



Displays

DARPA Tech 99

DARPA/MTO

Bruce Gnade



The letters "MTO" in a bold, blue, sans-serif font, set against a white starburst graphic with multiple points radiating outwards. The logo is located in the top right corner of the slide.

High Definition Systems

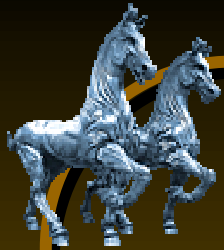
Objective: Develop leading-edge display technology to meet diverse, but specific, DoD needs. The goals include increased power efficiency, reduced weight and improved ruggedness, while pushing the state-of-the-art in display performance. Demonstrate DARPA-funded technology in military applications.



High Definition Systems

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- Current emphasis for HDS program
 - Accelerate the development of flexible, rugged displays (organic EL, zero-power reflective, self-assembled materials)
 - Push maturing technologies to demonstration phase (FED, Color EL)
 - Increase the demonstration of HDS supported technology (DMID, TFEL, plasma)



CLADS

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PROBLEM: CRT display systems used in AWACS, JSTARS and ABCCC are becoming unsupportable:

- **Logistics Support:** \$208K/CRT, MTBF ~ 500 hours

SOLUTION : Technology independent system TI-DMD, dpiX- AMLCD, Photonics - Plasma, etc.

Impact of FPD Technology:



- -1064 lb..
- -1750 watts
- MTBF > 3300 hours
- +70% viewing area





Small Image Sources

MTO



**1280 x 1024
AMLCD for Comanche**

**640x480 AMEL
for Land Warrior**



**DARPA, SSCOM, CECOM-NVESD, ARL, USARARL, Armstrong
Labs, NAWC**

Kopin Corp, Planar Inc., Sarnoff Corp., Allied Signal, Thesys, UMC, MIT-LL, U of FL,
GTRI, GIT, Oregon Graduate Institute, Honeywell, Hughes, Kaiser



High Brightness Image Sources **MTO** Rotocraft Avionics Systems

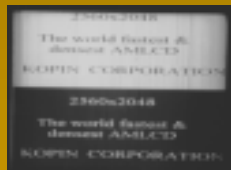
Performance goals

- 1280x1024
- 1650 ft-L
- 80:1 contrast ratio
- <1% reflectance
- Viewing angle +/-30°

Joint development program

- * DARPA
- * Comanche
- * Army
- * NVESD

Proposed Technologies



AMLCD - Kopin

AMEL - Planar



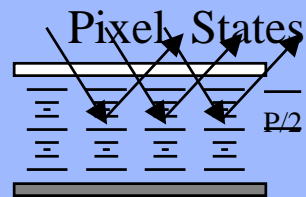
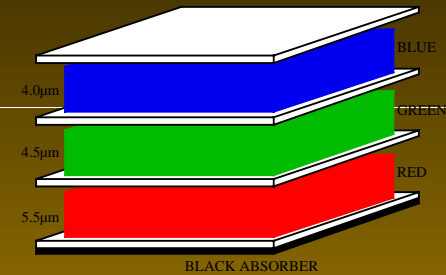


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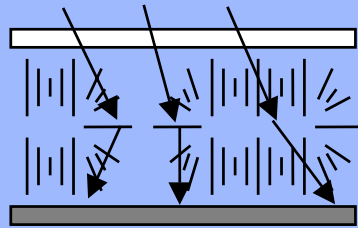
Zero-Power Displays

Advantages of cholesterics

- 1) Reflective in visible and IR
- 2) 2 AA batteries / year
- 3) Rugged plastic displays prevent breakage



Color Reflective Planar State



Black State



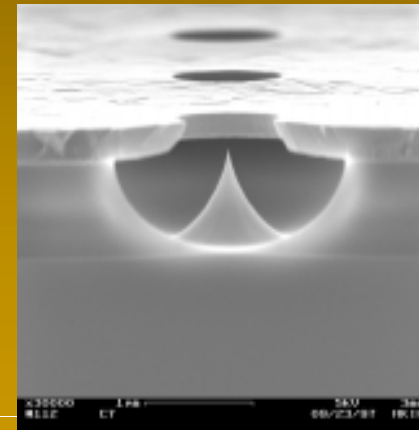
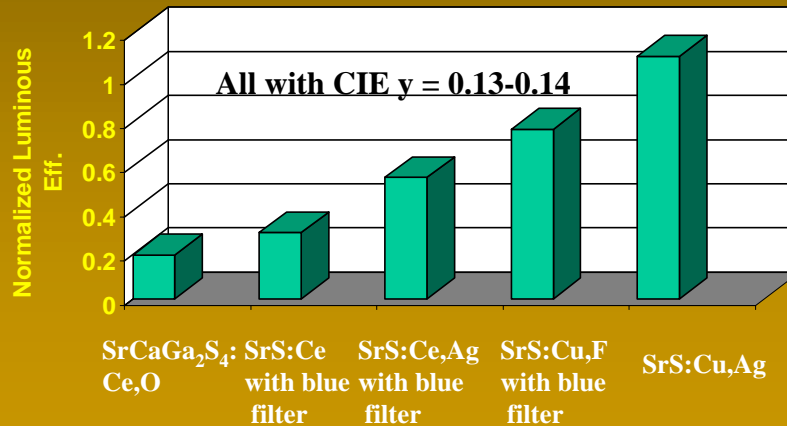
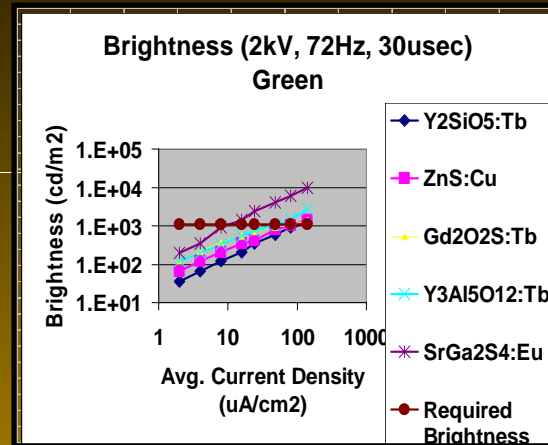


Materials for Emissive Displays

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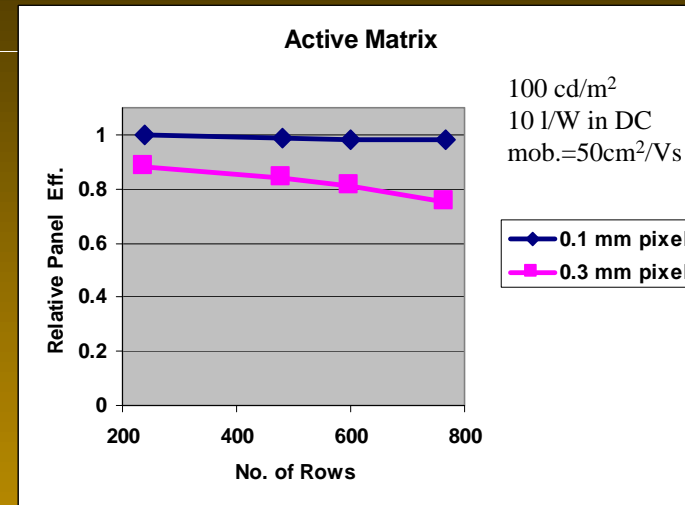
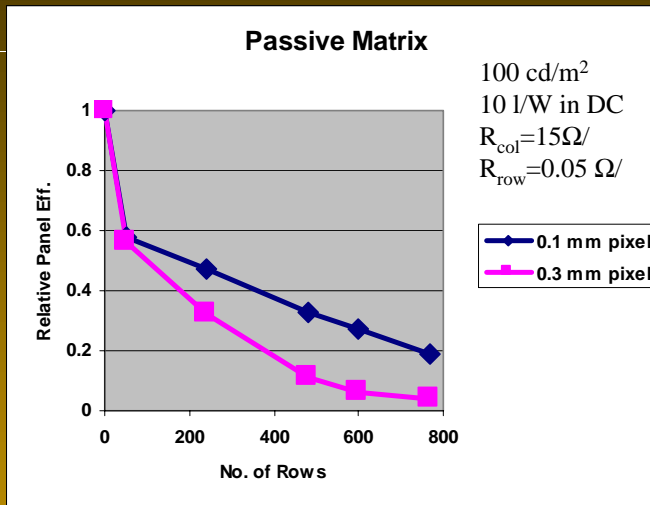
TFEL Phosphor Efficiency





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Active Matrix Backplanes on Flexible Substrates



- * Driving force for active matrix is power efficiency
- * Pulsed operation and low duty cycle in PM require high current
- * I^2R losses can reduce PM power efficiency by 25X

Provided by Jim Sturm - Princeton Univ. POEM



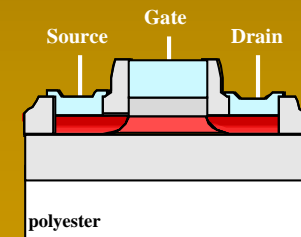
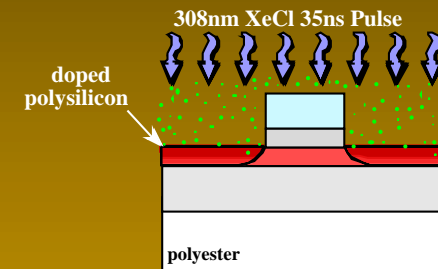
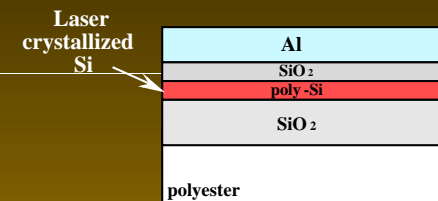
Poly-Si TFTs on Plastic

LLNL

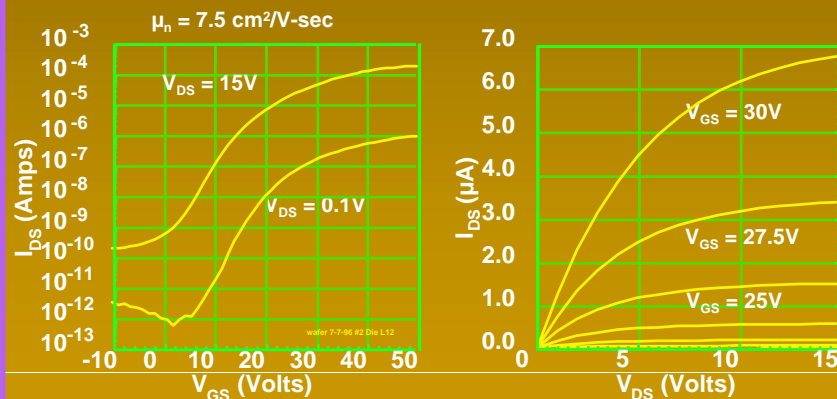
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- * Substrate = Polyester
- * Max. Processing Temp = 100°C
- * Max. Anneal Temp. = 150°C
- * Si Crystallization \Rightarrow 308nm XeCl Excimer Laser

Transistor Process Flow



Transistor I-V Curves

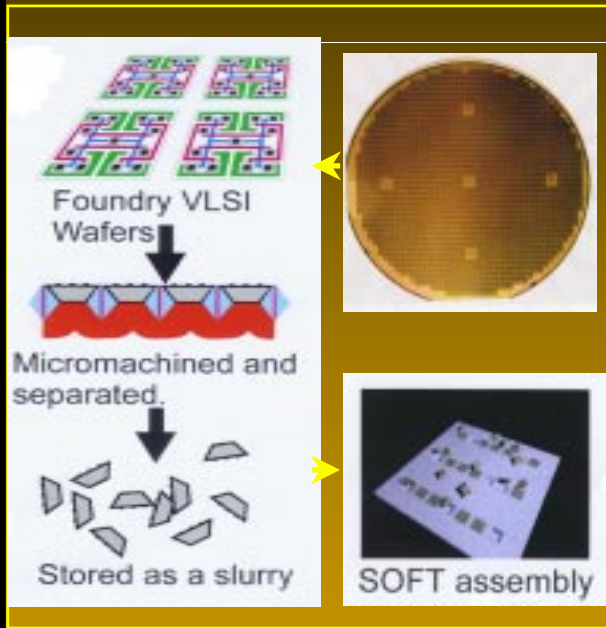




Self Orienting, Fluidic Transport

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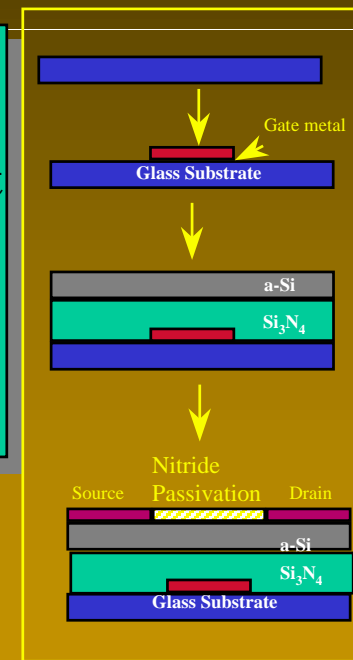
SOFT process Flow



SOFT Advantages

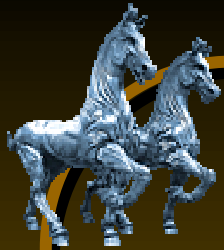
- 1) high performance electronics
- 2) technology independent
- 3) size independent
- 4) low temp. processing
- 5) low capital investment
- 6) 2×10^7 pixels/8" wafer

TFT process Flow



Beckman Display

Display Process

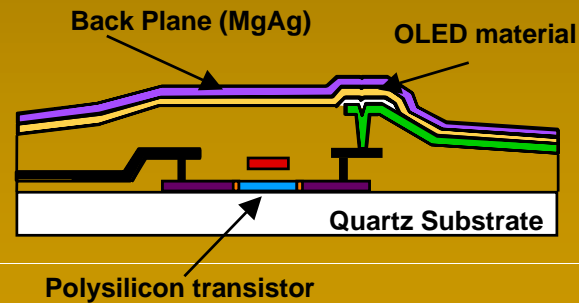


Active Matrix Organic LED

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Green: (Alq₃)
Luminance: 850 nits
Polysilicon

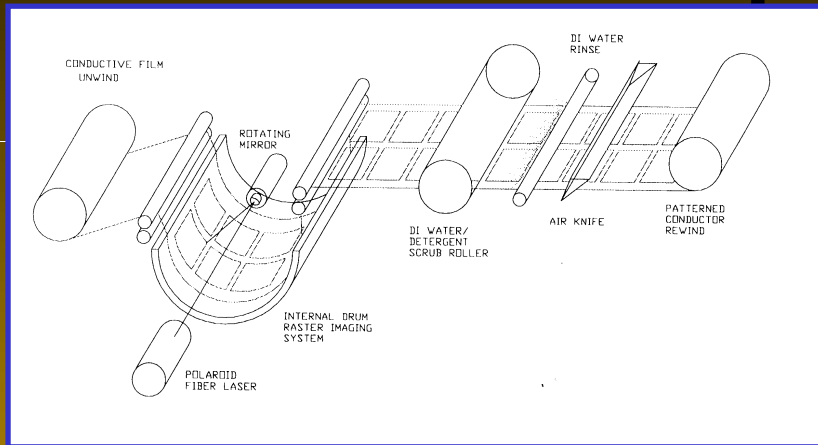
Planar Systems
Eastman Kodak
Sarnoff Corp
Princeton University





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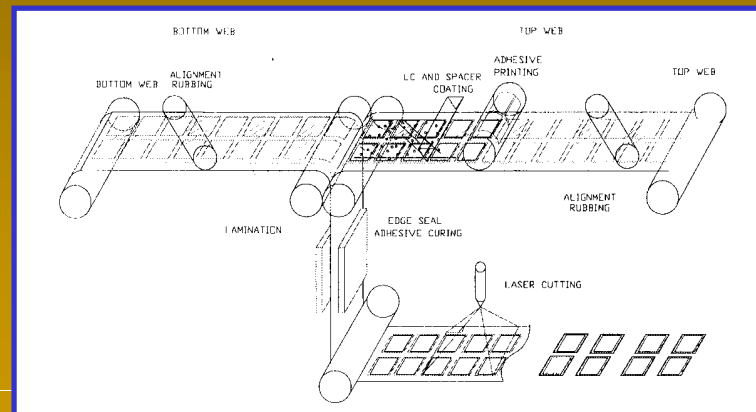
Roll-to-Roll Display Processing



Roll-to-Roll laser etching electrode patterning

Roll-to-Roll display assembly

Polaroid





Summary

What do we want in displays?

- * Low power
- * Rugged
- * Sunlight readable
- * Interactive
- * Inexpensive

