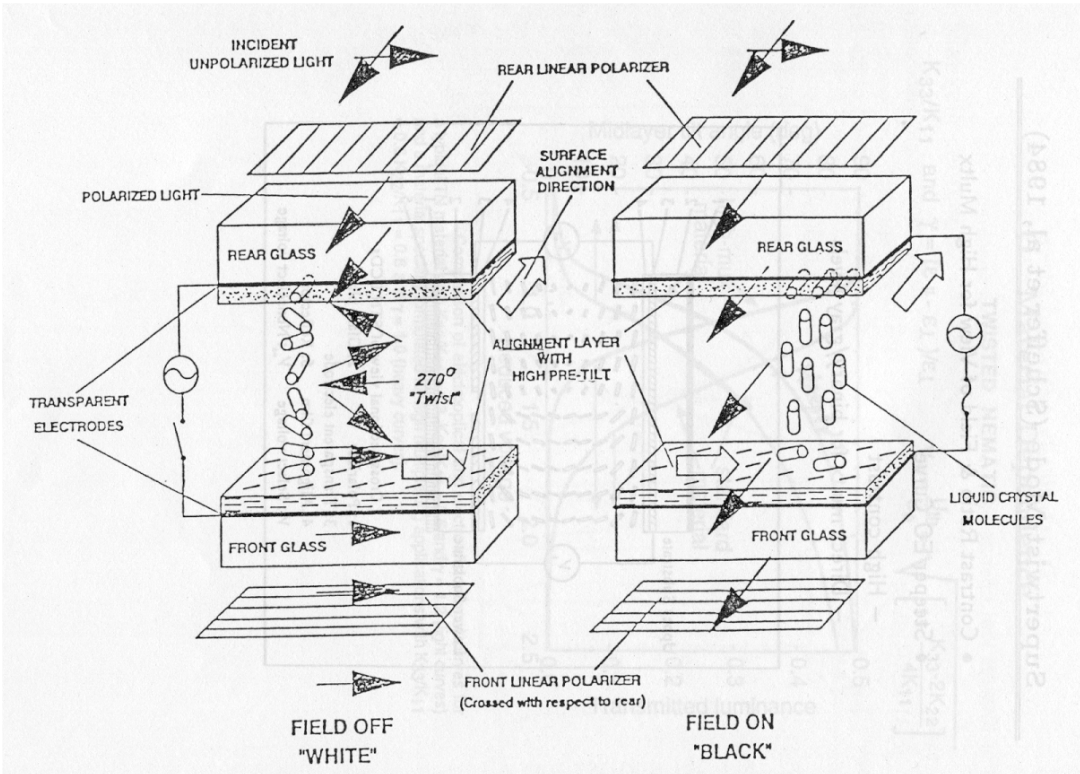
2.1 Thin Film Transistor Liquid Crystal Display(TFT-LCD)

* Types of LCDs



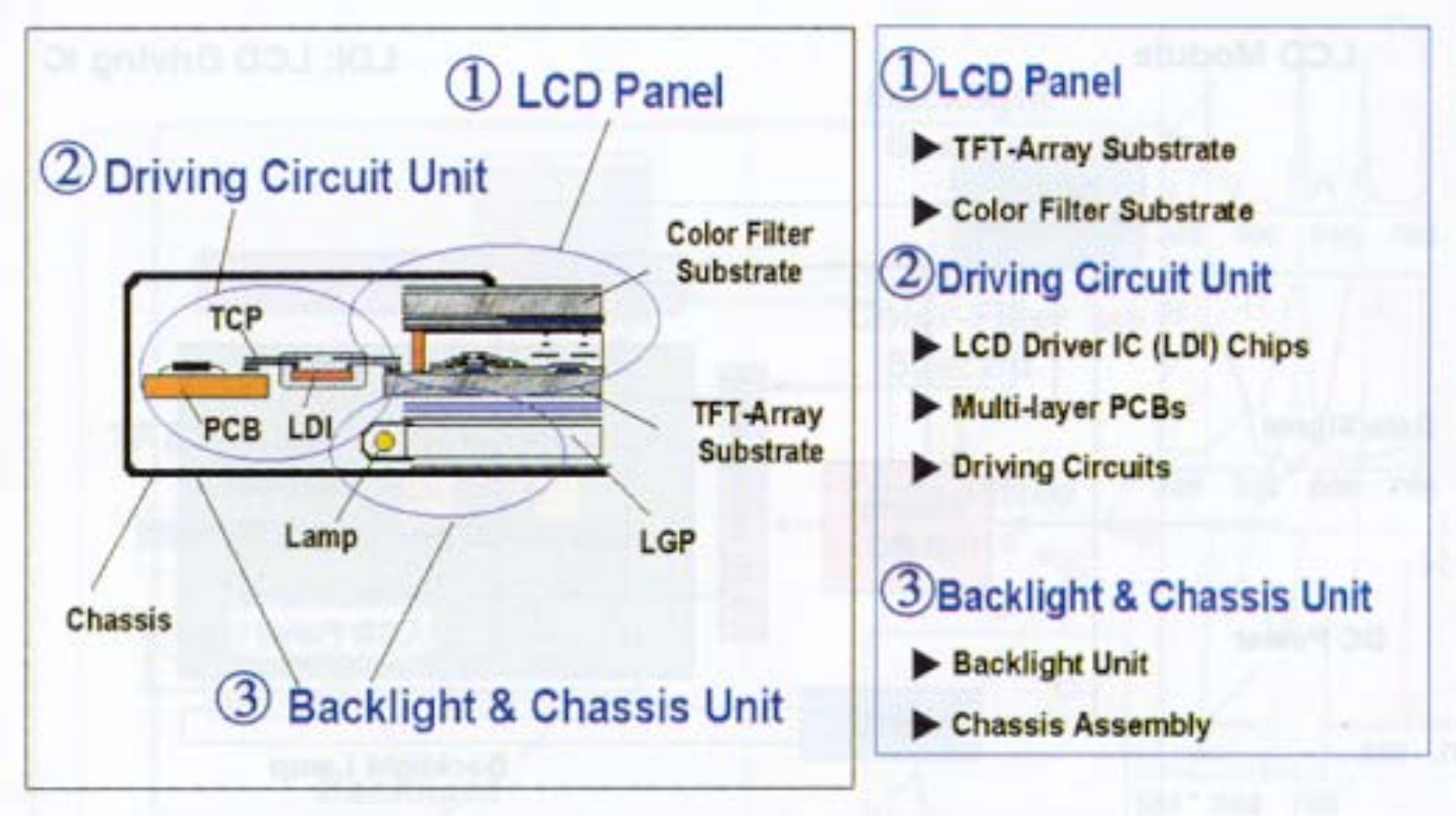
2.1 Thin Film Transistor Liquid Crystal Display(TFT-LCD)

*Example of STN mode



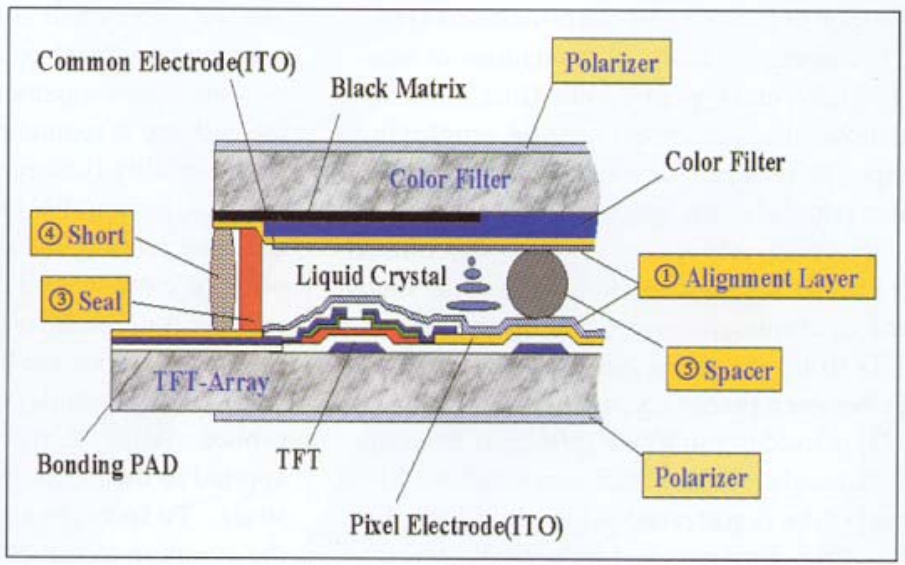
2.1 Thin Film Transistor Liquid Crystal Display(TFT-LCD)

* TFT-LCD structure



2.1 Thin Film Transistor Liquid Crystal Display(TFT-LCD)

* TFT-LCD structure



- < 54 inch
- Slow Response
- Leading technology in FPD
- Monitor & Mobile phone

2.1 Thin Film Transistor Liquid Crystal Display(TFT-LCD)

Fig. 40 inch TFT-LCD(Samsung)

2.1 Thin Film Transistor Liquid Crystal Display(TFT-LCD)

* Hot issues on TFT-LCD

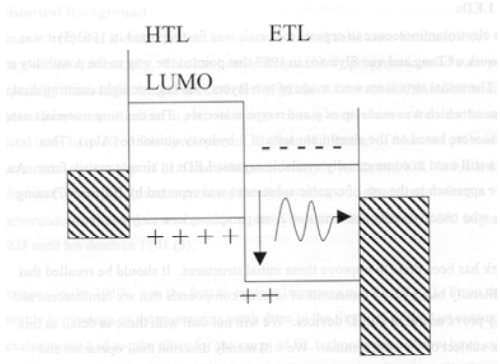
1. High Speed LC mode : < 10 msec
2. p-Si TFT : Low temperature process

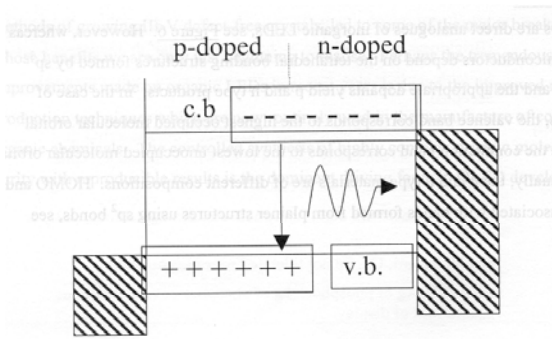
   Number of mask step

   Cost/Yield
3. System integration
4. 7th Generation manufacturing

2.2 Organic Light Emitting Diode(OLED)

Definition: Electronic display device utilizing visible emission from hole-electron recombination in forward biased LUMO-HOMO junction





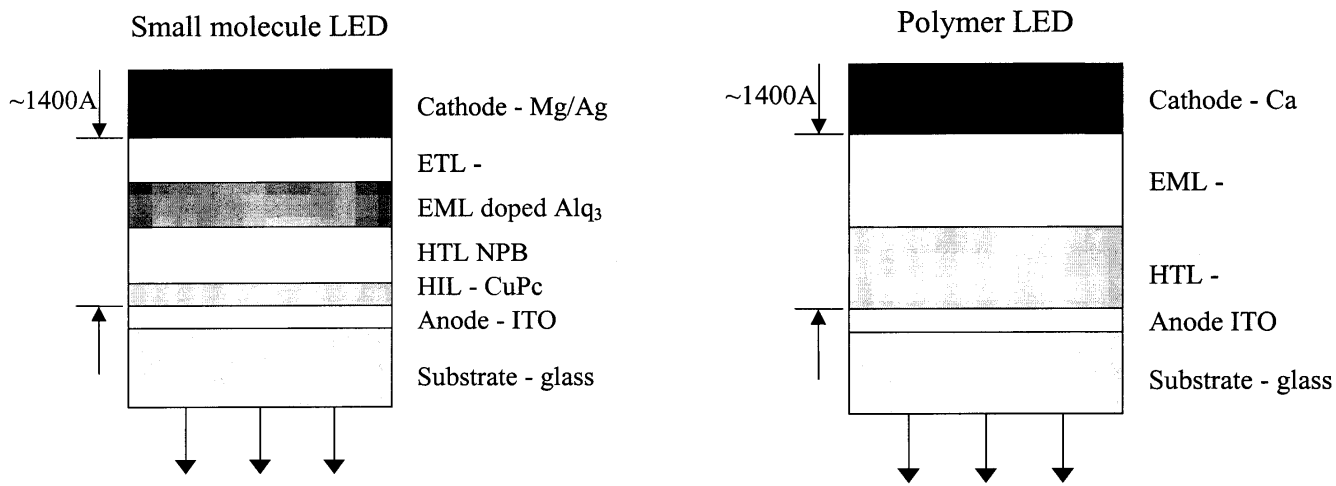
Organic LED Inorganic LED

*LUMO: Lowest Unoccupied Molecular Orbital -> Conduction band

HOMO : Highest Occupied Molecular Orbital -> Valence Band

2.2 Organic Light Emitting Diode(OLED)

* Types of LCDs



*ETL : Electron Transfer Layer

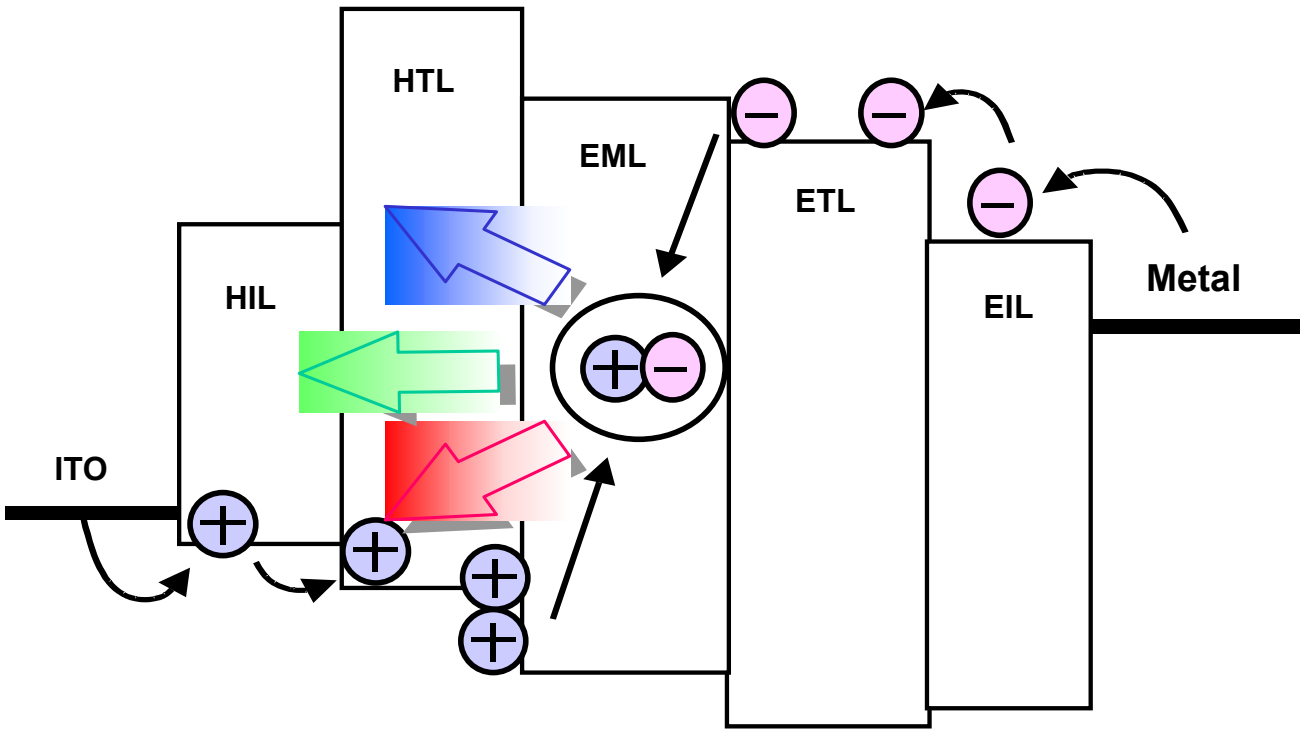
EML : Emitting Layer

HTL : Hole Transfer Layer

HIT : Hole Injection Layer , EIL : Electron Injection Layer

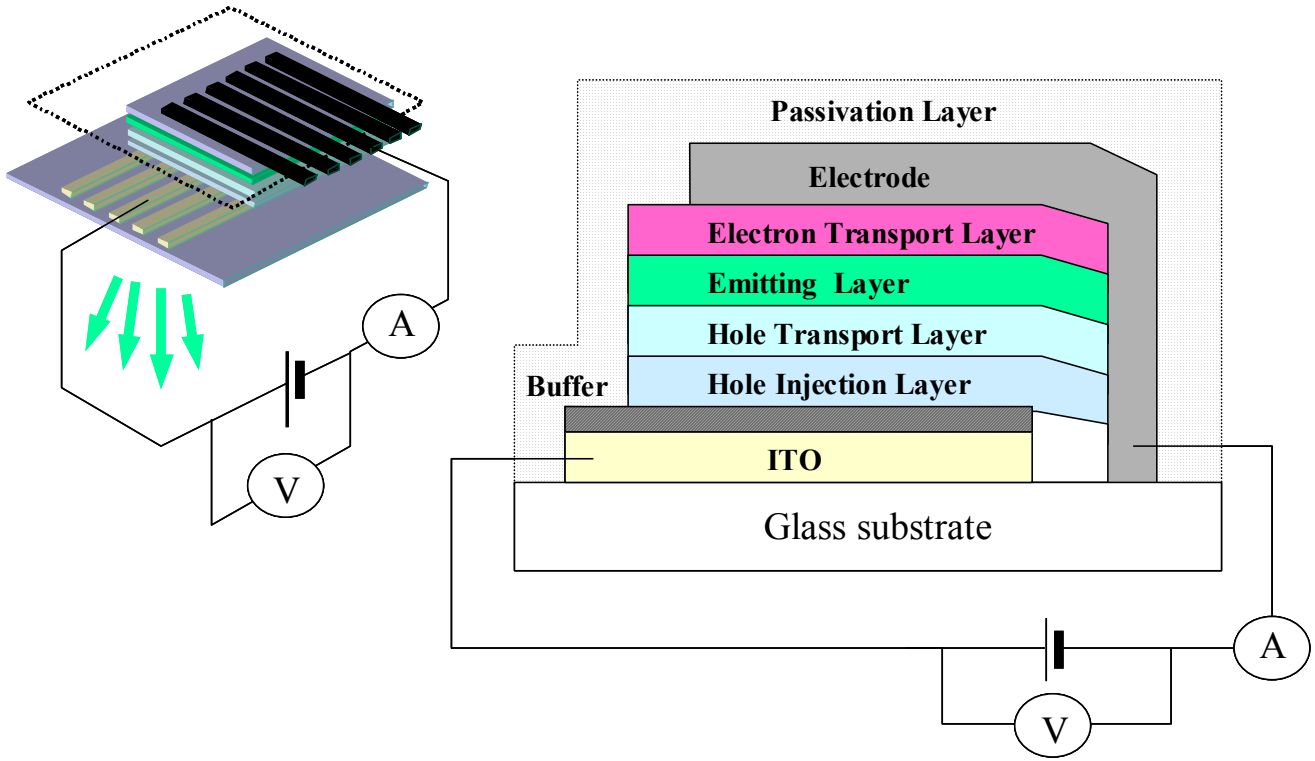
2.2 Organic Light Emitting Diode(OLED)

* OLED structure



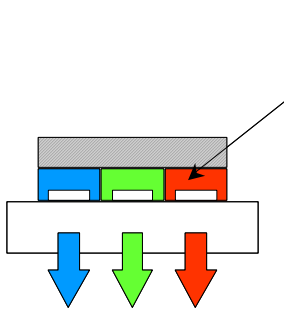
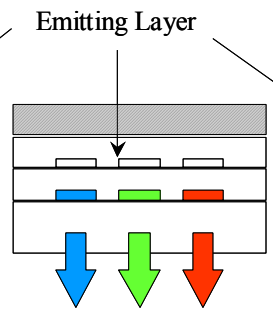
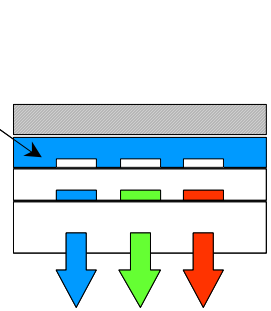
2.2 Organic Light Emitting Diode(OLED)

* OLED structure



2.2 Organic Light Emitting Diode(OLED)

* OLED structure

Color technology	 **Blue & Green & Red EL**	 **White EL + C/F for LCD**	 **Blue EL + Color Changing Material**
Company	Pioneer, NEC	TDK	Idemitsu
Merit	High quality image	Application of LCD C/F	High efficiency, Wide viewing angle
Theme	Red emitting material	High efficiency white EL	Red CCM material

2.2 Organic Light Emitting Diode(OLED)

* OLED technology

- **< 20 inch**
- **Reliability**
- **Emerging technology in FPD**
- **Monitor & Mobile phone**

2.2 Organic Light Emitting Diode(OLED)

* Hot issues on OLED

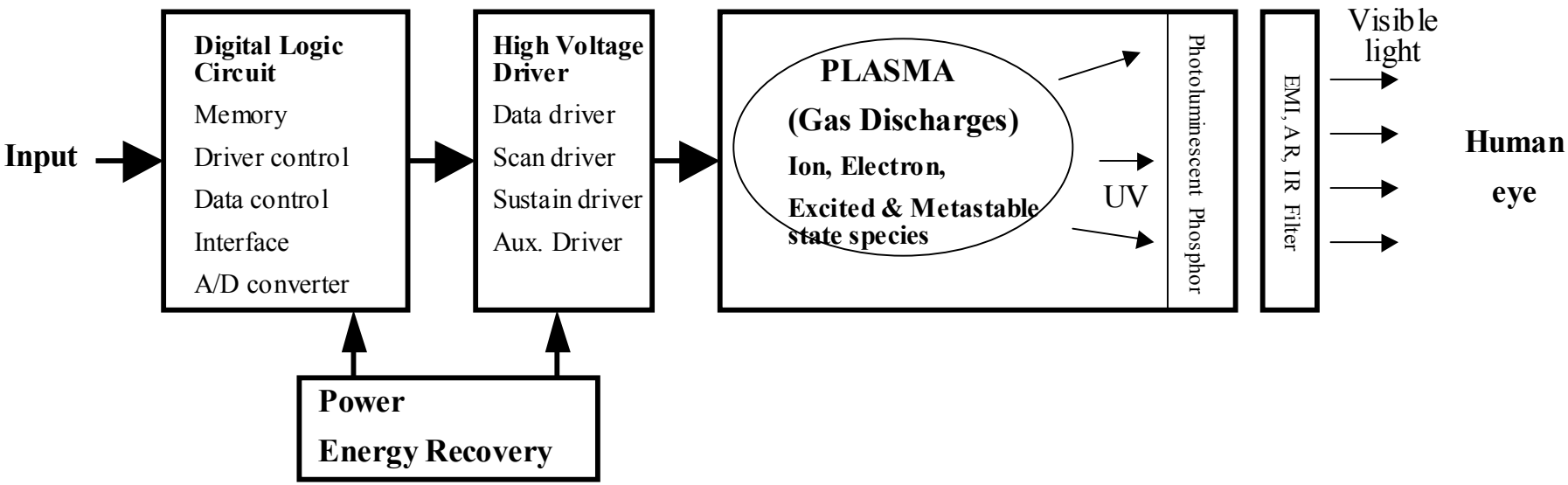
1. Small Molecules Show Great Promise for Mobile Application,
   But Needs Innovation for
   - *Large Size Glass Handling*
   - *Yield Increase*
   - *Longer Lifetime for General Application :*
     Materials and OLED Structure

2.Polymer LED Has Many Advantages for Low Cost Large Scale
   Manufacturing, But Needs for Innovation for
   - *Higher Efficiency and Longer Lifetime : Materials and Process*

3.Required Mature Infrastructure *: Machine, Parts, and etc.*

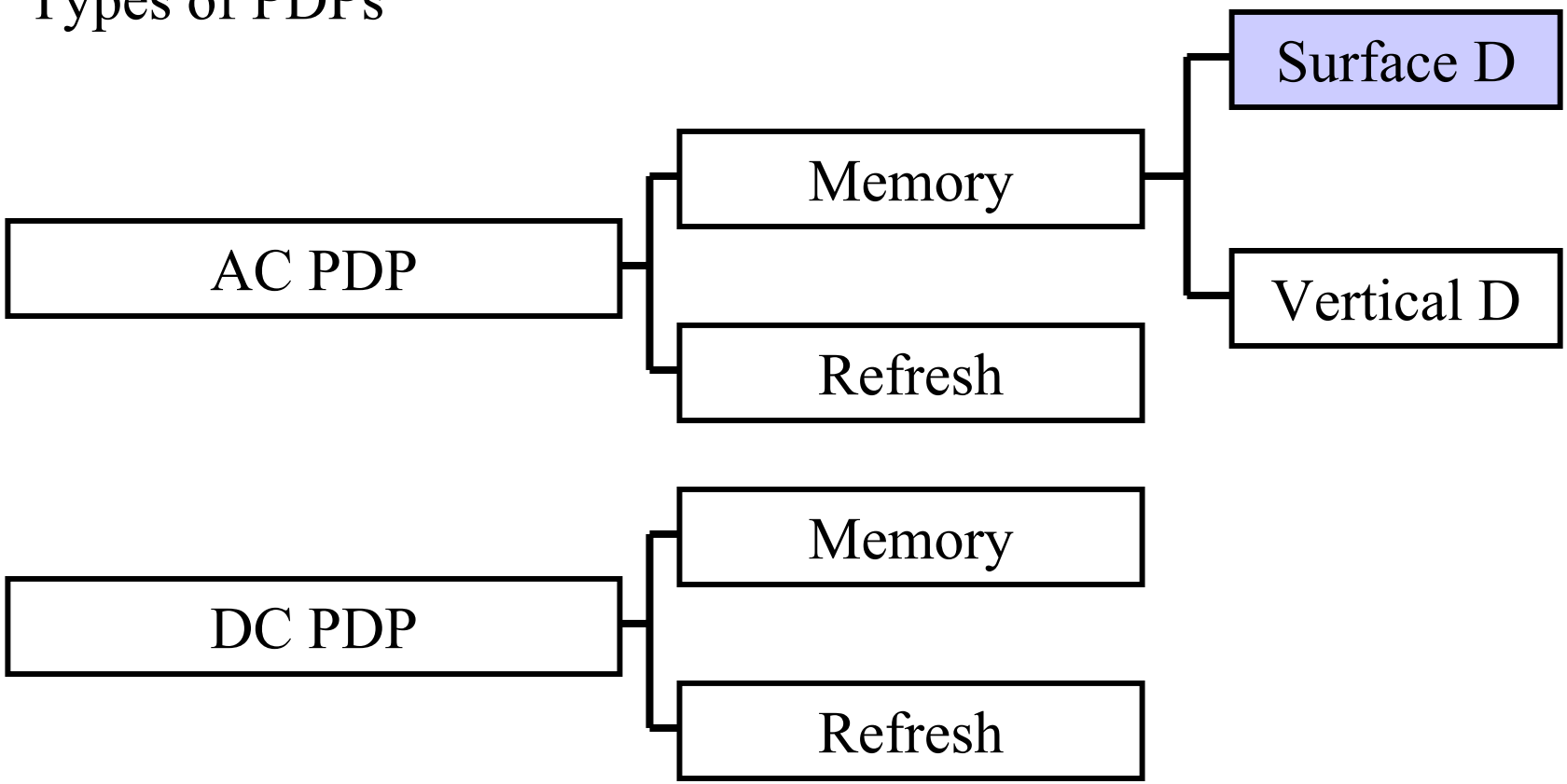
2.3 Plasma Display Panel(PDP)

Definition: Electronic display device utilizing Ultra Violet emission from the negative glow of the gas discharge



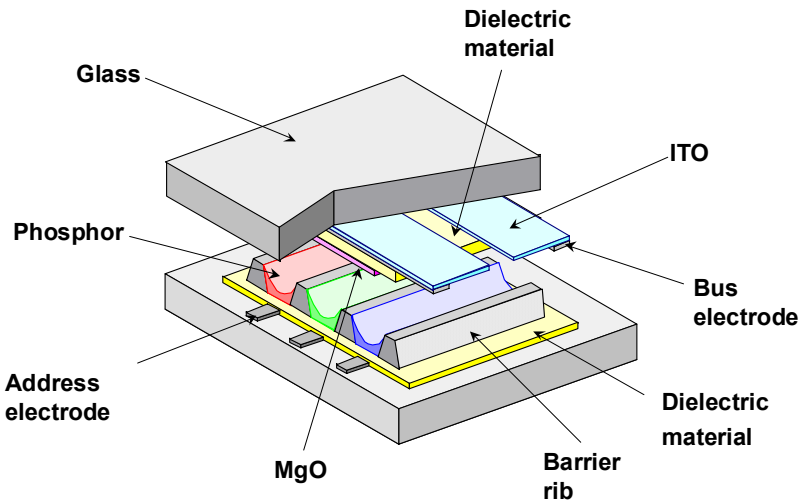
2.3 Plasma Display Panel(PDP)

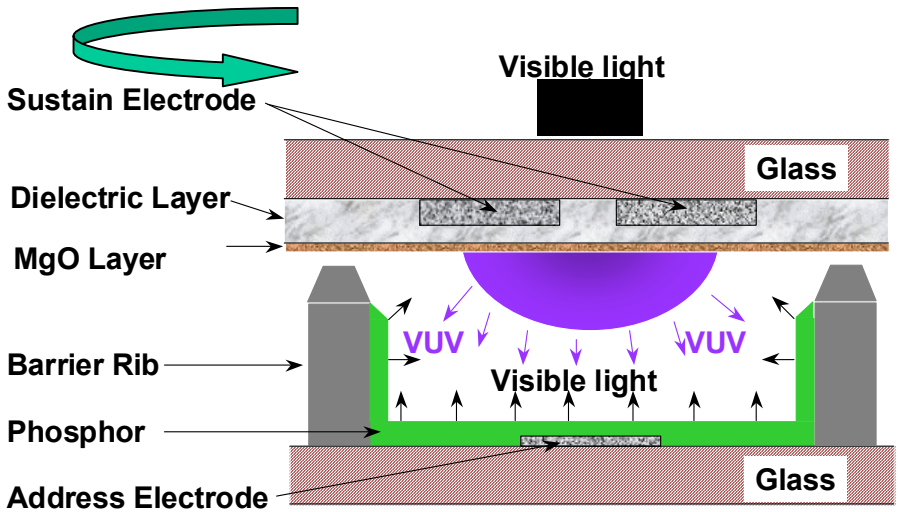
* Types of PDPs



2.3 Plasma Display Panel(PDP)

* PDP structure(Three electrodes Surface discharge type)





2.3 Plasma Display Panel(PDP)

- > 30 inch
- High price & Low Effi.
- TV and Business application

2. 3 Plasma Display Panel(PDP)

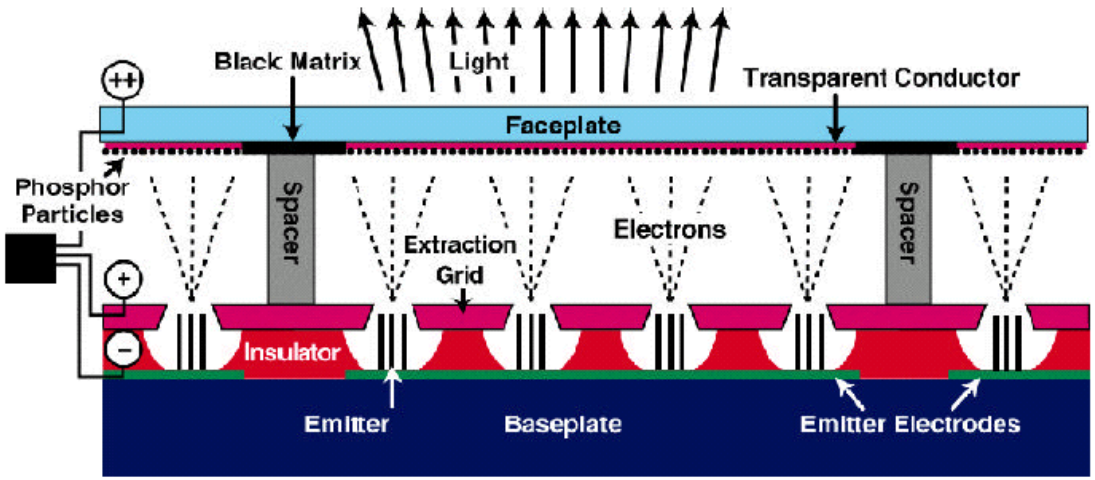
* Hot issues on PDPs

1. High Luminous efficiency
   - *Delta/mesh type structure*
   - *Gas Composition :High Xe contents, non-Xe gas mixtures*
   - *Long gap discharge*
2. Picture quality
   - *False contour*
   - *Luminance/Contrast*
   - *Low level gray control*

3. Cost

2.4 Field Emission Display(FED)

Definition: Electronic display device utilizing cold electron emission from the field emitter array



2.4 Field Emission Display(FED)

* Types of field emitter array(FEA)

(1) Silicon-based Micro-tip FEA

Silicon Tip, Metal tip

(2) Glass-based Micro-tip FEA

Micro-tip, Thin Film edge emitter

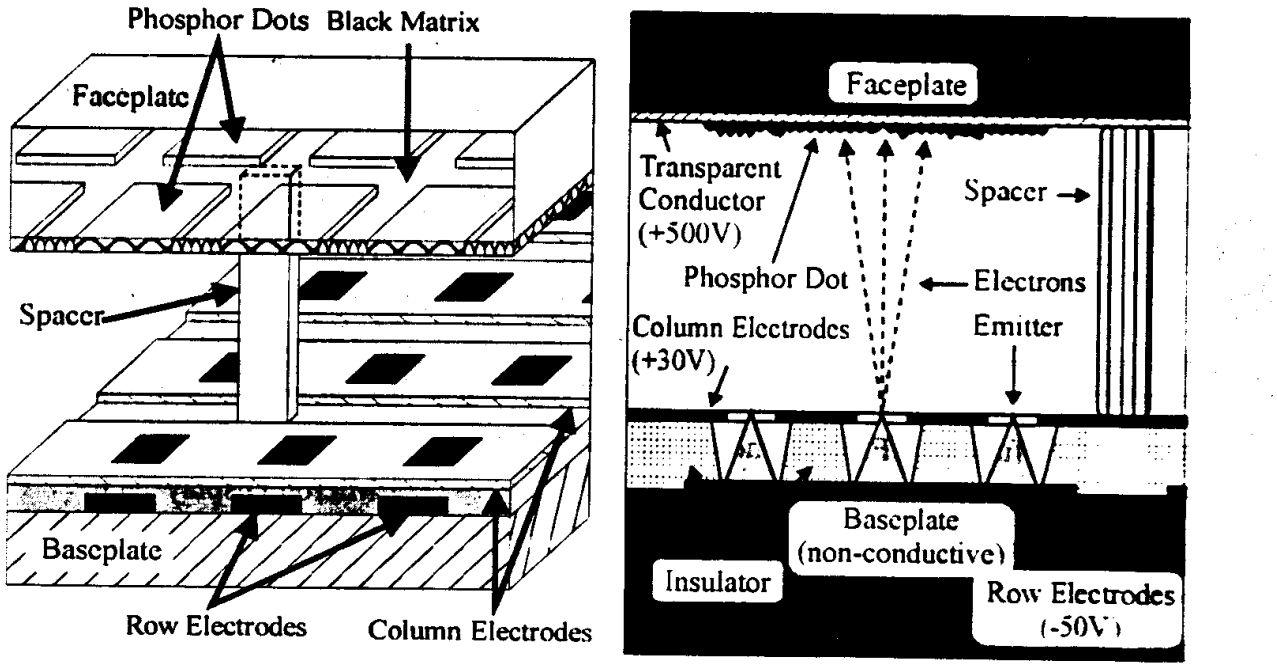
Carbon Nano Tube, Diamond

Surface Conduction Emission, MIS, MIM

(3) TFT-Controlled FEA

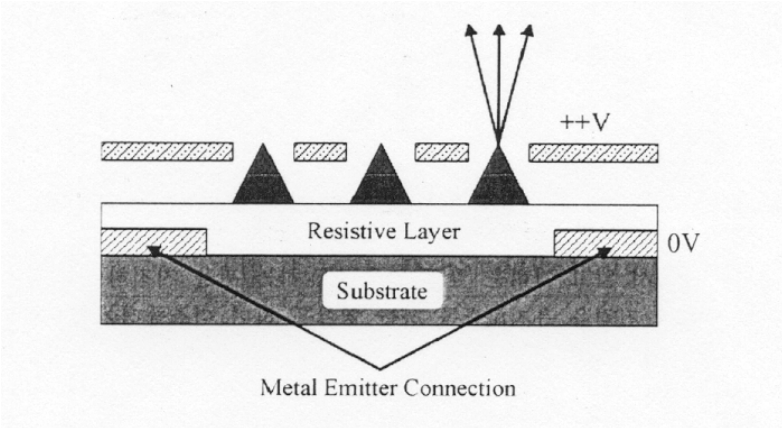
2.4 Field Emission Display(FED)

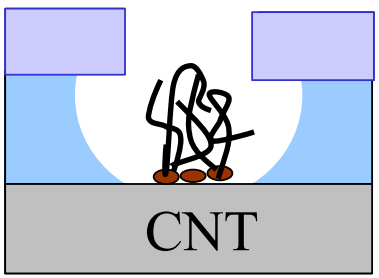
* FED structure

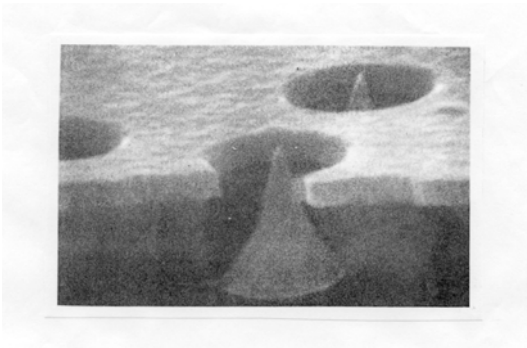


2.4 Field Emission Display(FED)

* FED structure

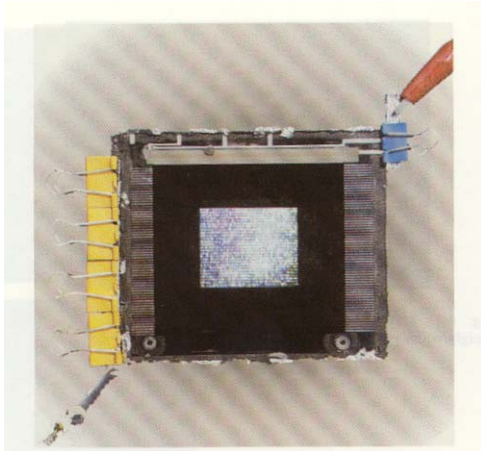






2.4 Field Emission Display(FED)

* FED technology



- < 20 inch
- Reliability
- Monitor & TV

2.4 Field Emission Display(FED)

* Hot issues on FEDs

1. FEA Reliability problem
   - *New emitter material : CNT*

2. Packaging
   - *In-line packaging*

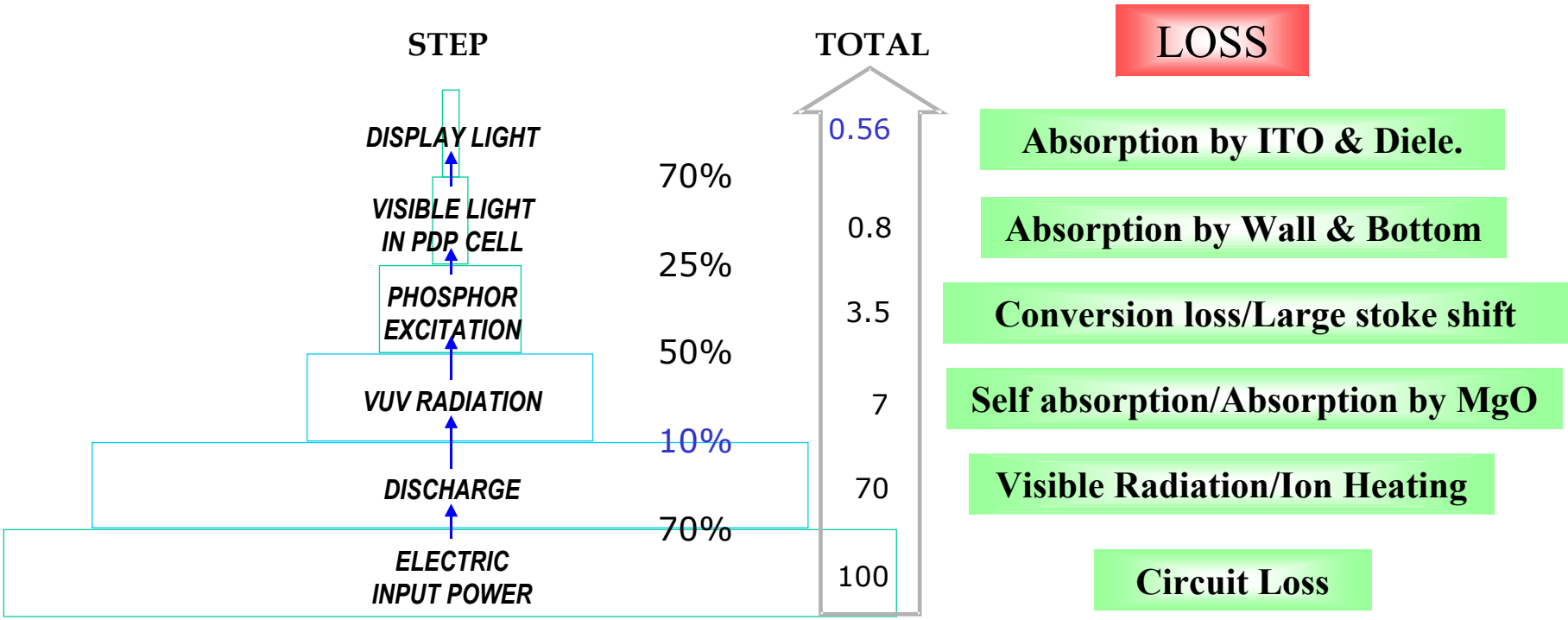
3. Low voltage phosphor

3. Hot issues on Plasma Display

- **Low Luminous Efficiency**
  - ➔ **High Power consumption**
  - ➔ **High cost (Especially, driving electronics)**
- **Current status : 1.5 lm/W**
- **Target : 5 lm/W (Final target : 10 lm/w)**

3. Hot issues on Plasma Display

➢ Energy Loss Mechanism (Xe gas-mixture) in PDP



3. Hot issues on Plasma Display

- **Approaches to improve luminous efficiency**

New Discharge mode	Gas Composition	Optimization	New Material

3. Hot issues on Plasma Display

- **New discharge mode**

1. **Townsend Discharge**
2. **Positive Column Discharge**
3. **Hollow Cathode Discharge**

3. Hot issues on Plasma Display

- **Gas composition**

1. **He or Ne based Xe gas mixtures : 2 or 3 compositions**
2. **Excimer gas, N_2 gas**
3. **High Xe contents**

3. Hot issues on Plasma Display

- **Optimization**

1. Sustain electrode
2. Large area phosphor
3. Pixel structure
4. Optimum driving condition

3. Hot issues on Plasma Display

- **New materials**

1. **High quantum efficiency phosphor**
2. **Small stoke shift phosphor**
3. **Protecting layer**

3. Hot issues on Plasma Display

➢ **High Efficiency PDP depending on discharge mechanism**

1. High intensity UV emitting Source

- Townsend discharge

- High Xe contents discharge

- N_2 & Excimer gas discharge

- Hollow Cathode discharge

3. Hot issues on Plasma Display

- **High Efficiency PDP depending on discharge mechanism**

2. Low field & High excitation rate

- Long gap discharge

- Positive Column discharge

3. Hot issues on Plasma Display

- **High Efficiency PDP depending on discharge mechanism**

3. Electron heating

- High Frequency (RF) discharge

- High gas pressure/High Xe Contents

- N_2 gas-mixture discharge

- Hollow Cathode discharge

3. Hot issues on Plasma Display

- **High Efficiency PDP depending on discharge environment**

1. Discharge volume and Large Phosphor area

- **Meandering Structure**
- **SDR structure**
- **Positive Column Discharge**

3. Hot issues on Plasma Display

- **High Efficiency PDP depending on discharge environment**

2. Cell/Panel optimization and driving scheme

- T shape sustain electrode

- ALIS type PDP

- Auxiliary pulse perturbation

3. Hot issues on Plasma Display

- **High Efficiency PDP depending on phosphor**

1. Longer wavelength UV source & Small Stoke shift

- Excimer gas / Hg

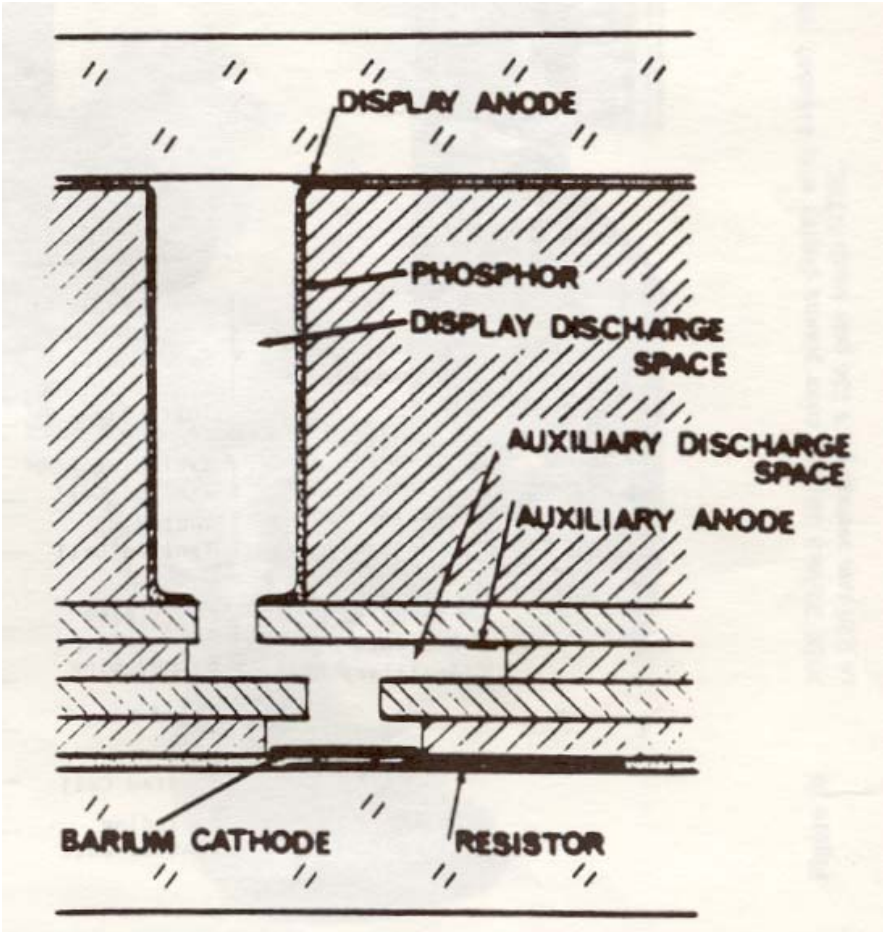
- N_2 gas

- Possibility of Quantum Cutting

3. Hot issues on Plasma Display

➢ Townsend discharge PDP (SID'90 , Hitachi)

- High UV source
- Larger phosphor area
- High voltage
- Very short pulse (0.1~0.2 μsec)
- High Value resistor

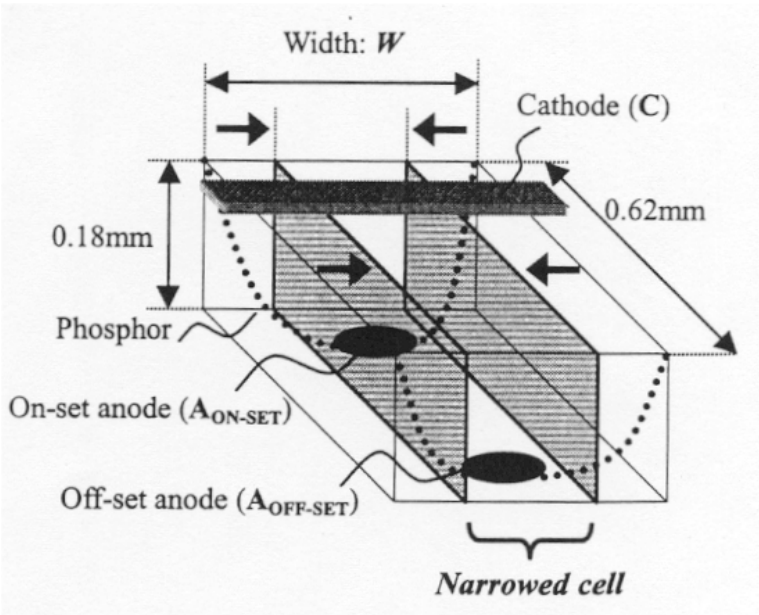


3. Hot issues on Plasma Display

➢ Positive Column Discharge PDP

- Larger phosphor area
- Low field and high excitation rate
- Long pulse
- UV emission depends on gas pressure

➢ Positive Column Discharge PDP (IDW'00 , NHK)



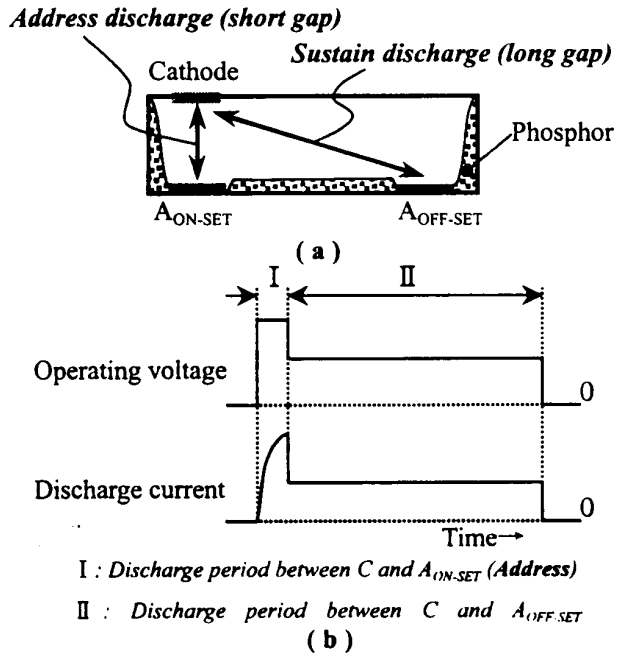


Fig. Positive Column DC PDP proposed by NHK

3. Hot issues on Plasma Display

➢ Positive Column Discharge PDP(IEEE ED, 1978 , NHK)

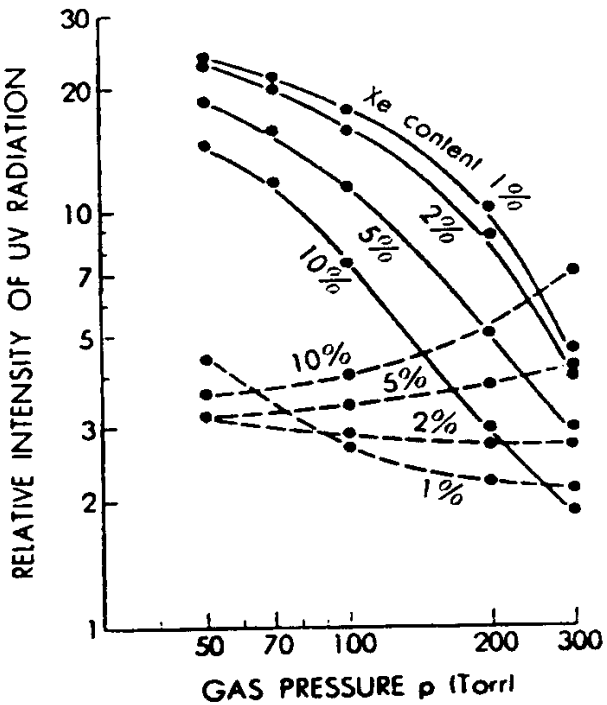


Fig. UV radiation from Positive Column DC PDP(He+Xe)
Positive column (—), Negative glow (- - - -)

3. Hot issues on Plasma Display

➢ Hollow cathode Discharge PDP

- High density plasma source
- High gas pressure (Short gap approach)
- Electron heating

3. Hot issues on Plasma Display

➢ Hollow cathode Discharge PDP (SID'98/IDRC'98 HPD)

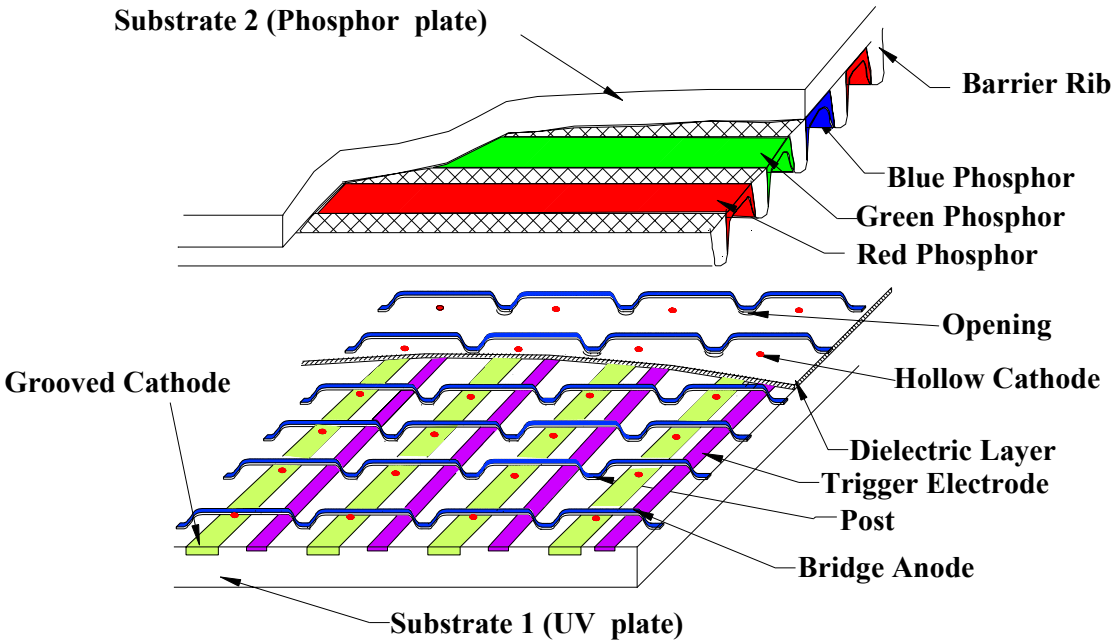


Fig. Hollow Cathode discharge PDP proposed by HPD

3. Hot issues on Plasma Display

➢ Hollow cathode Discharge PDP(IDRC'98, HPD)

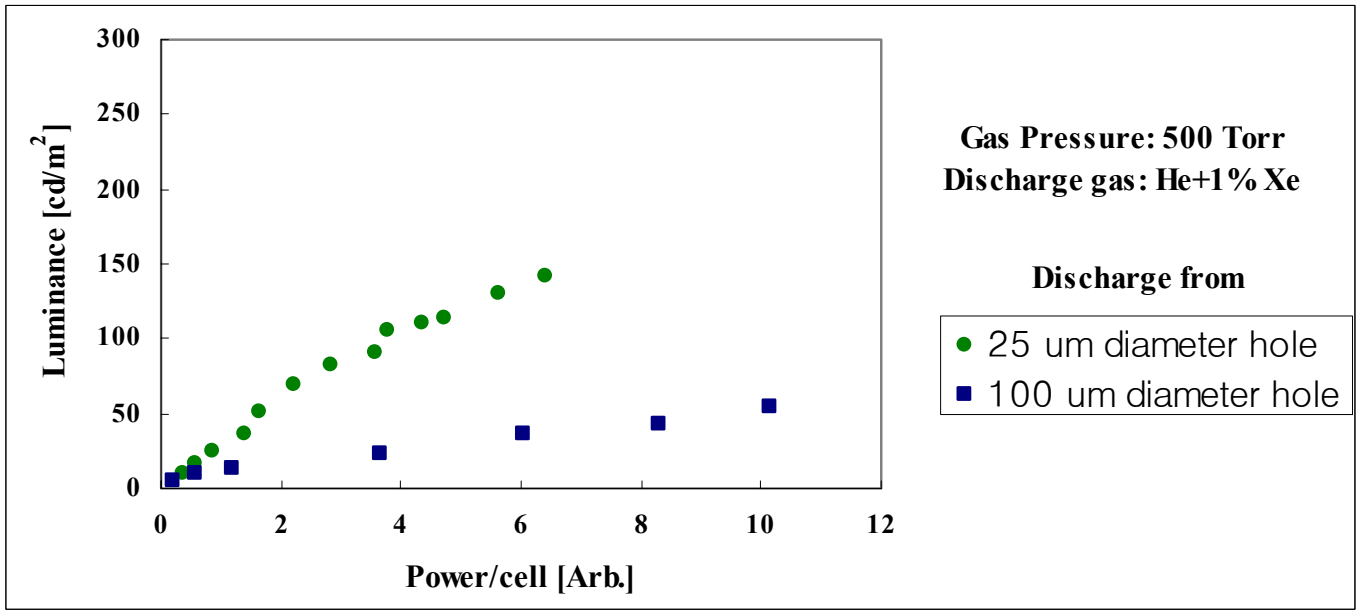
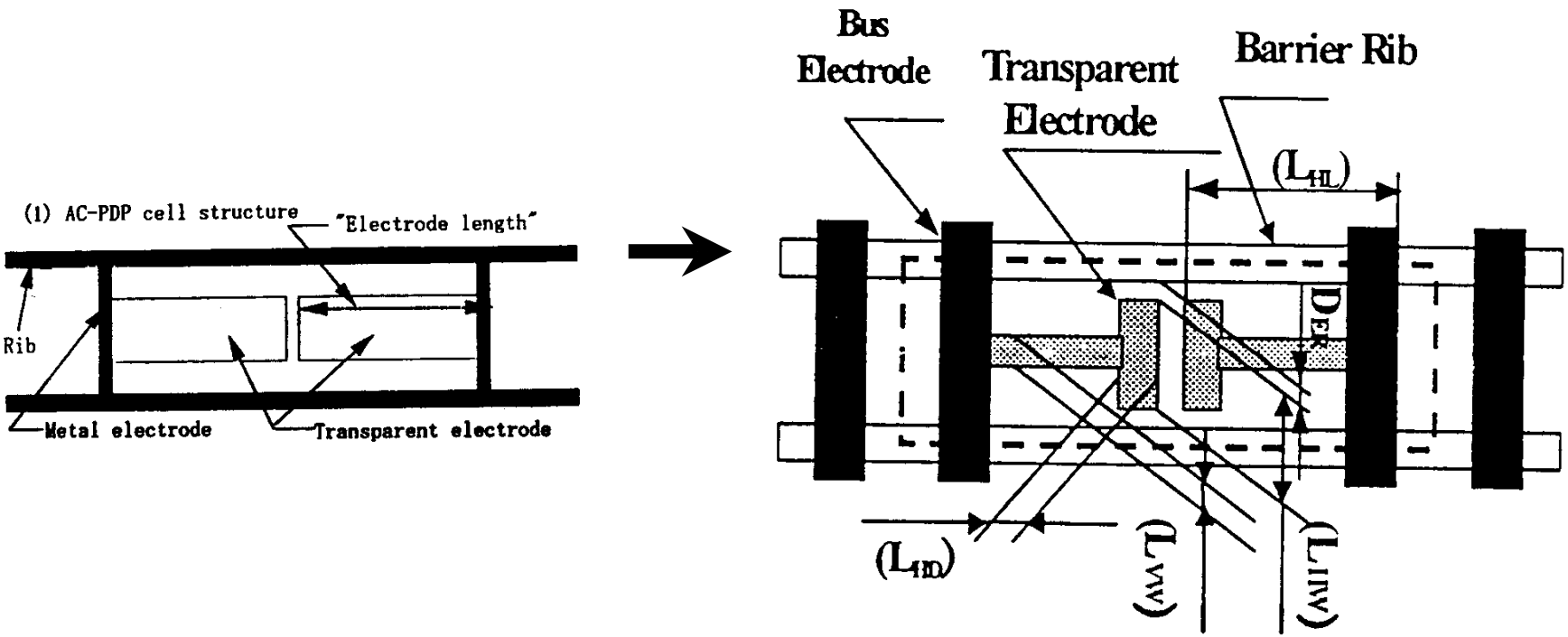


Fig. Luminance v.s. Power of Hollow Cathode discharge PDP

3. Hot issues on Plasma Display

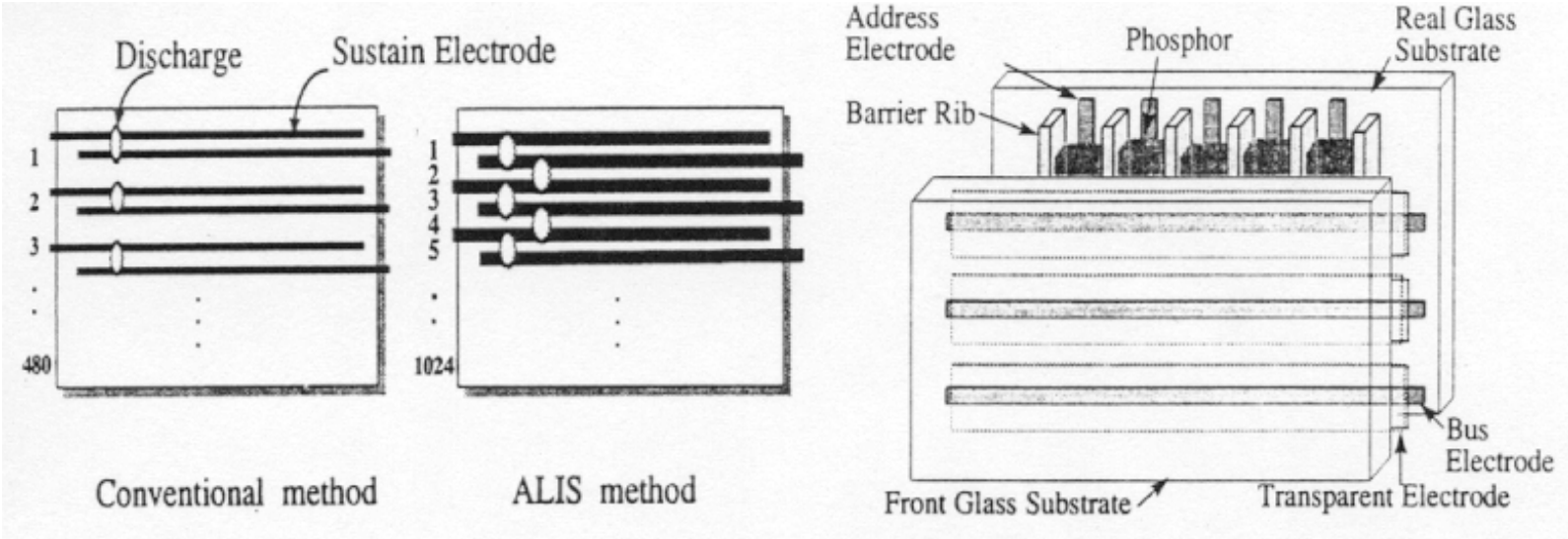
- **T shaped sustain electrode (IDW'98, Pioneer)**



Pioneer type AC PDP

3. Hot issues on Plasma Display

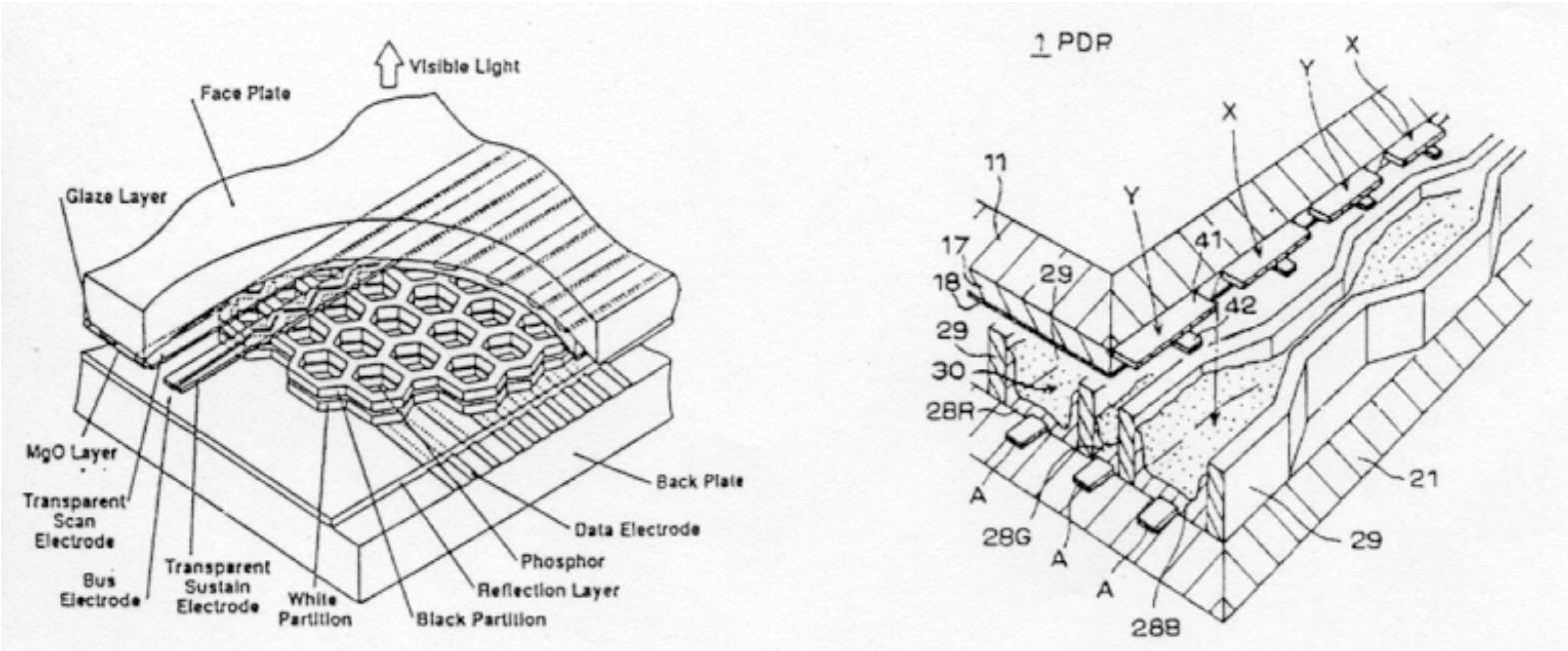
- **Rearrange the sustain electrodes and the new driving scheme(SID'99, Fujitsu)**



Fujitsu ALIS type AC PDP

3. Hot issues on Plasma Display

- **Large discharge and phosphor area**

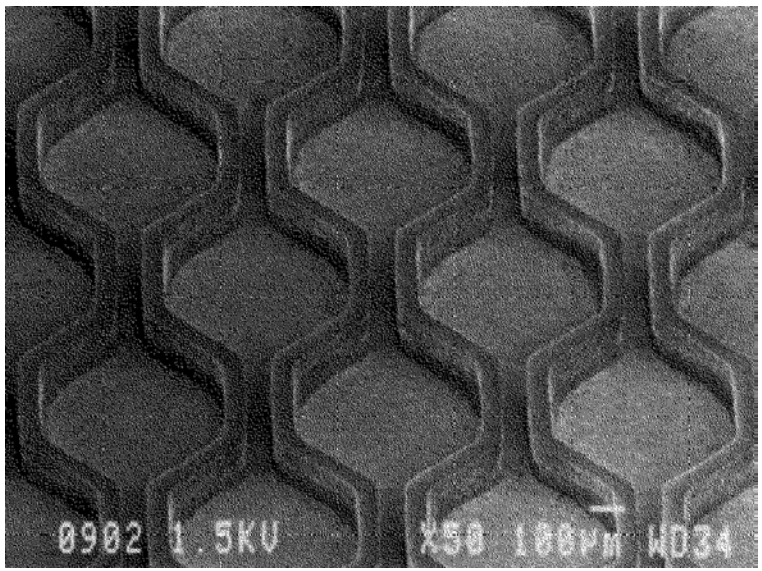


(a) NEC Honeycomb -like

(b) Fujitsu Meandering B/R

3. Hot issues on Plasma Display

- **Large discharge and phosphor area (IDW'99 , Fujitsu)**



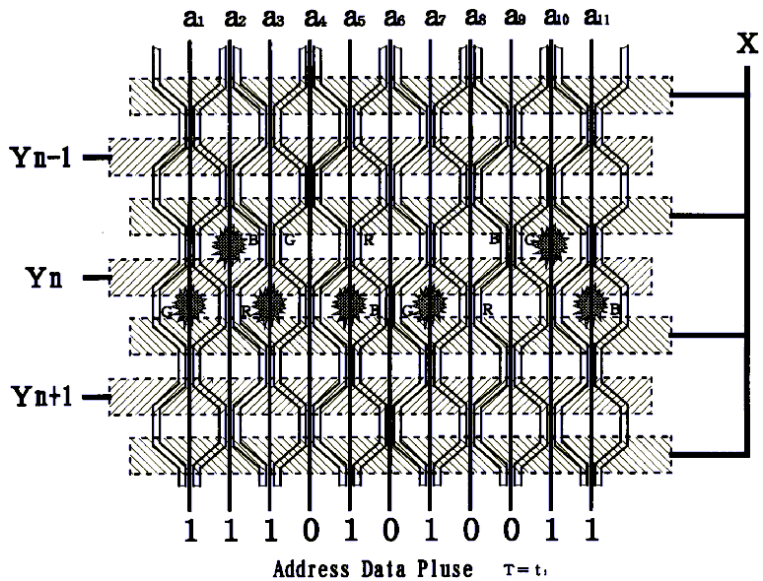


Fig. Delta structure with Meandering B/R

3. Hot issues on Plasma Display

➢ Large discharge and phosphor area (SID'01 , SNU)

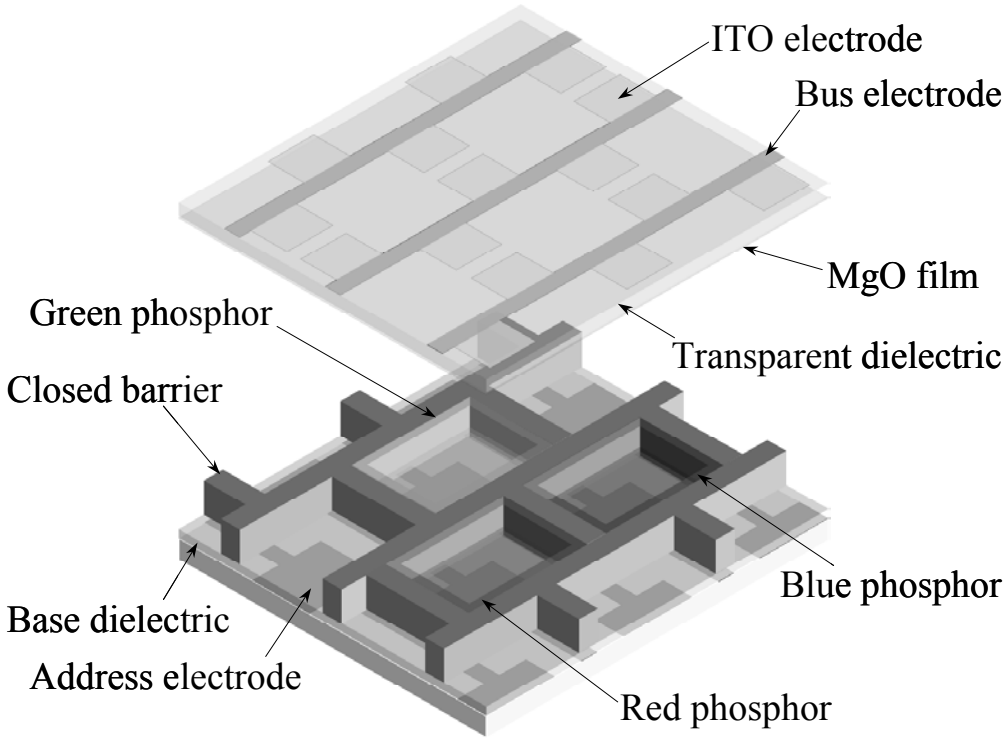
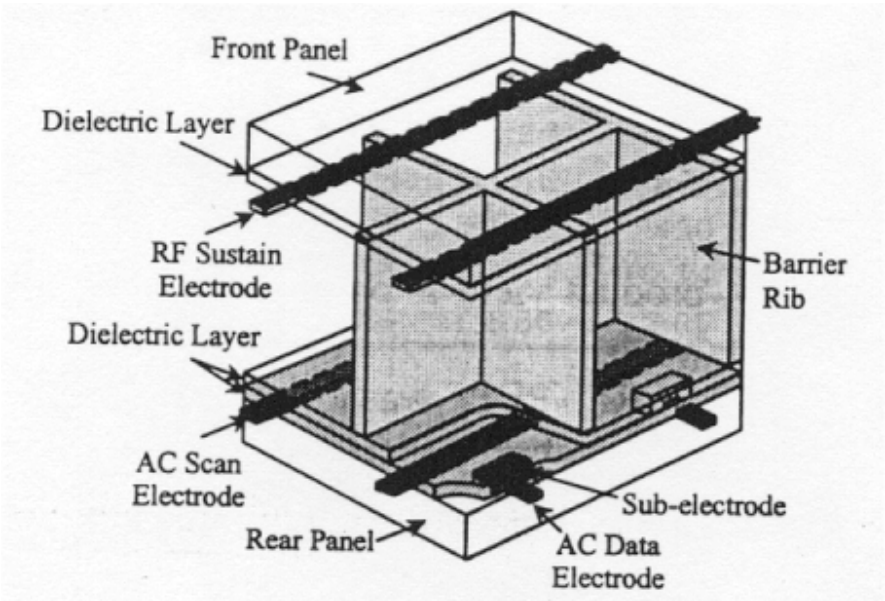


Fig. Segmented Electrode in Delta Color Arrayed Rectangular Sub-pixels (SDR) Structure

3. Hot issues on Plasma Display

- **Electron heating(IDW'99, LG)**



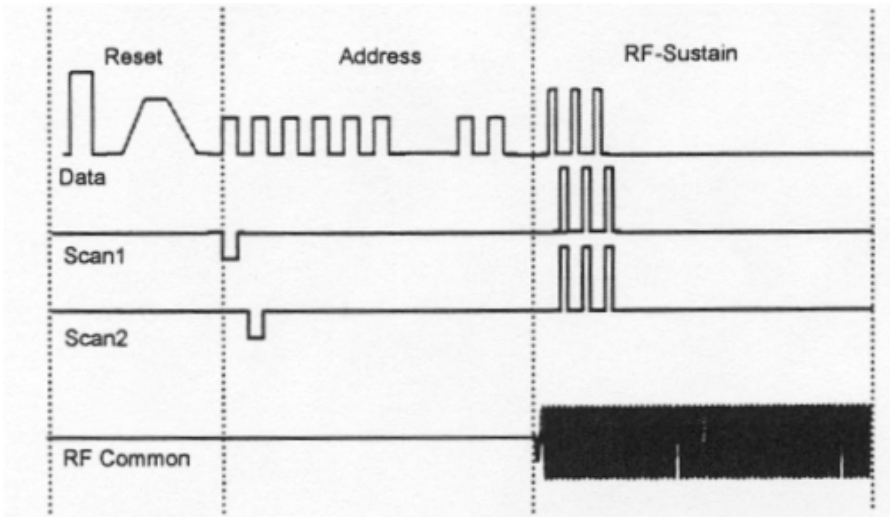


Fig. RF PDP proposed by LG

3. Hot issues on Plasma Display

➢ Electron Excitation of Xe

Normal Surface Discharge(Ne+Xe5%) (IDW'99 from Prof.Whang)	
Ion heating Ionization	Electron Excitation of Xe
76	24

RF Discharge(Ne+Xe10%) (IDW'99 from Prof.Boeuf)	
Ion heating Ionization	Electron Excitation of Xe
30	70

3. Hot issues on Plasma Display

➢ High Xenon contents PDP(SID'02, Philips)

- High UV source
- High Xe excitation rate (Directly into Xe($^3P_1$), Xe($^3P_2$))
- Electron heating efficiency

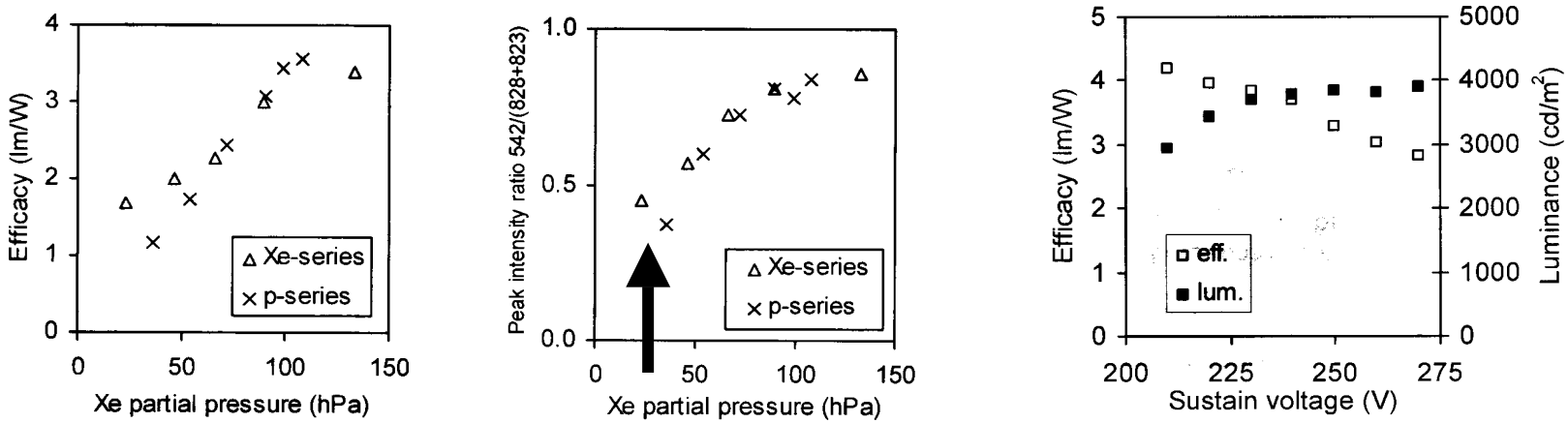
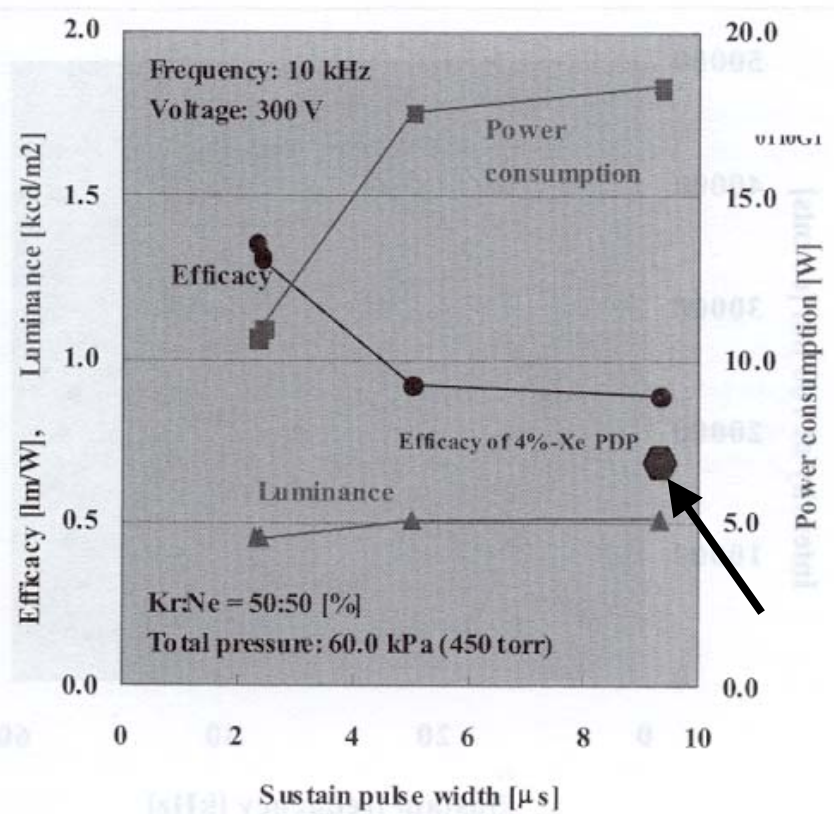


Fig. High Xe PDP data (↑ current level)
(Pressure series at Xe 13.5%, Xe series at pressure at 600hPa(450 torr))

3. Hot issues on Plasma Display

- **Excimer gas discharge PDP (SID'02, Samsung SDI)**
  - XeF(351 nm), XeI(254 nm), XeKr(146 nm)
  - No self-absorption
  - Longer wave length(XeF,XeI) compared to Xe



3. Hot issues on Plasma Display

- N_2 gas-mixture discharges

- UV emission with the range of 300~390 nm
- Small stoke shift compared to that of Xenon
- Electron heating efficiency is greater than that of Xe-Ne mixture [Philips, IDW'01]
- Possibility for using Quantum Cutting
- High UV source
- High excitation rate

3. Hot issues on Plasma Display

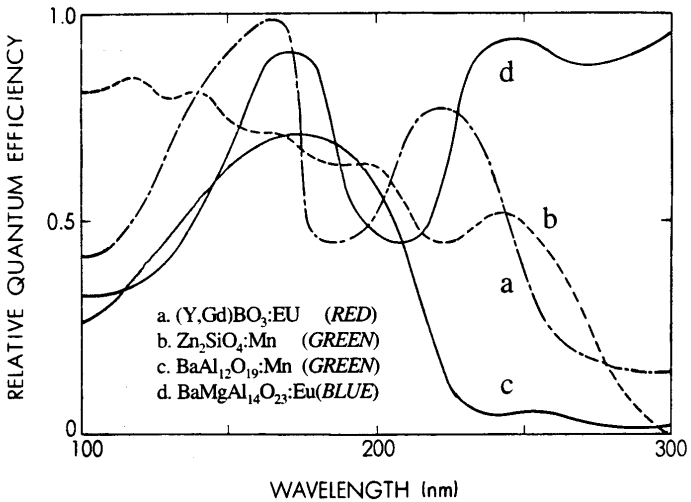
- N_2 gas-mixture discharges

Normal Surface Discharge(Ne+Xe5%) (IDW'99 from Prof.Whang)	
Ion heating Ionization	Electron Excitation of Xe
76	24

N_2 gas-mixture Discharge(Ne+$N_2$5%) (IDW'01 from Philips)	
Ion heating Ionization	Electron Excitation of Xe
60	40

3. Hot issues on Plasma Display

- **Conventional PDP phosphor and VUV from Xe gas mixtures**



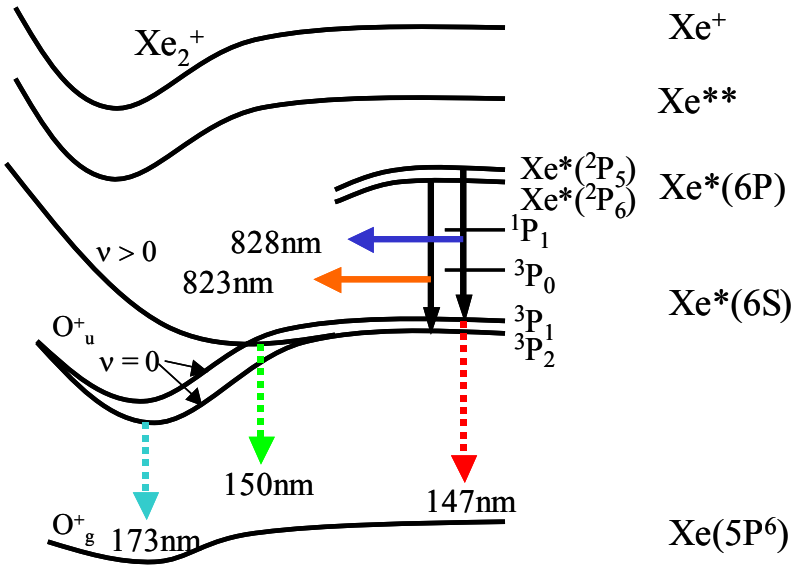
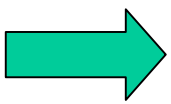


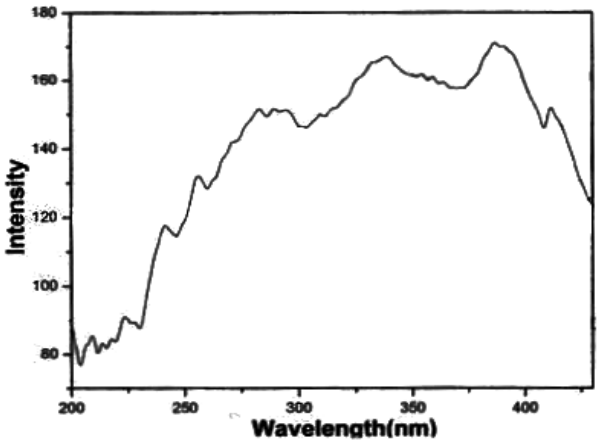
Fig. Quantum efficiency of conventional phosphor and energy BD of Xe gas

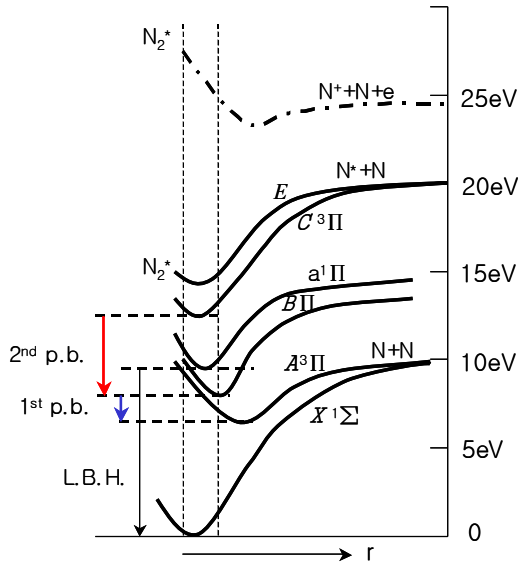


Large Stoke Shift

3. Hot issues on Plasma Display

➢ New Phosphor and Near Ultra Violet





N_2 Emission

(1) First Positive ($B\,^3\Pi_g - A\,^3\Sigma_u^+$)

⇒ IR region 868.3nm~1234.7nm

(2) Second Positive ($c\,^3\Pi_u - B\,^3\Pi_g$)

⇒ UV region 300nm~400nm

(3) Lyman-Birge-Hopfield (L.B.H.)

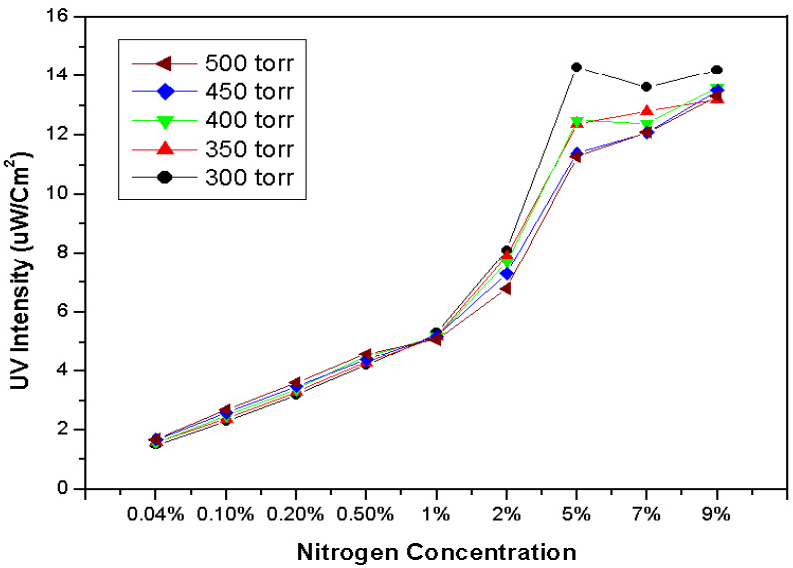
($a\,^1\Pi_g - X\,^1\Sigma_g^+$)

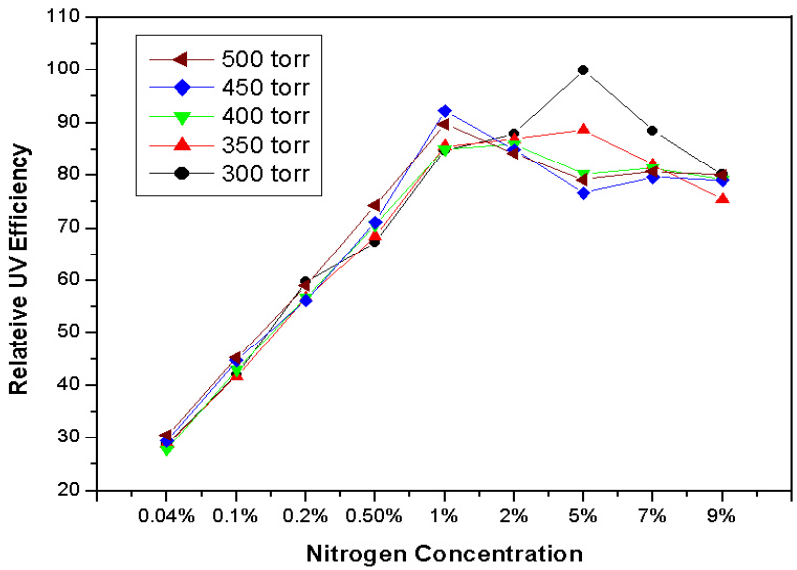
Fig. Excitation graph of new phosphor and energy BD of N_2 gas

➡ Small Stoke Shift / Quantum Cutting

3. Hot issues on Plasma Display

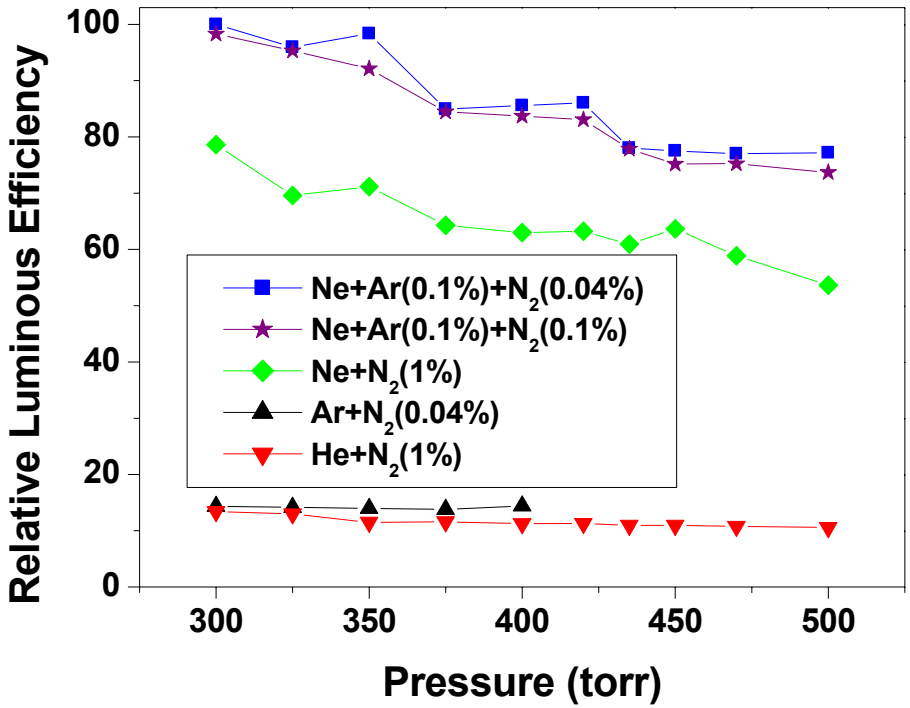
- Near UV intensity - N_2 gas-mixture discharges





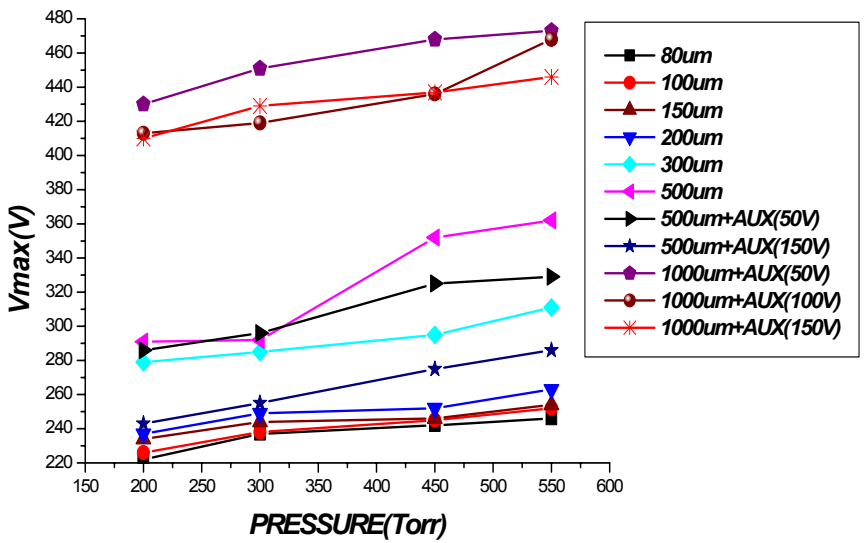
3. Hot issues on Plasma Display

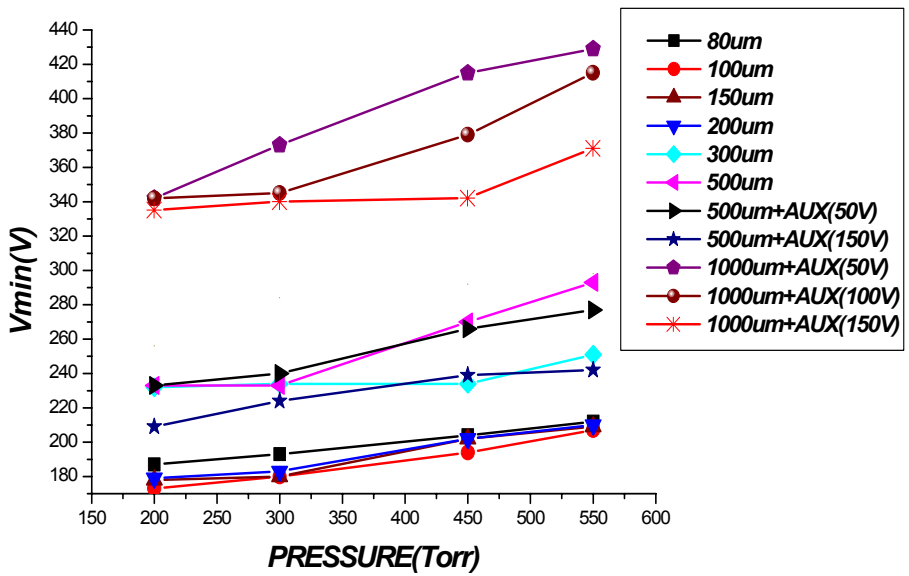
- Efficiency - N_2 gas-mixture discharges



3. Hot issues on Plasma Display

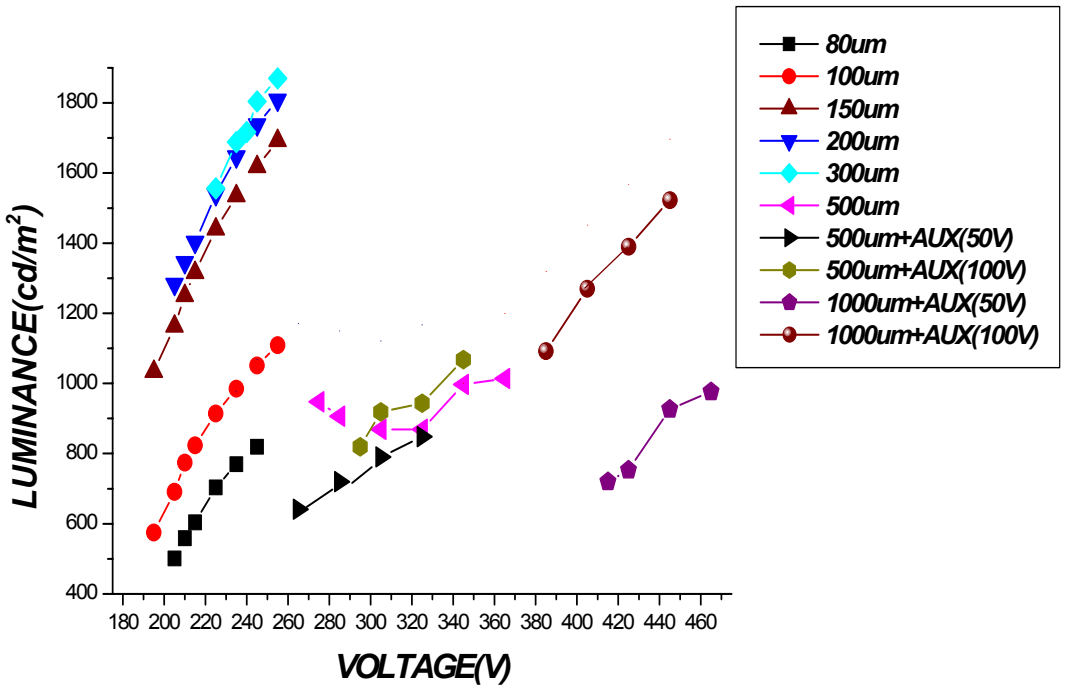
- Long gap discharges ➔ High Electron Excitation of Xe





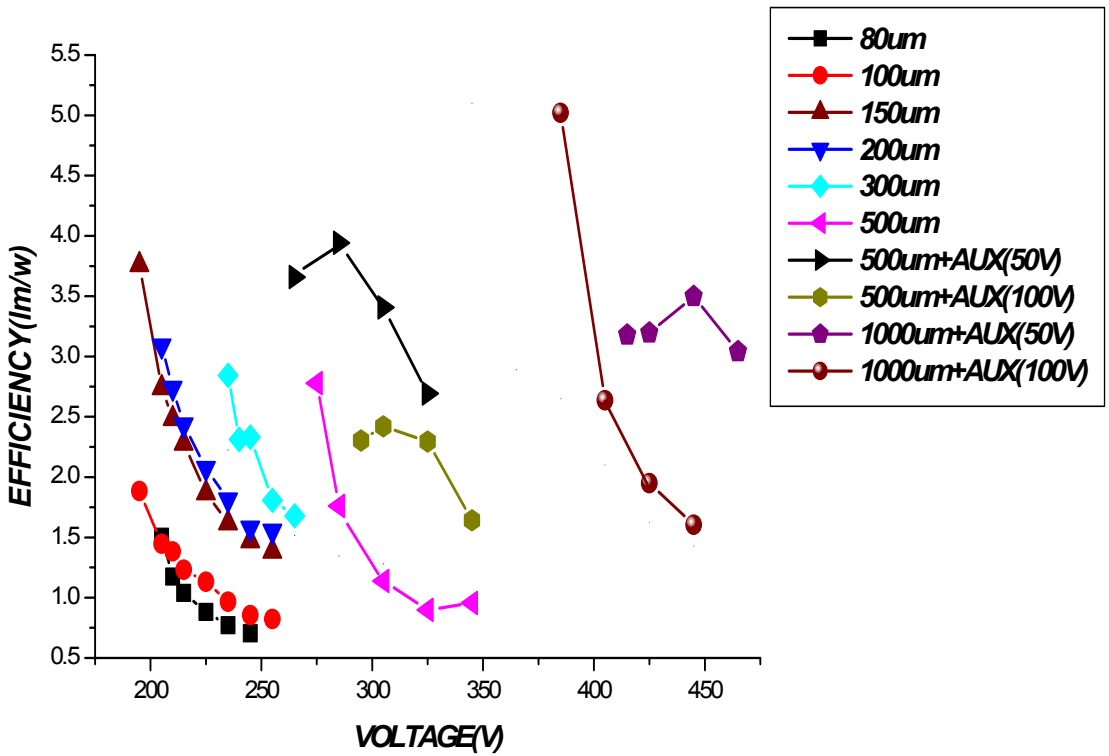
3. Hot issues on Plasma Display

- Long gap discharges



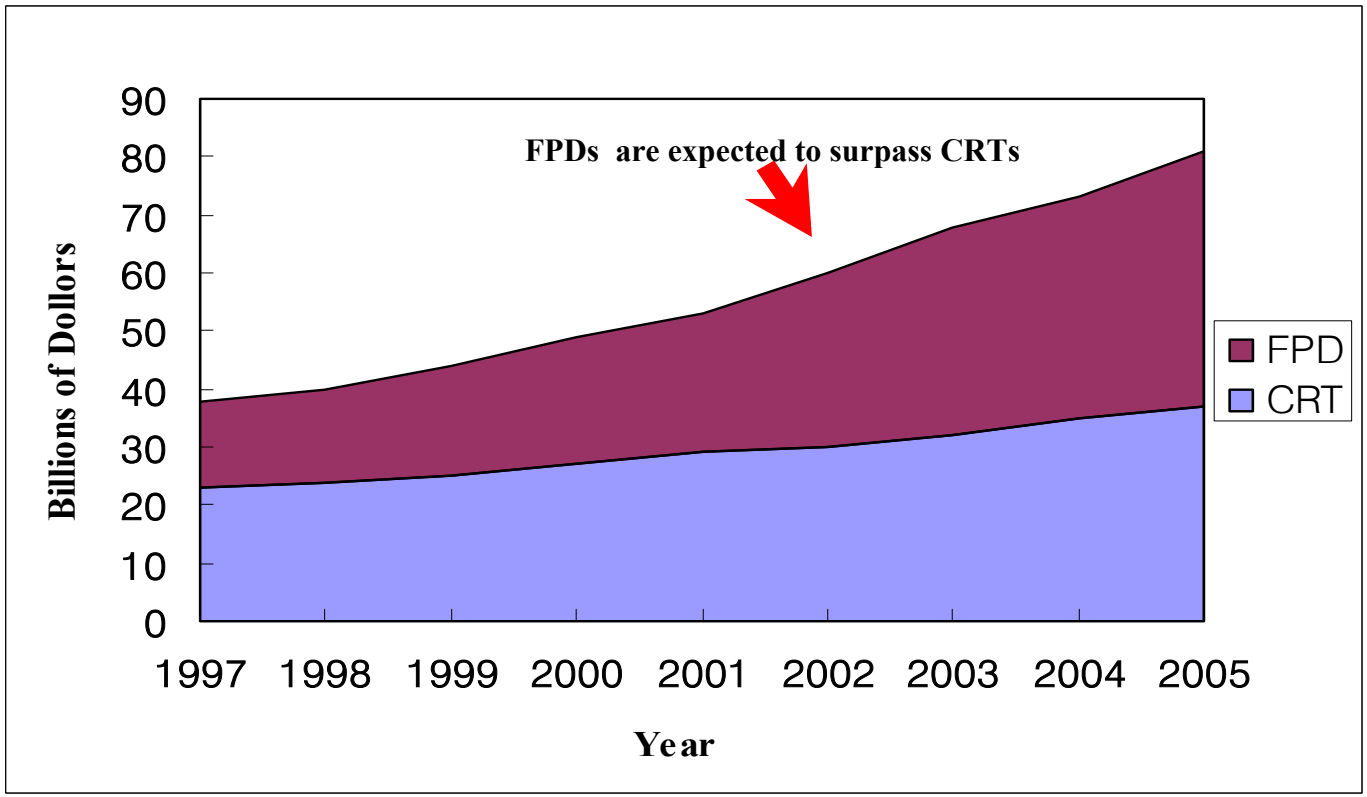
3. Hot issues on Plasma Display

- Long gap discharges



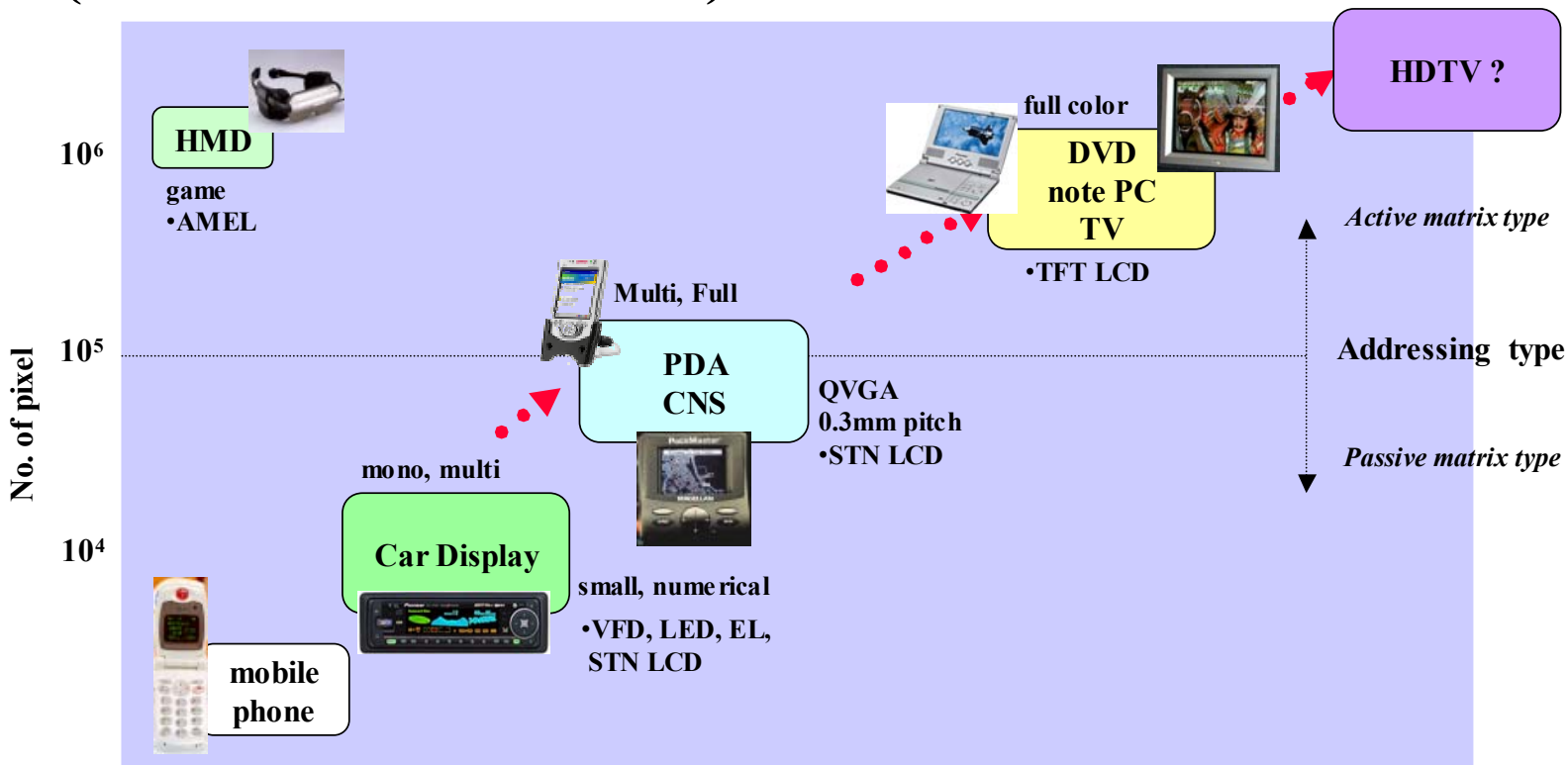
4. Summary

- Worldwide Display Module Market (Past and Future)



4. Summary

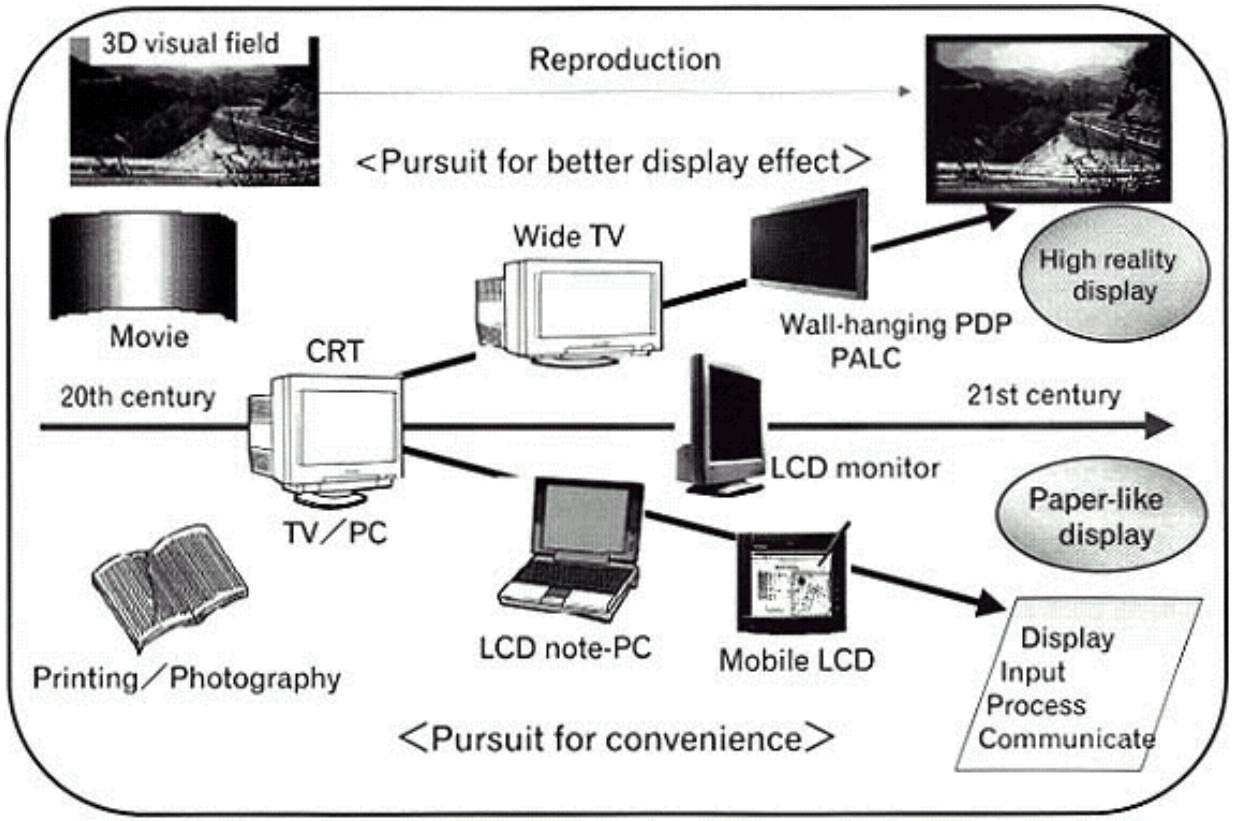
* Technology trends of information display devices (Small and medium size)



HMD : Head Mount Display
PDA : Personal Digital Assistance
VFD : Vacuum Fluorescent Display

4. Summary

* Technology trends of information display devices



4. Summary

* Technology trends of information display devices