

Flexible Display

Korea Electronics Technology Institute
Electronics Devices Research Center

KE TI

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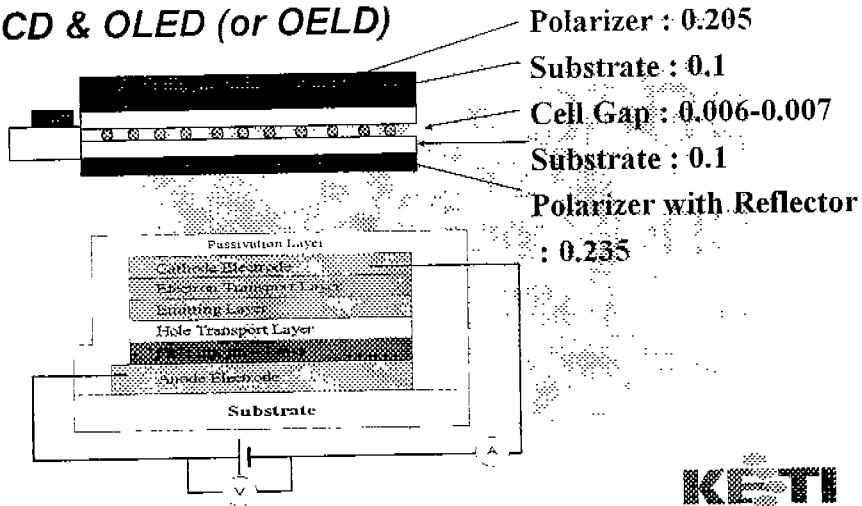
⌘ *Future Works*

⌘ *Conclusion*

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Flexible Display

LCD & OLED (or OELD)



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Comparison of FPD

구분	TFT-LCD	유기ELD	무기ELD	PDP	VFD	FFD
대면적화	▲	○	▲	○	×	○
두께	○	○	○	▲	▲	○
경량화	○	○	○	○	○	○
견고성	○	○	○	○	○	○
사용안도	▲	○	○	○	○	○
응답속도	○	○	○	○	○	○
밝기	○	○	○	○	○	▲
해상도	○	○	○	○	○	○
문트리스노	○	○	○	○	○	○
응용계조	○	○	○	○	▲	○
시야각	▲	○	○	○	○	○
전연색	○	○	▲	○	×	▲
안정성	○	▲	○	○	○	○
구동전압	○	○	○	▲	○	○
소비전력	○	○	▲	▲	○	○
저가적화	○	○	▲	▲	○	○

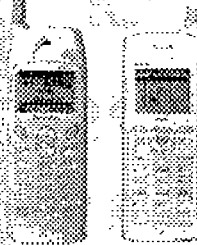
○가장좋음, ○중음, ▲중간, ×나쁨

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Trends of Display

⌘ Portable Characteristics of Mobile Devices

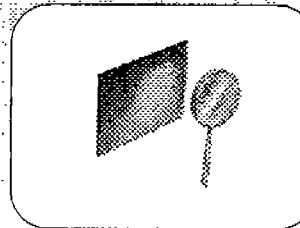
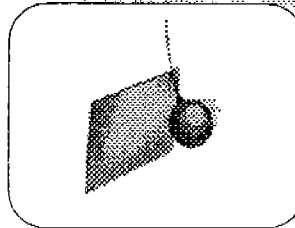
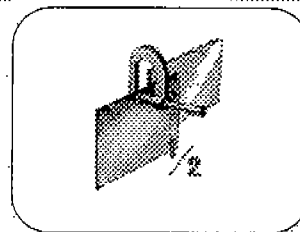
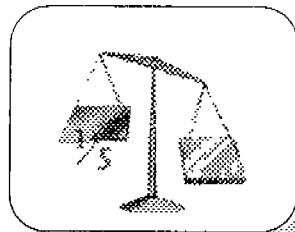
- ☑ High Quality Image & Low Power Consumption
 - ☑ Full Color, High Resolution, Moving Picture
- ☑ Thinner & Lighter
- ☑ High Impact Resistance
- ☑ Various Shape & Curved Display
- ☑ Large Size
- ☑ Low Cost



Substrate Change (Glass -> Plastic Film)
Flexible Display (LCD, OLED)

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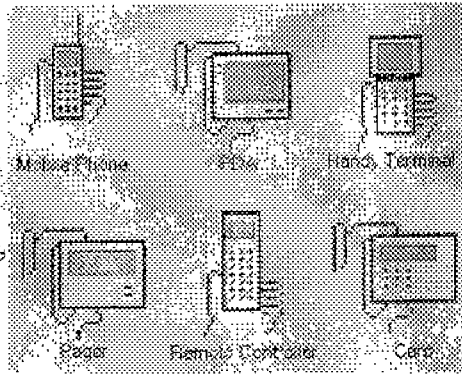
Features of Flexible Display



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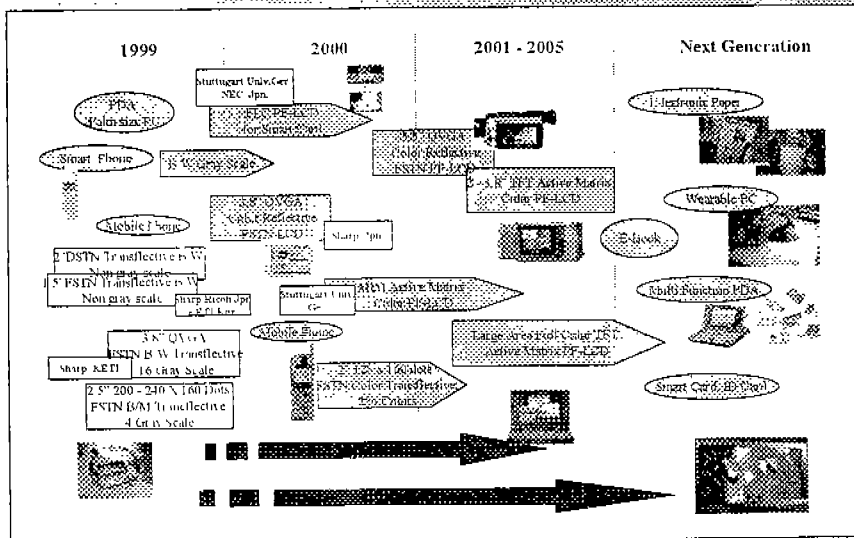
Applications of Flexible Display

☞ *Mobile Devices* such as Mobile Phone (*IMT-2000*, Cellular Phone, CDMA, GSM, PCS, etc), *PDA*, *CNS*, Pager, Remote Controller, *Smart Card*, Handy Terminal, *HMD*, *HPC*, *DSC*, *Note book PC* and so on



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Technology Trend



Effect of Substrate Change

**Low Temp. Process (110 C)
Local Micro Groove
Electrostatics**

New Low Temp. Fabrication Process

New Materials & Machine for Low Temp. Process

New Design & Module Fabrication

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Plastic Substrate

⌘ **Material : Polyolefin**

⌘ **A (Polycarbonate)**

☒ Thickness : 100 μ m, 45 ohms/square

☒ Maximum Temp. : 120 C

☒ Low Thermal Resistance

⌘ **B (Polyethersulfone)**

☒ Thickness : 180 μ m, 45 ohms/square

☒ Maximum Temp. : 190 C

☒ Chemically Unstable

⌘ **C (PET)**

☒ Thickness : 200 μ m, 60 ohms/square

☒ Maximum Temp. : 150 C

☒ High Birefringence : Not Applicable to STN LCD

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Plastic Substrate

⌘ Local Micro Groove

- ☒ Non-uniform Coating & Exposure
 - ☒ Cell gap, Rubbing, LC Filling, Deposition, etc
- ☒ Vacuum Chuck with High Density of Micro Holes
- ☒ Parallel Fixing Plate

⌘ Flexibility & Shrinkage

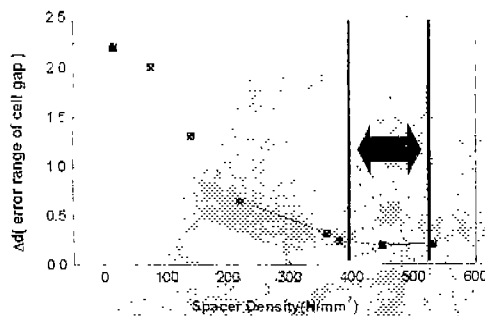
- ☒ Non-uniform Cell Gap, Stress on ITO Electrodes
- ☒ Low Temperature Process with or w/o Pressure
- ☒ New Materials for Low Temp. Process

⌘ Thermal Instability

- ☒ Thermal Instability of Substrate Itself during Process
- ☒ Low Temperature Process with or w/o Pressure
- ☒ New Materials for Low Temp. Process

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Spacer Spray



⌘ Non-rigidness

- ☒ Difficult to Maintain Uniform Cell Gap

⌘ Increasing Spacer Density

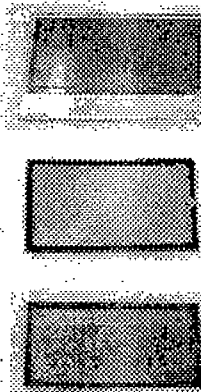
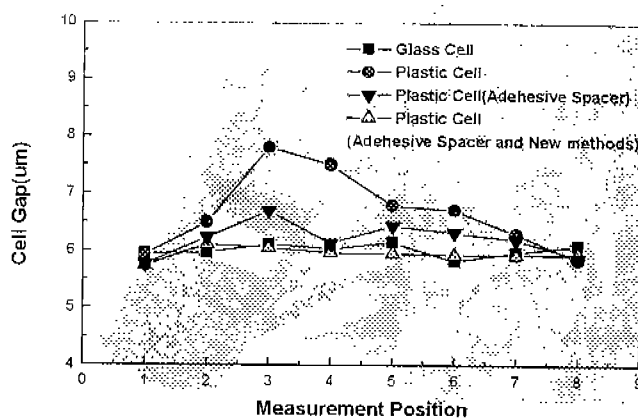
Glass : 200-250n/mm²
 Plastic : 400-450n/mm²



Uniform Cell Gap

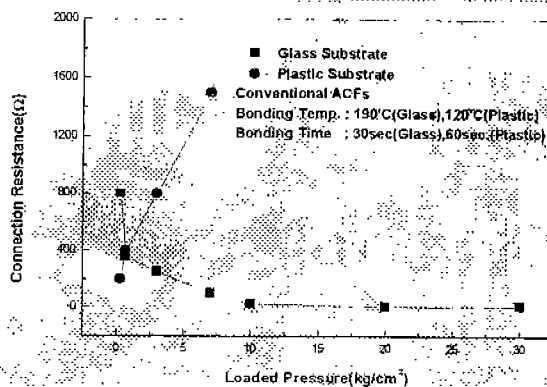
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Cell Gap



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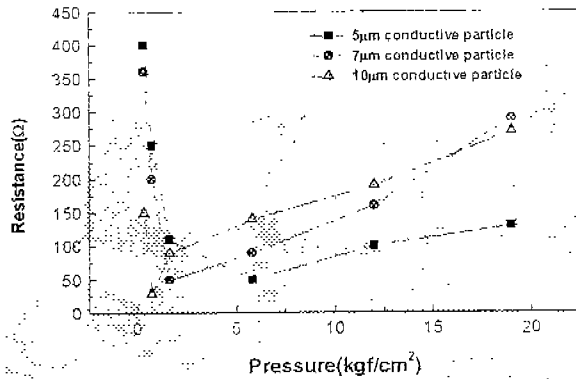
Conventional Proc. & Mater.



⌘ Conventional Process (Rigid Conductive Particles & Rapid Heating & Process)

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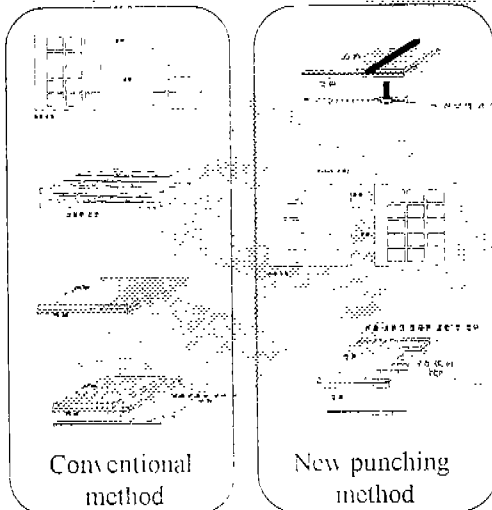
New Process & Material



⌘ New Material & Process - More Elastic Conductive Particles & Slow Heating & Process (2°C/s, 0.3kg/s)

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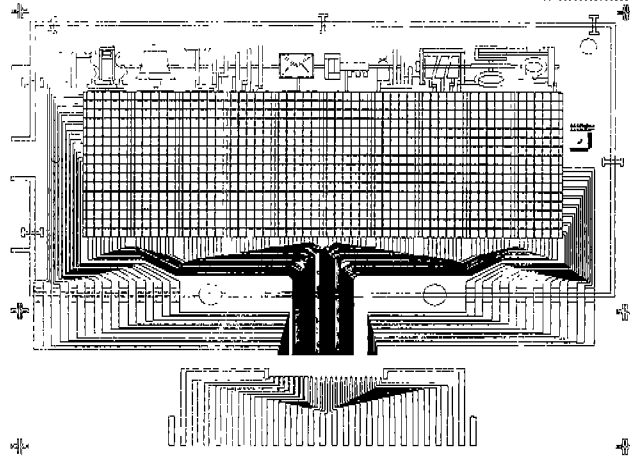
Scribing



- ⌘ Conventional Methods
 - ☒ After Assembly, Scribing Upper Plate with Diamond Cutter
 - ☒ RF-LCD-Defects on the Lower Electrodes - Thin Thickness of Substrates
- ⌘ New Punching Methods
 - ☒ Before Assembly, Punching Upper Plate
 - ☒ Not Defects on the Electrode, Improvement of Yields

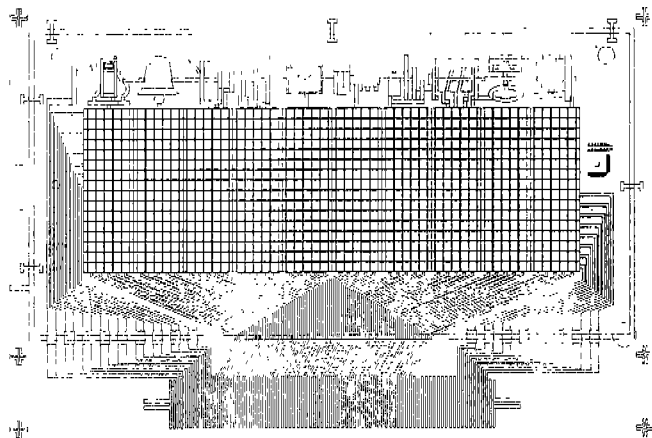
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Design (Character, COG)



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Design (Character, TAB)

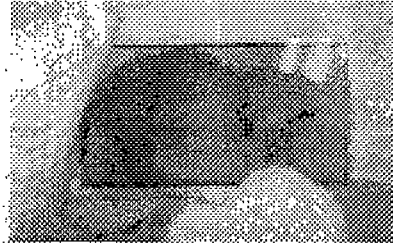


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PFLCD Sample



■ COP & TAB Type



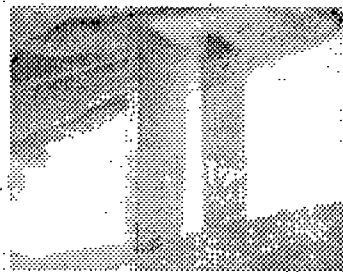
■ Transmissive Type

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PFLCD Sample



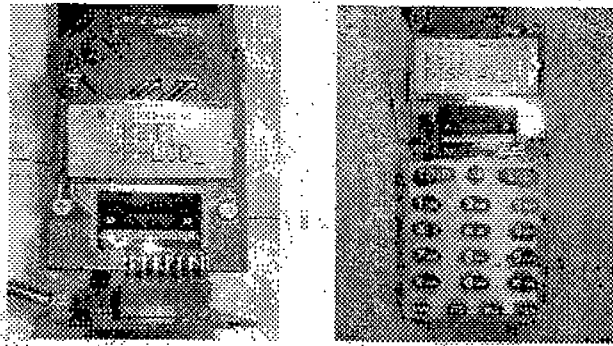
■ Flexible



■ Thin Thickness

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PFLCD Sample



■ Transflective Type

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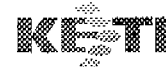
Specification of PFLCD

Item	Feature	Item	Feature
Size	39 x 23.8mm	Viewing Area	35 x 17.1mm
Duty Ratio	1/18 Duty 1/5 Bias	Dot Size	0.53 x 0.64mm
Active Area	T.B.D	Maximum Process Temp	110
Dot Pitch	0.53 X 0.64 mm	Operation Voltage	2.4 ~ 3.6V
Thickness	0.6 mm	Type	Transflective
Weight	0.6g	Contrast Ratio	> 8:1
Mode	NW	Response Time	< 200ms

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PFLCD Comparison

Item	Specification (Reflective Mode)		
	Glass LCD (Typical)	Sharp	KETI
Substrate Thickness	0.7, 0.5mm	0.4, 0.2mm	0.27, 0.1mm
Weight	10, 6g	1.8, 1.3g	1.0, 0.7g
Contrast Ratio	5:1	8:1	8:1
Response Time	250-280ms	250ms	200ms
V _{on}	5-7V	5-6V	5-6V
Power Consumption	1<W		1<W



Future Works

⌘ Portable Devices such as IMT-2000, PDA, etc

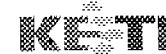
- ⌘ Small and Medium Display
- ⌘ High Quality Image
- ⌘ A Lot of Image Data
- ⌘ Moving Picture

⌘ Active Matrix Driving Devices

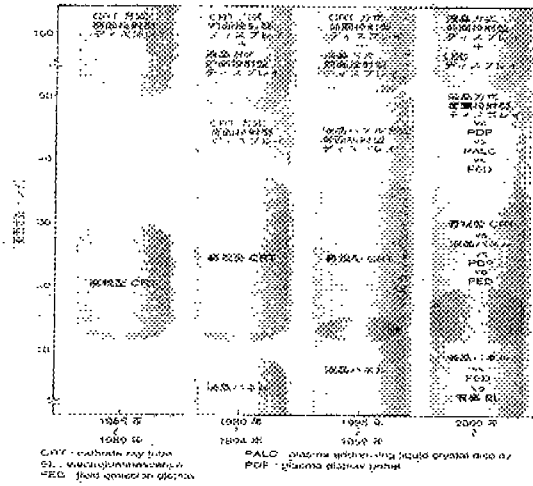
- ☐ AM LCD & AM PFLCD with TFT, MIM, TFD devices
- ☐ AM OLED with TFT, MIM, TFD, Ring Diode devices

⌘ Ultra Thin & Foldable Devices

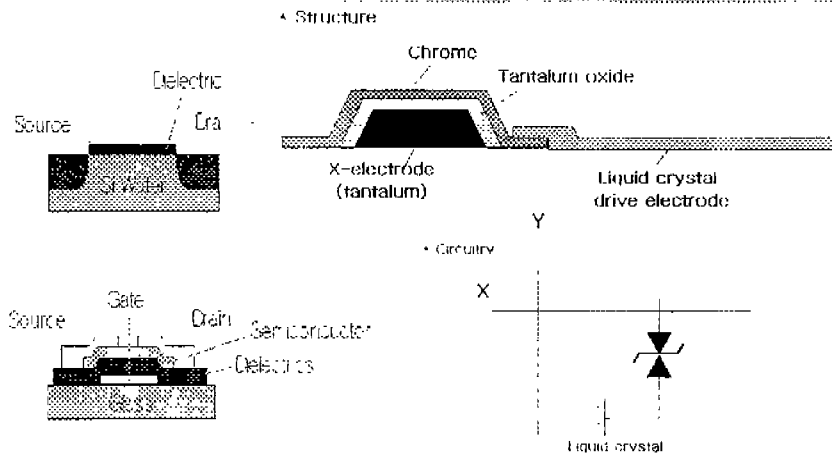
- ☐ Foldable Display, Rollable Display, Wearable PC, E-book, Electronic Newspaper



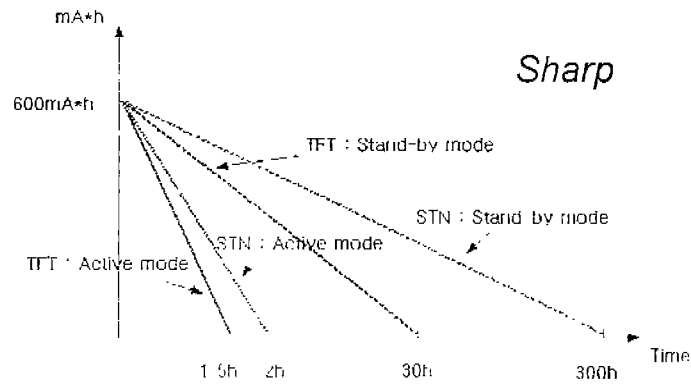
Market Trends of FPD



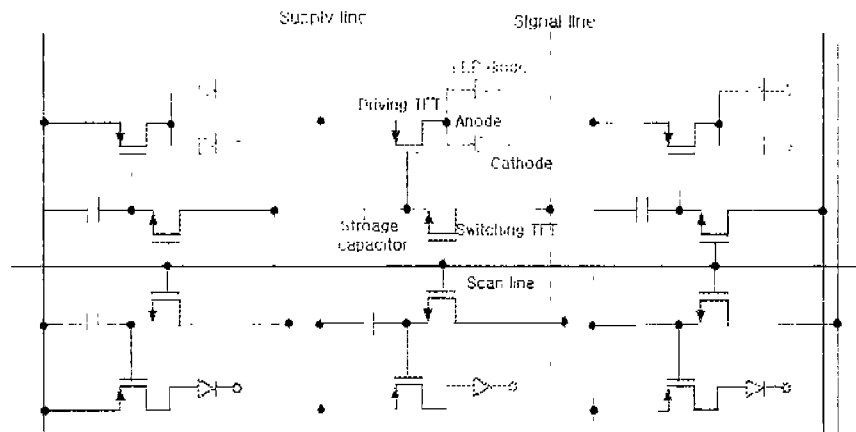
MIM Structure & Eq. Circuit



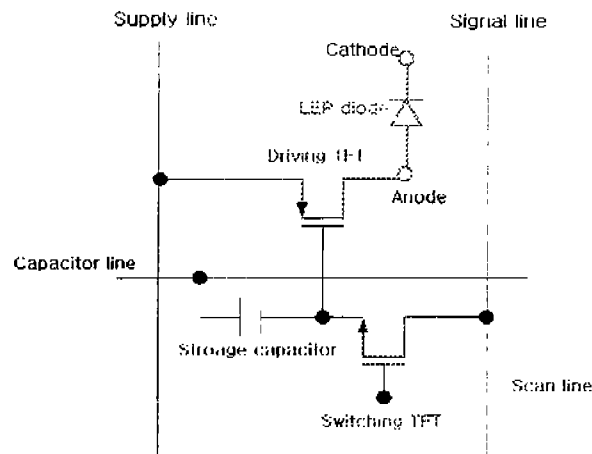
STN & TFT for Cellular Phone



Digital Driving Circuit (ARG)



Analog Driving Circuit (CCG)



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Conclusions

⌘ Flexible Display (LCD, OLED)

Excellent Portable Characteristics

- High Quality Image
- Low Power Consumption
- Thinner & Lighter, Large Size, Low Cost
- High Impact Resistance
- Various Shape & Curved Display

⌘ Active Matrix Driving Devices

- High Quality Image
 - Full Color, High Resolution, Moving Picture, etc
- Switching Device such as TFT, MIM, TFD, Diode

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