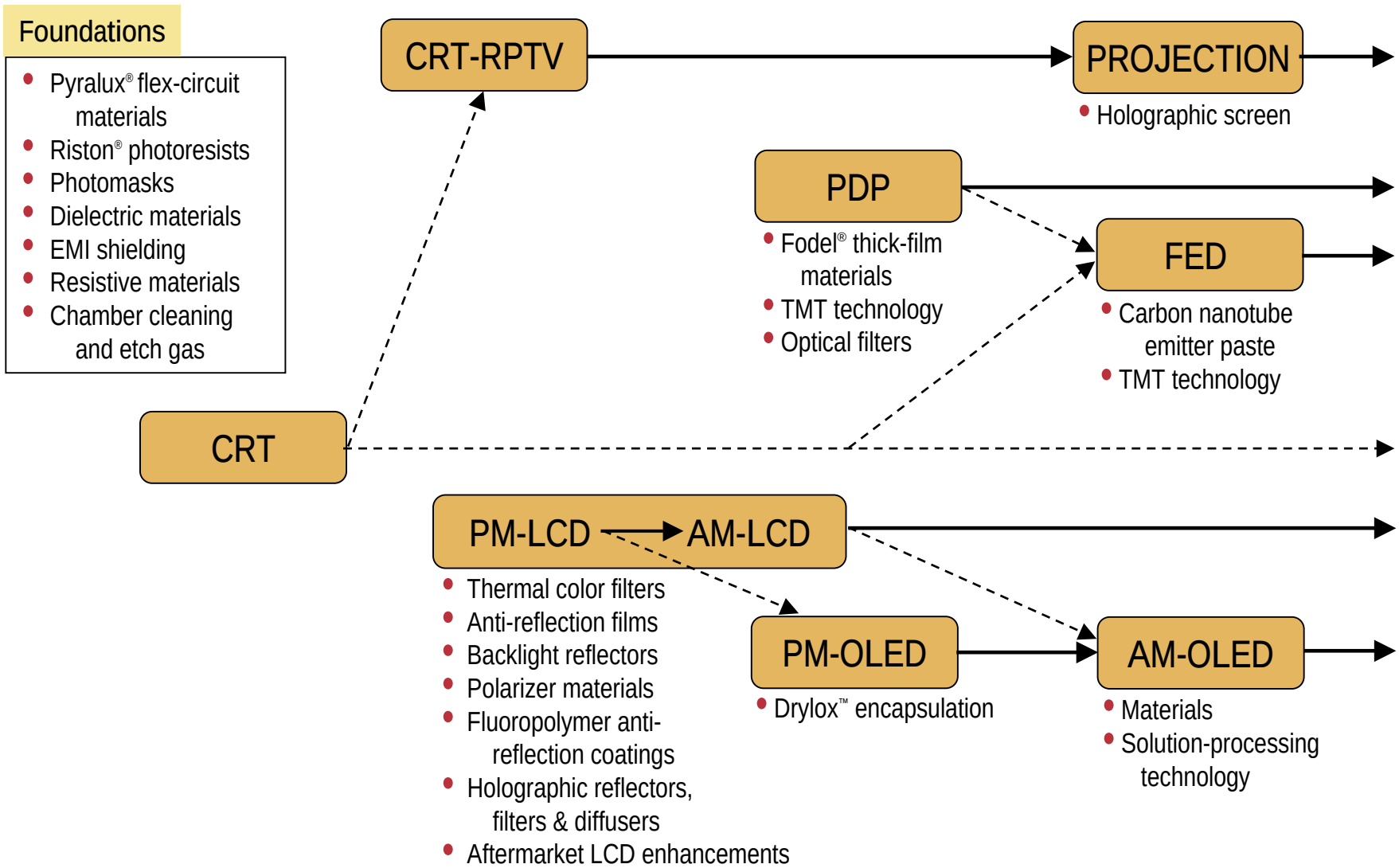
Display Technology At DuPont

Peter Compo
Managing Director
DuPont Displays

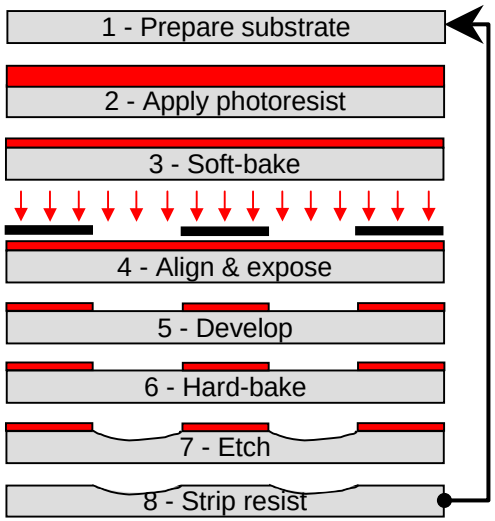
DuPont's Approach to Displays

- Apply interdisciplinary materials science and technology to a broad range of display types
- Take a systems approach to innovation by integrating process technology & equipment with materials as needed
- Focus on "direct precision patterning" (i.e., ***printing*** in its various forms) as a key direction for industry cost reduction

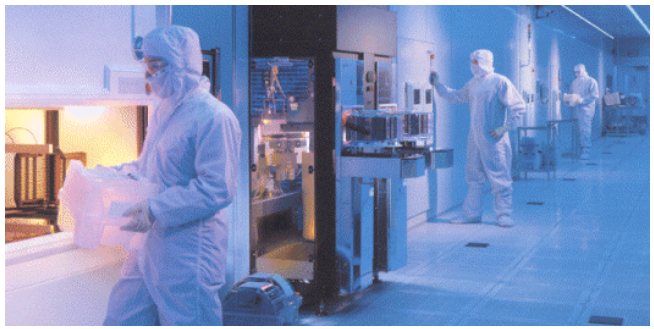
DuPont Displays' Scope



The Difficulty of Photolithography

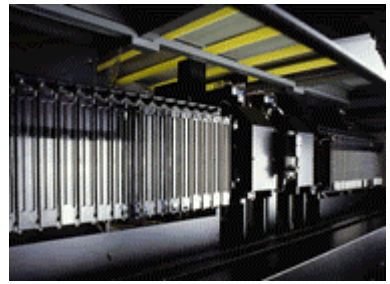


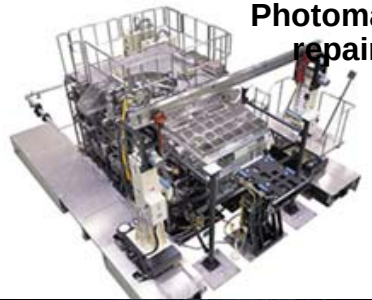
Many steps, many cycles



Requires clean room

Photomask storage





Photomask repair

Wet chemical process

Plasma etch/ash

Expensive, complex equipment

Coater-developer

Wet processor

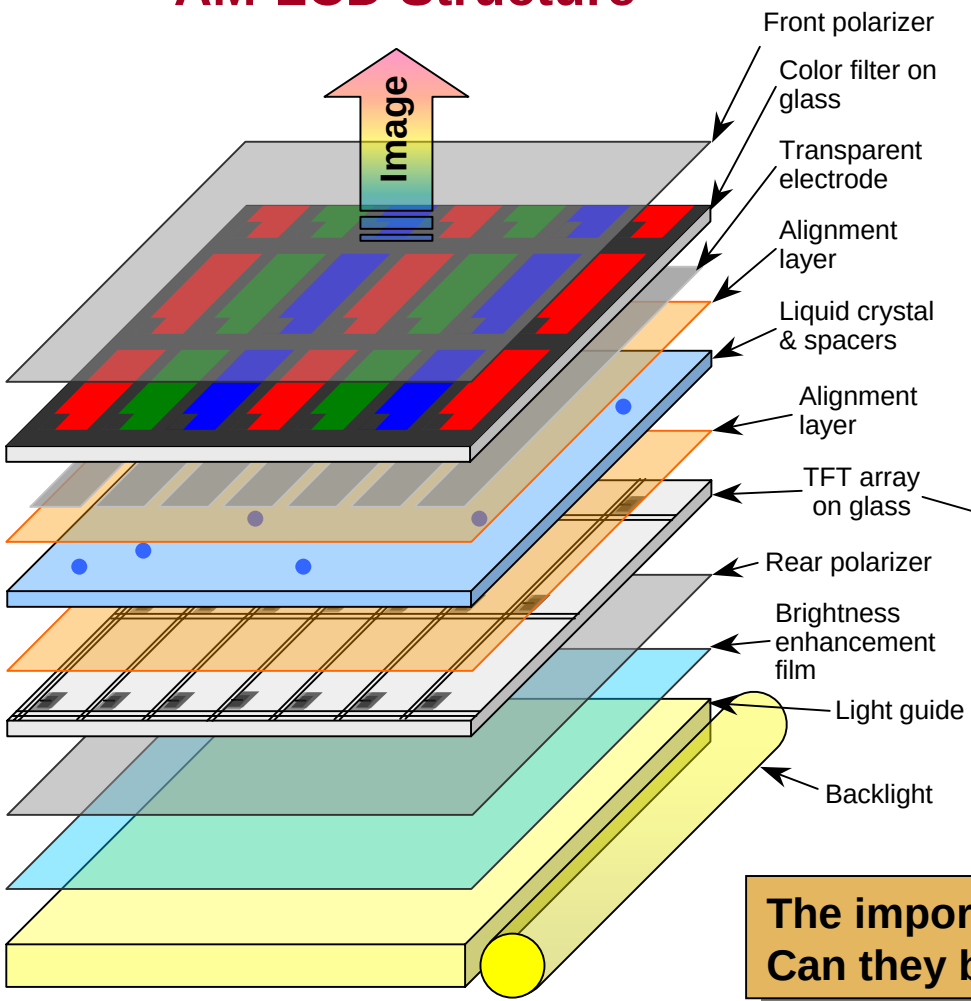
Very expensive masks

Organic Light-Emitting Diode Displays

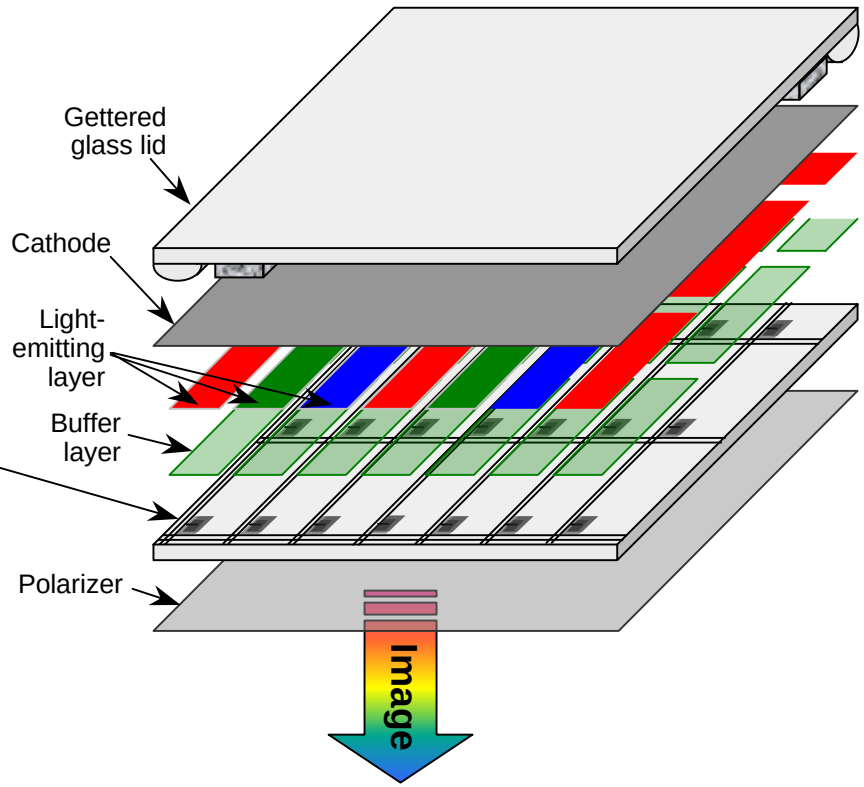
Enabling Technology for Solution-Processed OLEDs

The main advantage of OLEDs is a simpler structure

AM-LCD Structure

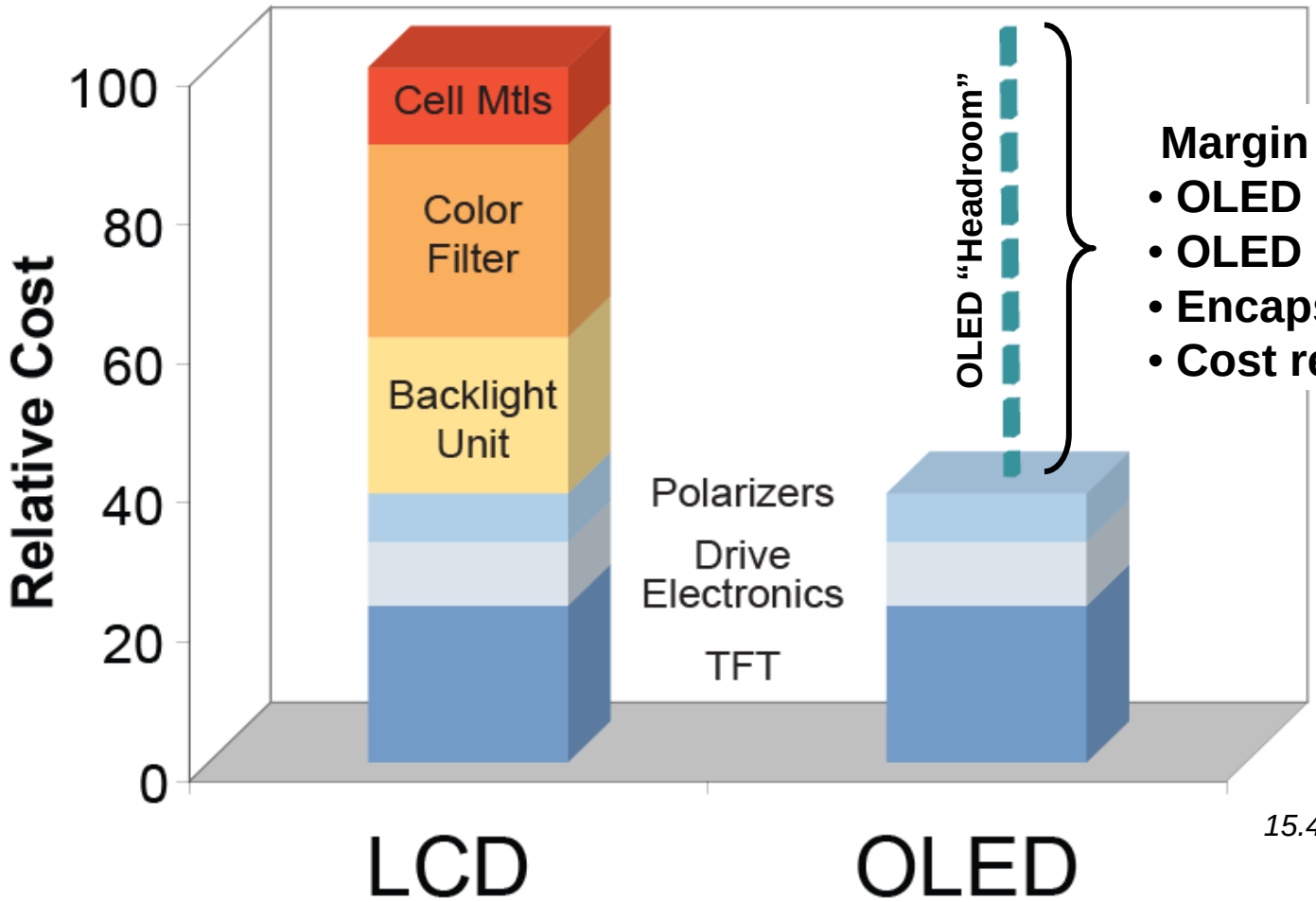


AM-OLED Structure



The important question is:
Can they be manufactured at lower cost?

OLEDs may have a significant margin to compete with LCDs on cost

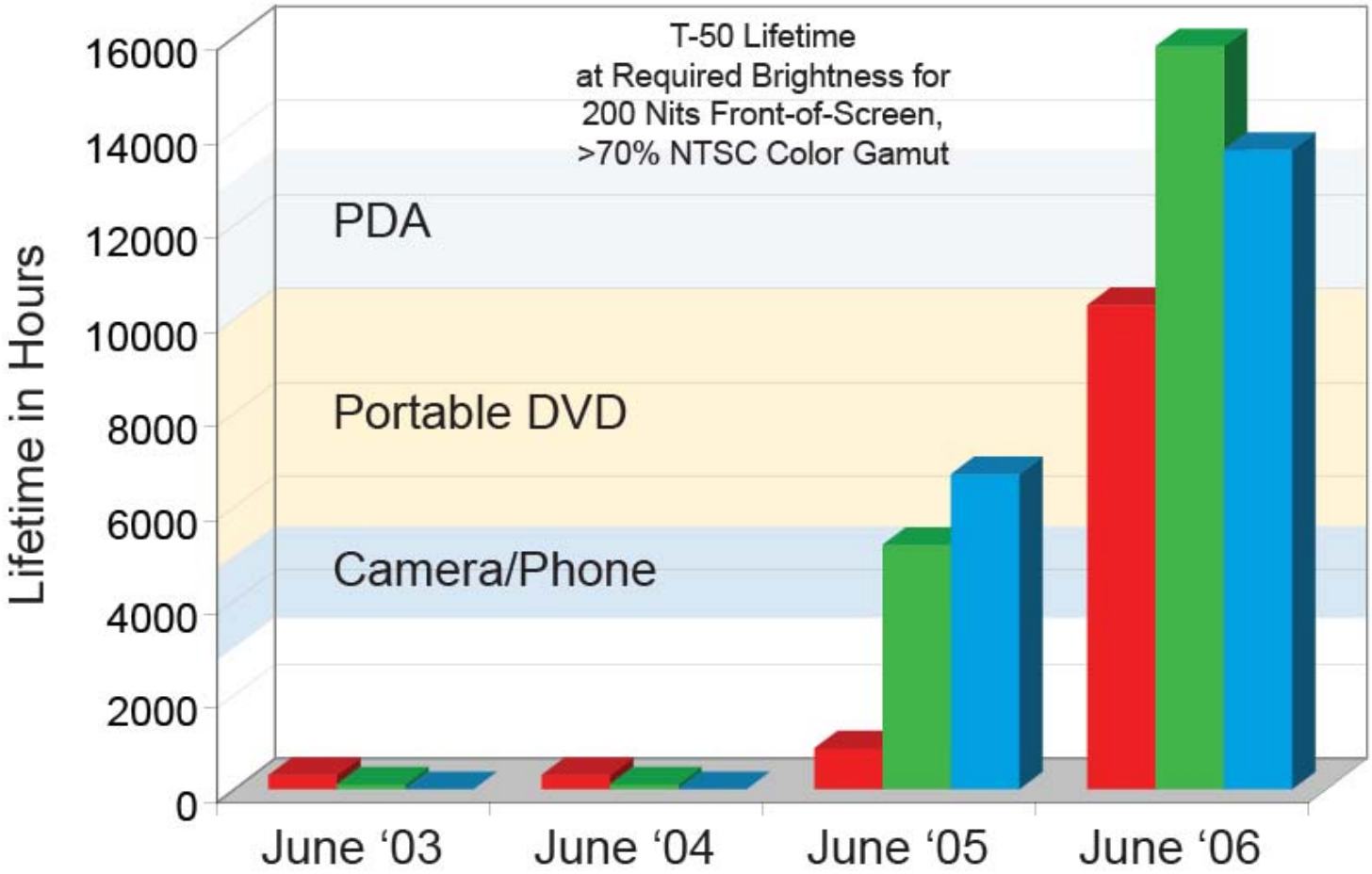


Margin available to cover

- **OLED material**
- **OLED patterning**
- **Encapsulation**
- **Cost reduction**

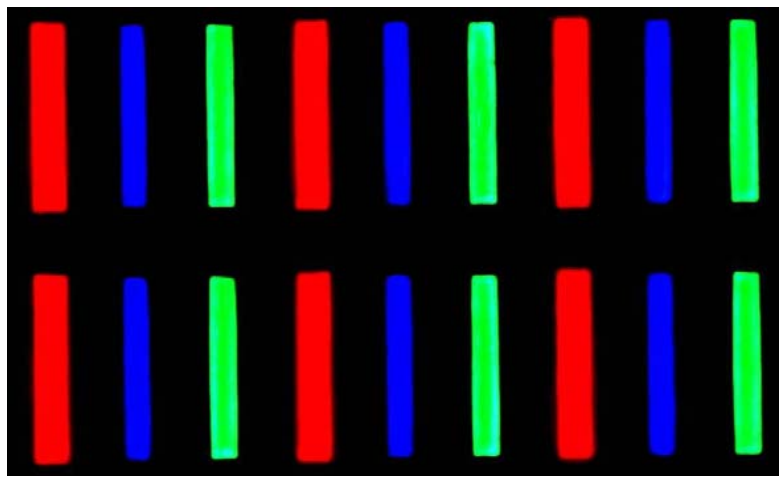
15.4" WXGA notebook display

DuPont solution materials lifetime progress

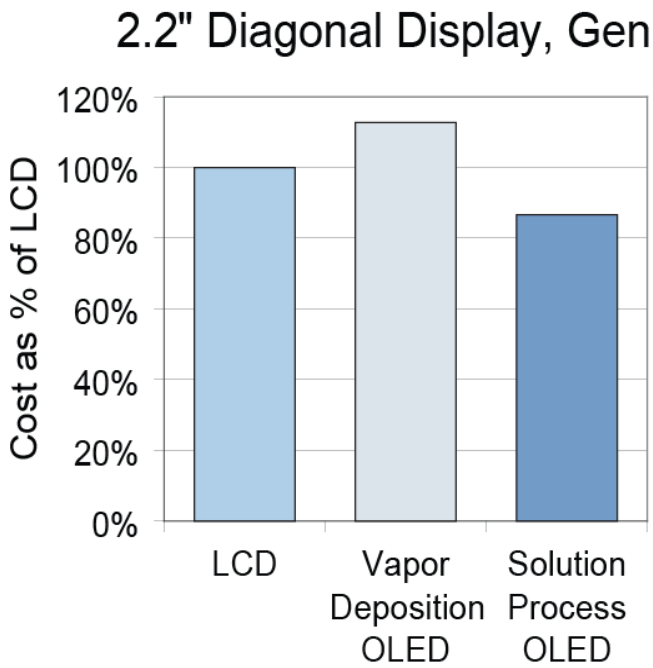


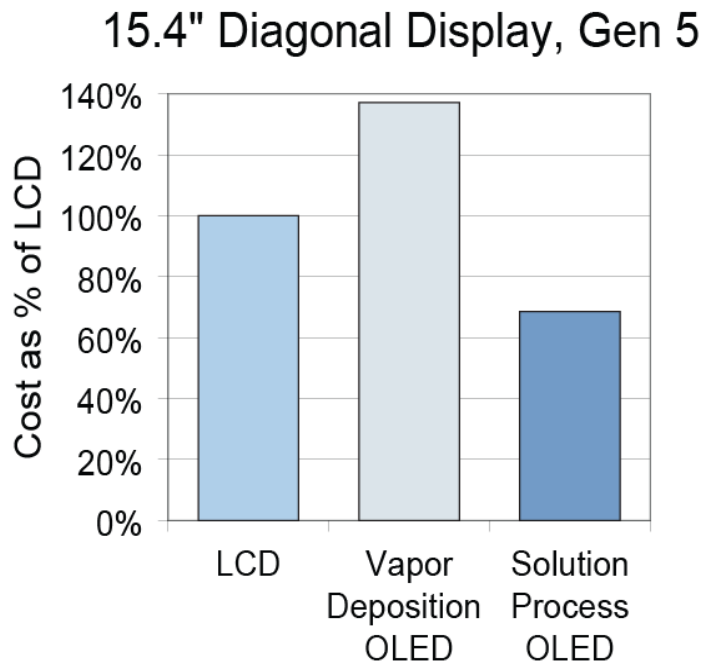
Based on test coupon data, assumes 40% aperture ratio and 55% loss from polarizer

World’s first demonstration of full color AMOLED panel with solution printed small molecule technology



Model shows significant cost advantage for solution processed OLEDs





- Model conservatively assumes higher costs for OLEDs
  - OLED-TFT and drivers significantly higher than LCD
  - 10-20% lower yield than LCD
- More room for OLEDs to compete if these assumptions prove overly conservative

DuPont DB material improves lifetime and efficiency for solution and evaporated OLEDs

Solution Processed Polymer

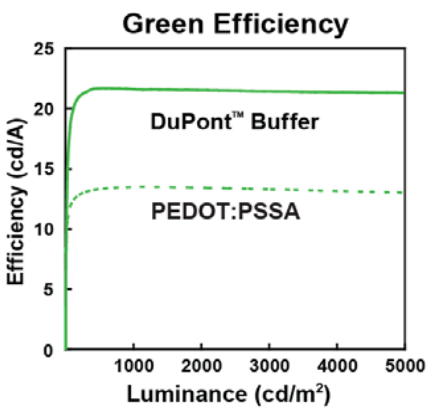
	Lifetime (Hours to T_{50})	
	DuPont™ Buffer	PEDOT:PSSA
Sumation™ 1303 (L_0 = 1,000 cd/m²)	13,000	1,800
Red polymer (L_0 = 450 cd/m²)	25,000	5,000

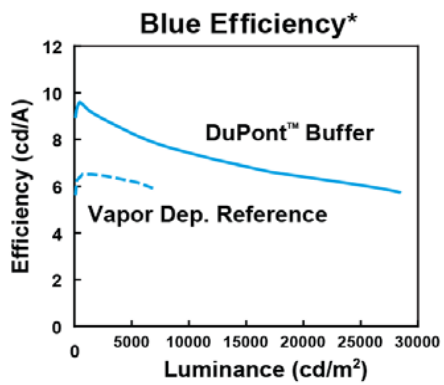
Vapor Deposited Small Molecule Fluorescent

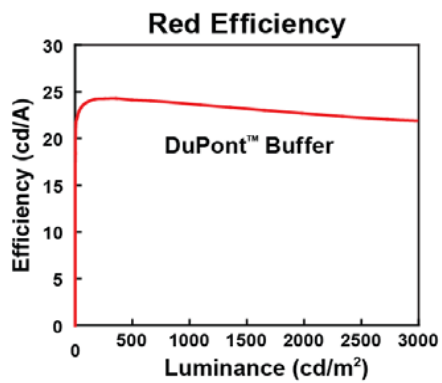
	Lifetime (Hours to T_{50})
Blue*	2 X longer**
Green*	>5,000 @ 5000 nits

Vapor Deposited Small Molecule Phosphorescent

	Lifetime (Hours to T_{50})
Red I	>120,000 @ 500 nits
Red II	>60,000 @ 500 nits
Green*	3-4 X longer**



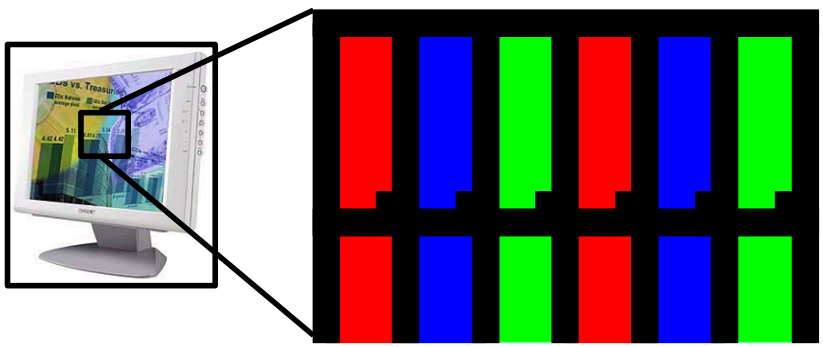




*Data from potential customer **As compared to vapor deposited reference device

Thermally Imaged Color Filter System

Materials, Process Technology and Manufacturing Equipment



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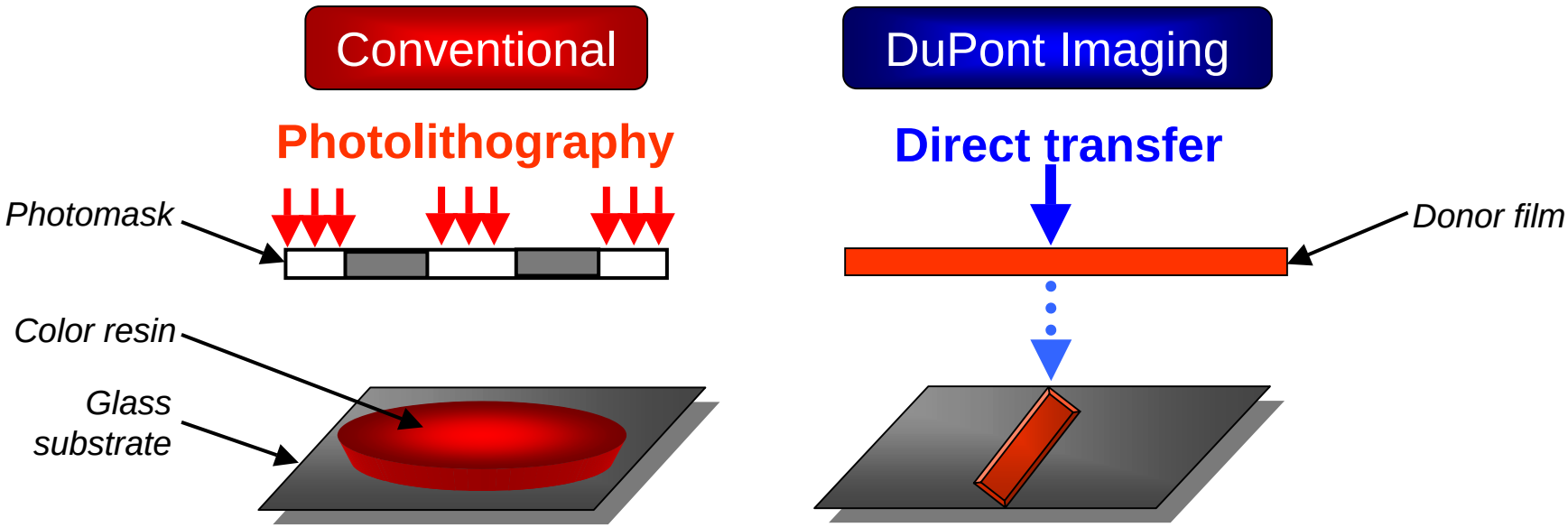
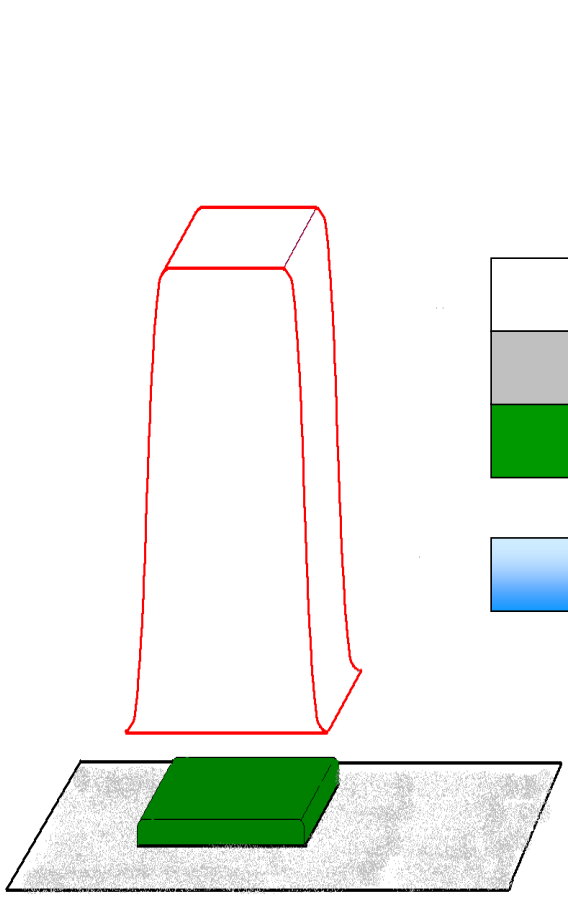
Technology Comparison



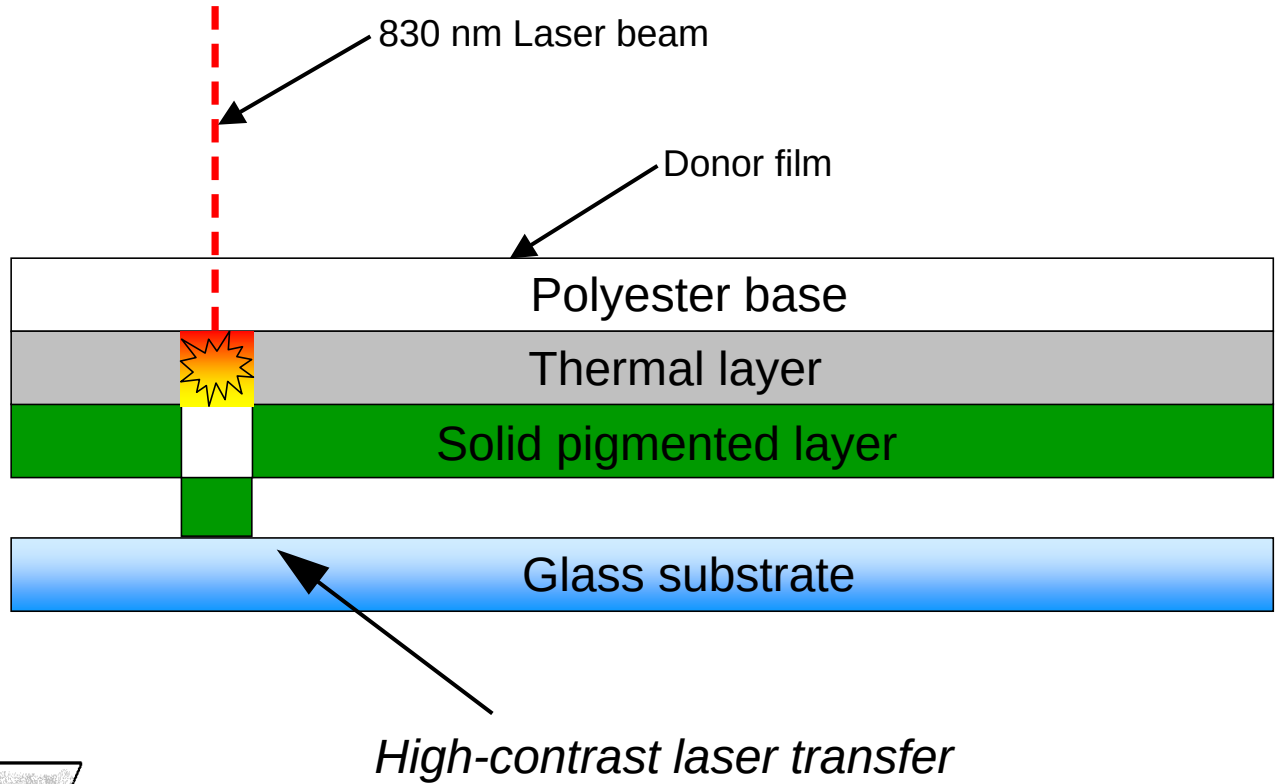
	Conventional	DuPont Imaging
Process	Wet coating => photo	Material transfer by laser
Materials	RGB photosensitive resin	Film
Physical	Wet (chemical)	Dry
Photomasks	Yes	No

Scalability to large sizes & ~30% total cost reduction

DuPont Thermal Multilayer Technology

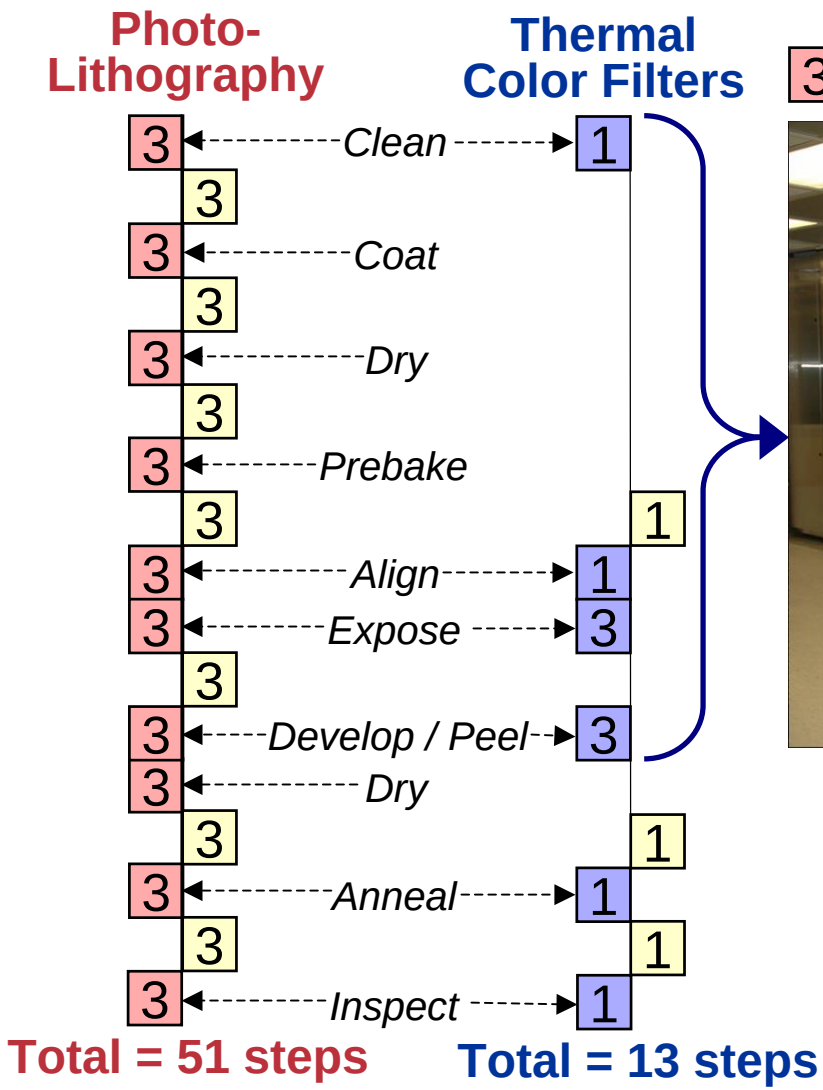


Laser action



High-contrast laser transfer

Process Comparison

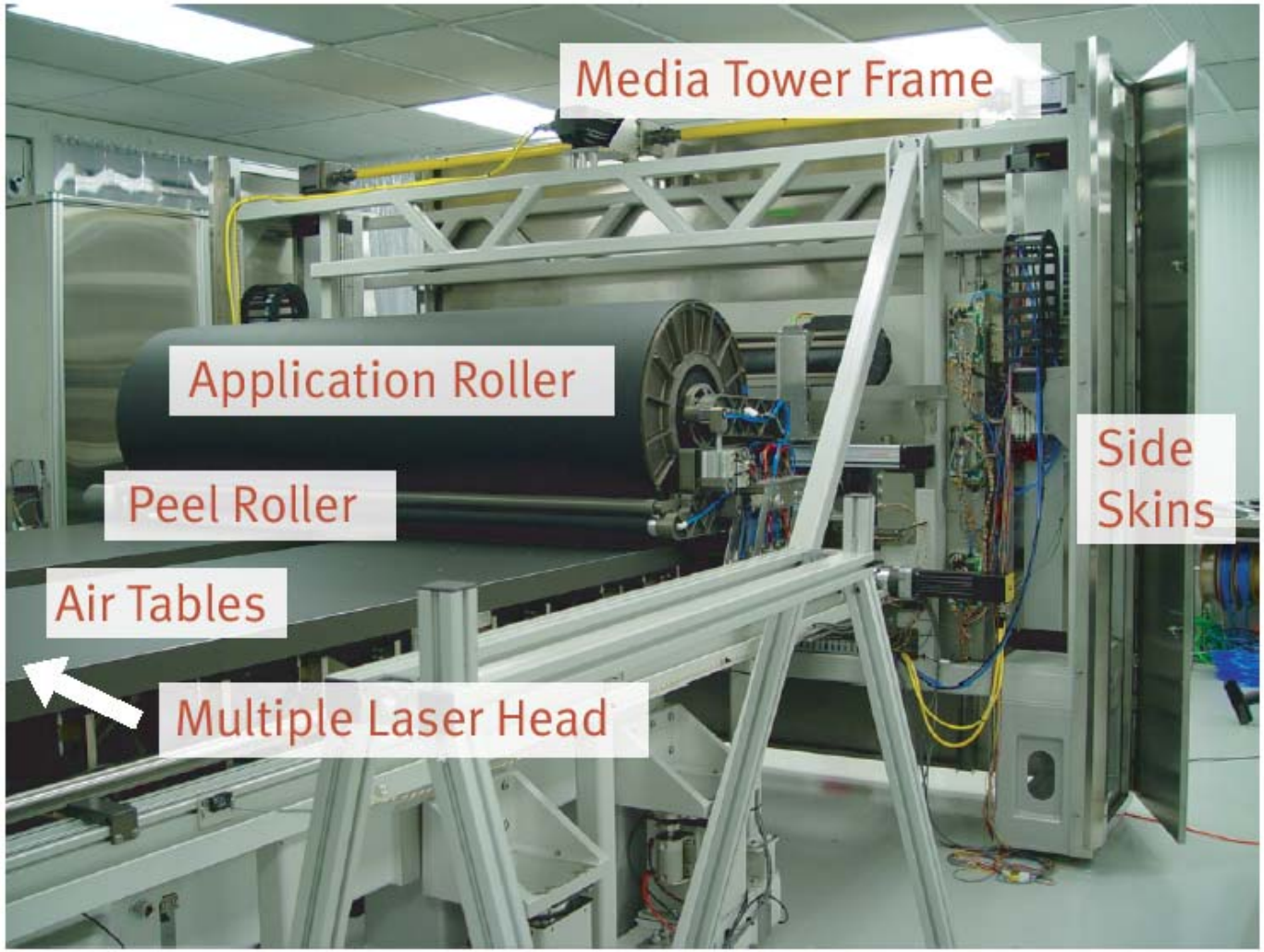


3 1 = Process steps

3 = Glass transportation steps

- No wet coating or processing
- 75% reduction in process steps
- >50% reduction in cleanroom space

DuPont Thermal Color Filter Imager

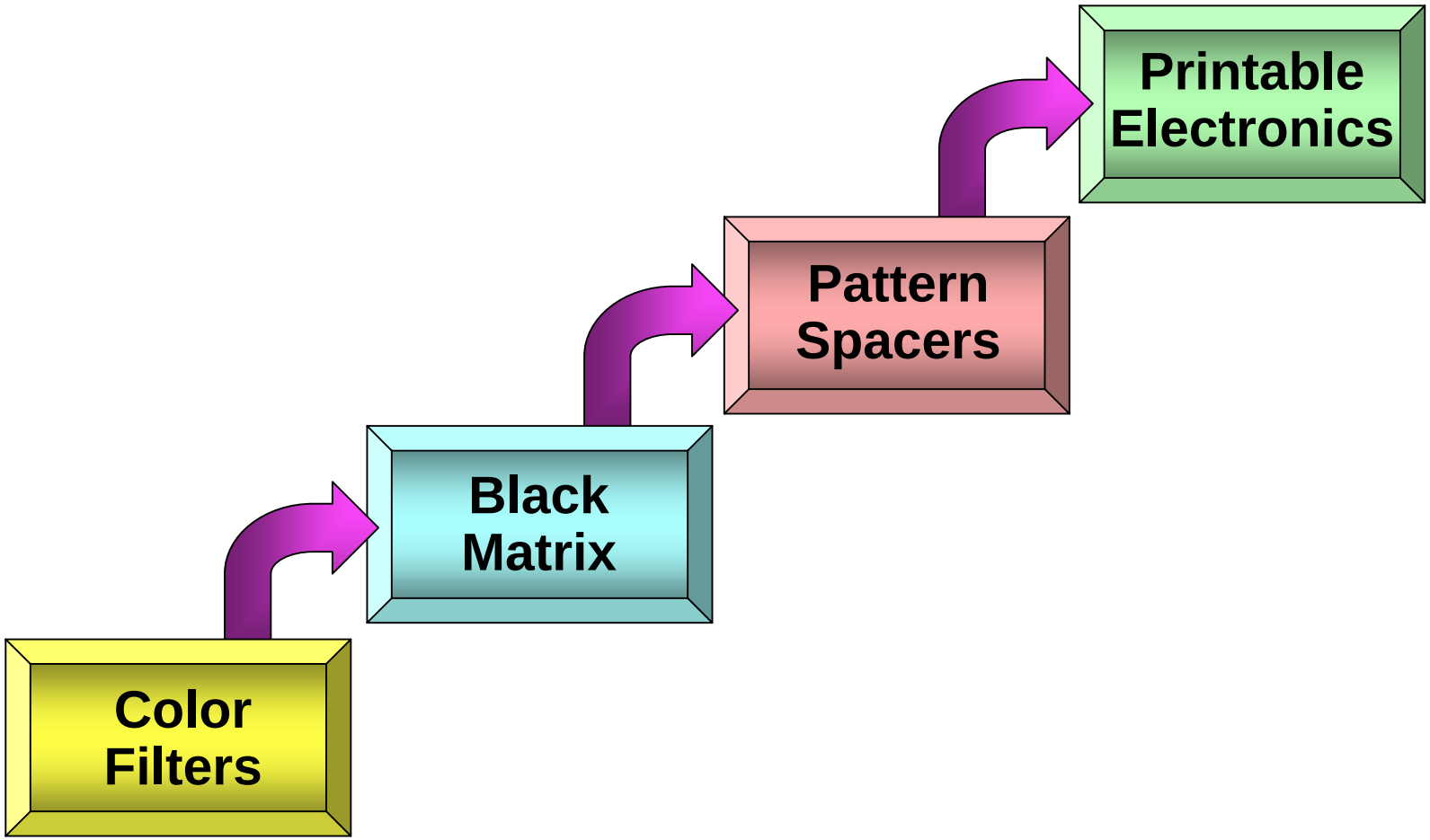


Mass production prototype (gen-7 compatible)

DuPont Thermal Color Filter System Benefits

- **Completely dry imaging process leverages the advantages of using light**
  - No photomasks
  - No liquid handling
  - No delivery nozzles or slots to clog
  - Increased uptime
- **Greatly simplified process**
  - Fewer process steps
  - Simpler pattern job changeover
  - Less cleanroom space
- **Highly scaleable & adaptable process**
  - Easy to add incremental capacity
  - Increased manufacturing redundancy
  - Relatively insensitive to type of substrate (glass/polyester, flexible/rigid, thin/thick, etc.)

Thermal Transfer Technology Roadmap



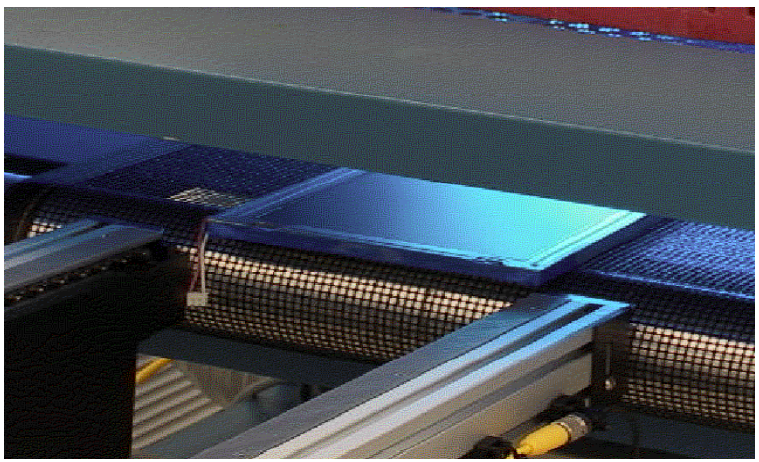
LCD Enhancements

Our products are designed to “bridge the gap”:

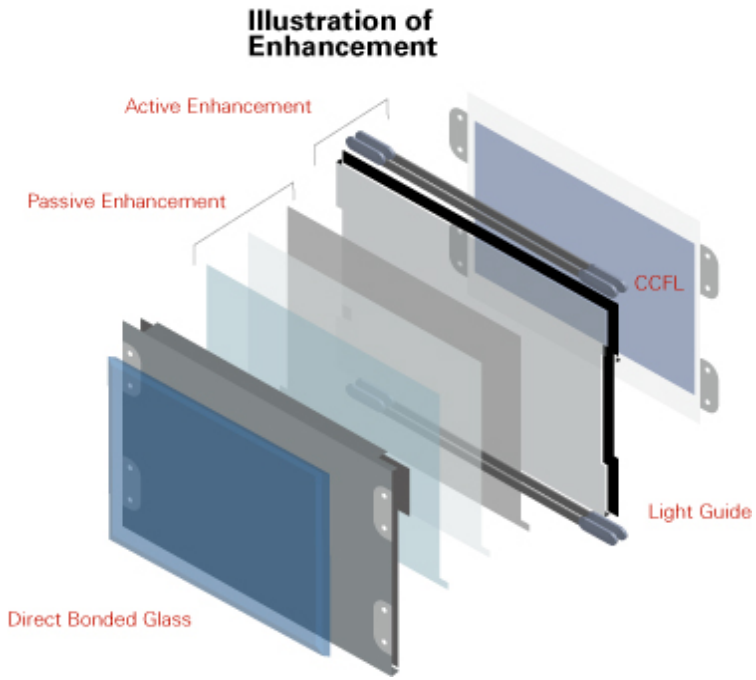
We enhance "off-the-shelf" displays so that they can be integrated into the products of customers with challenging industrial applications.

Enhancements Main Product Lines

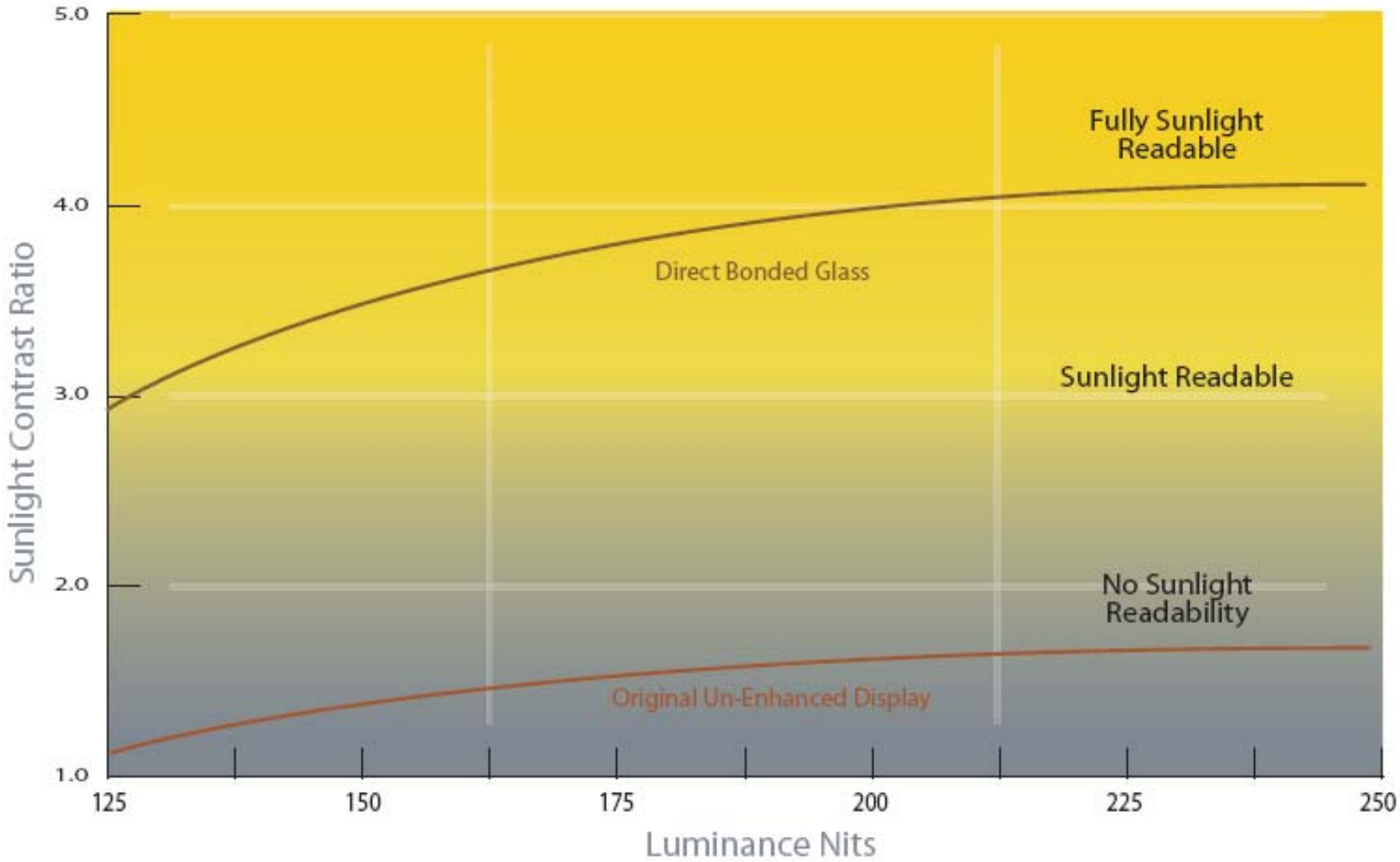
Direct Bonded Glass to an LCD panel



Comprehensive active and passive LCD enhancements



Sunlight Readability



Typical non-enhanced notebook LCD display has a sunlight readable contrast ratio of approximately 1.5 to 1. With DuPont's glass bonding technology the contrast ratio is 4 to 1, an improvement of 266% .

Enhancement Markets

Optical Films & Coatings

High-Performance Materials for the Flat-Panel Displays Industry

A New, High-Priority Program at DuPont

- **Mission**
  - Unleash DuPont's practically unlimited range of films, coatings & related technologies and apply them to displays
    - It's a natural place where DuPont can bring innovation

- **Relevant technologies**
  - Fluoropolymers
  - Composite materials
  - Photopolymers
  - Precision patterning
  - Nano-particles

- **Initial targets**
  - Anti-reflection
  - Reflectors
  - Diffusers
  - Backlight materials
  - Holographic devices

- **Initial focus:** LCDs
- **Future focus:** Expansion into PDP, FED, OLED, emerging

First Two Products Are Under Development

- **Backlight reflector**
  - Innovative composite material – different than conventional reflectors
  - Reflects more blue light – CCFL can use less blue phosphor
  - Higher overall & diffuse reflectivity – it's a better reflector
  - Less yellowing due to UV exposure – no UV coating needed
  - Less change in reflectance due to long-term high temperature
- **Anti-reflective coating**
  - Low reflectivity requires a material with a low index of refraction
    - DuPont fluoropolymers have the lowest index of refraction of any material in the world

Thick-Film Technology for PDP & FED

DuPont Fodel® Paste System

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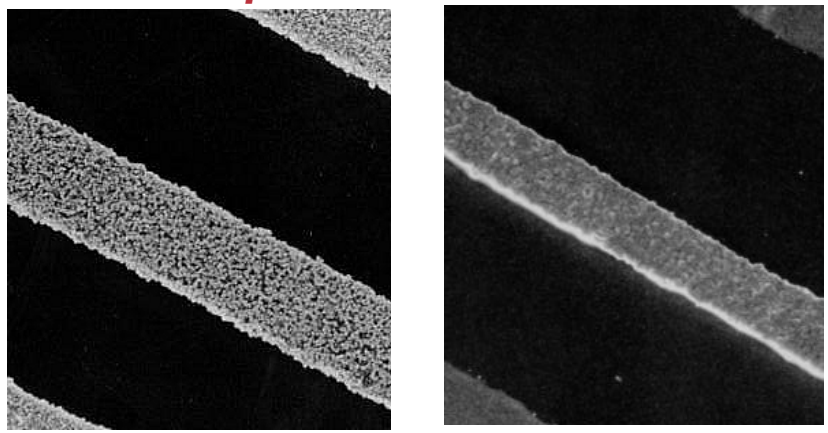
Key Ingredient that Allows PDP to Compete with LCD

- **Fodel® thick-film, photo-imageable, paste system**
  - Paste developed in 1980s
  - Patented Ag-black bus system developed in 1990s
  - Now the industry-standard metallization process for PDP
  - Fodel will enable next-generation emissive thick-film display technologies such as FED (Field Emission Display)

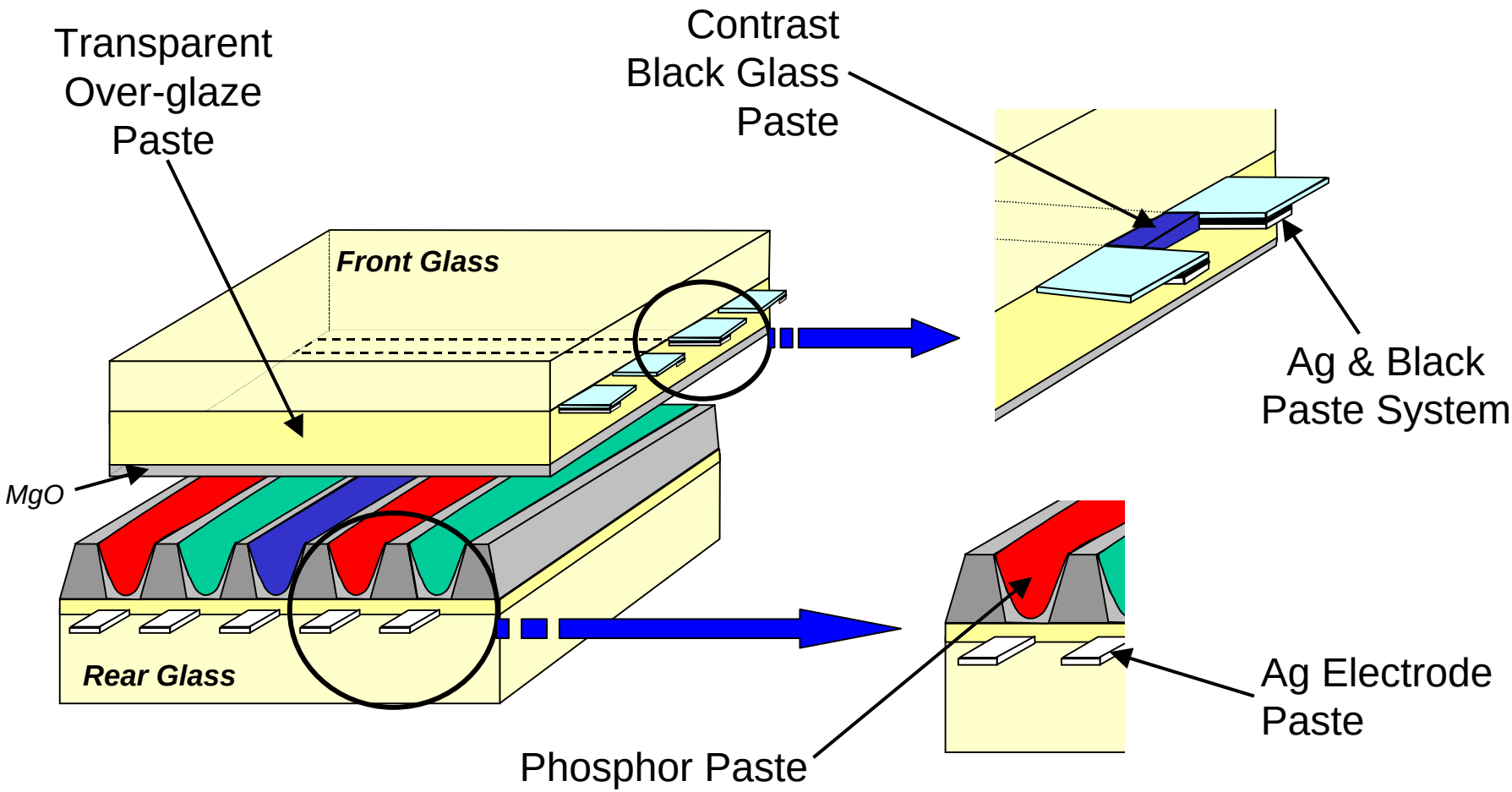
Developed ***Fired***



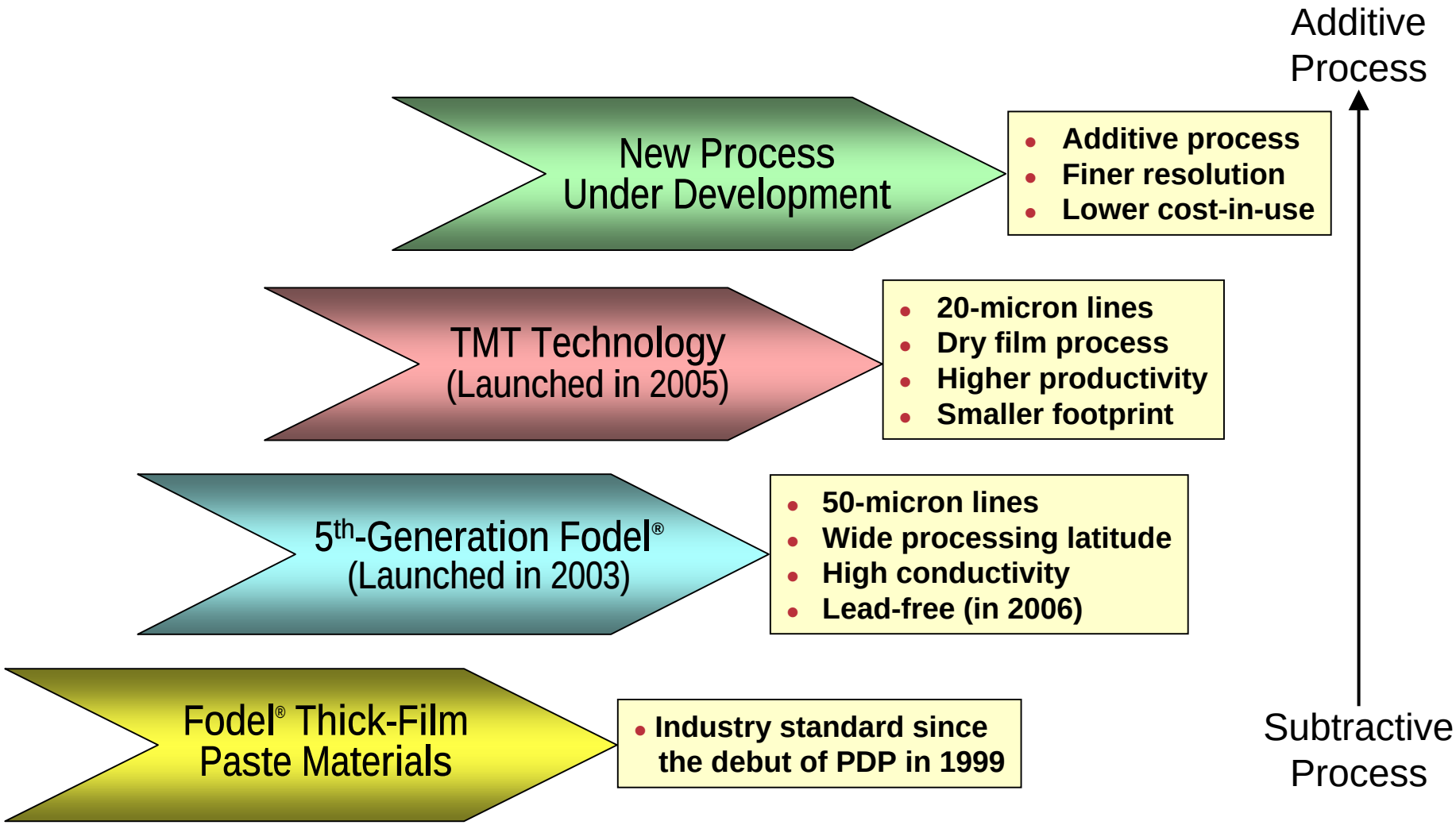
- High throughput
- High yield
- Low cost
- Simple process

50-micron fine-line resolution for HDTV

DuPont Fodel® Thick-Film Pastes in PDP Structure

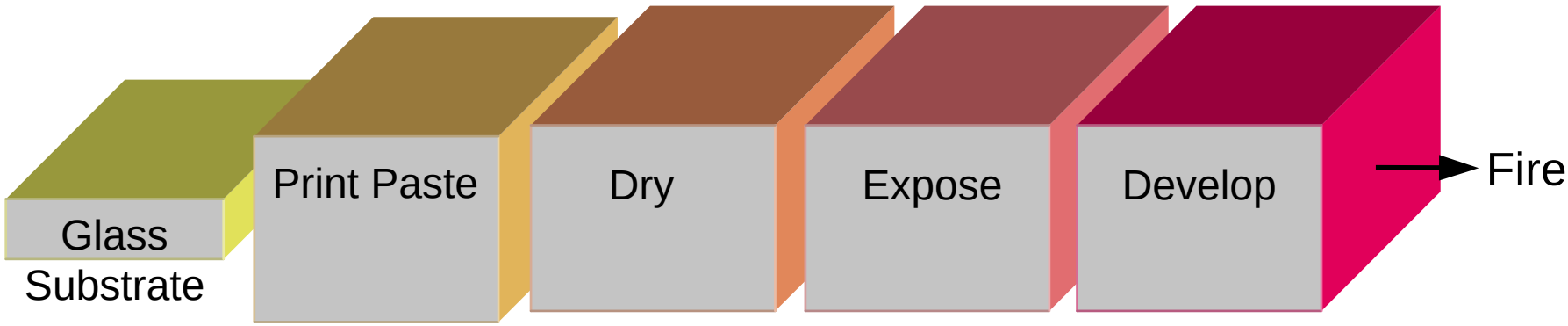


DuPont Fodel® PDP Technology Roadmap

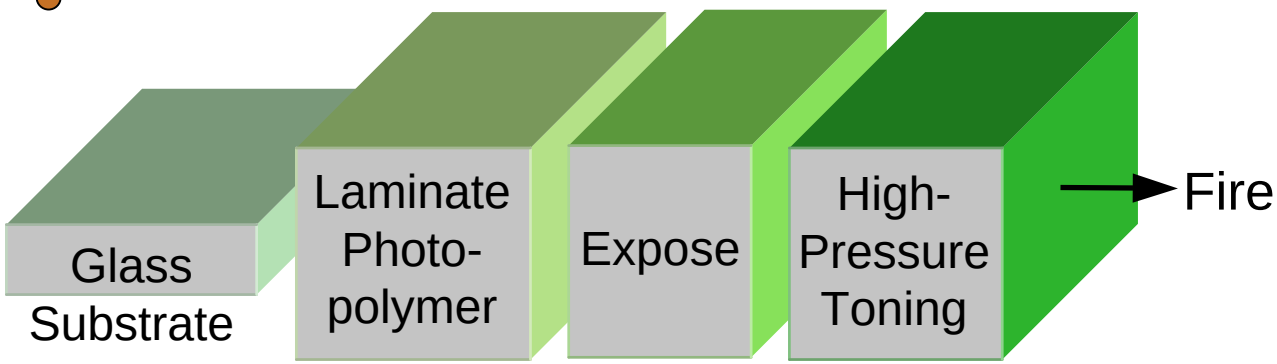


Comparison of Fodel® and TMT Processes

Fodel® Screen-Printable/Photo-Imageable Paste



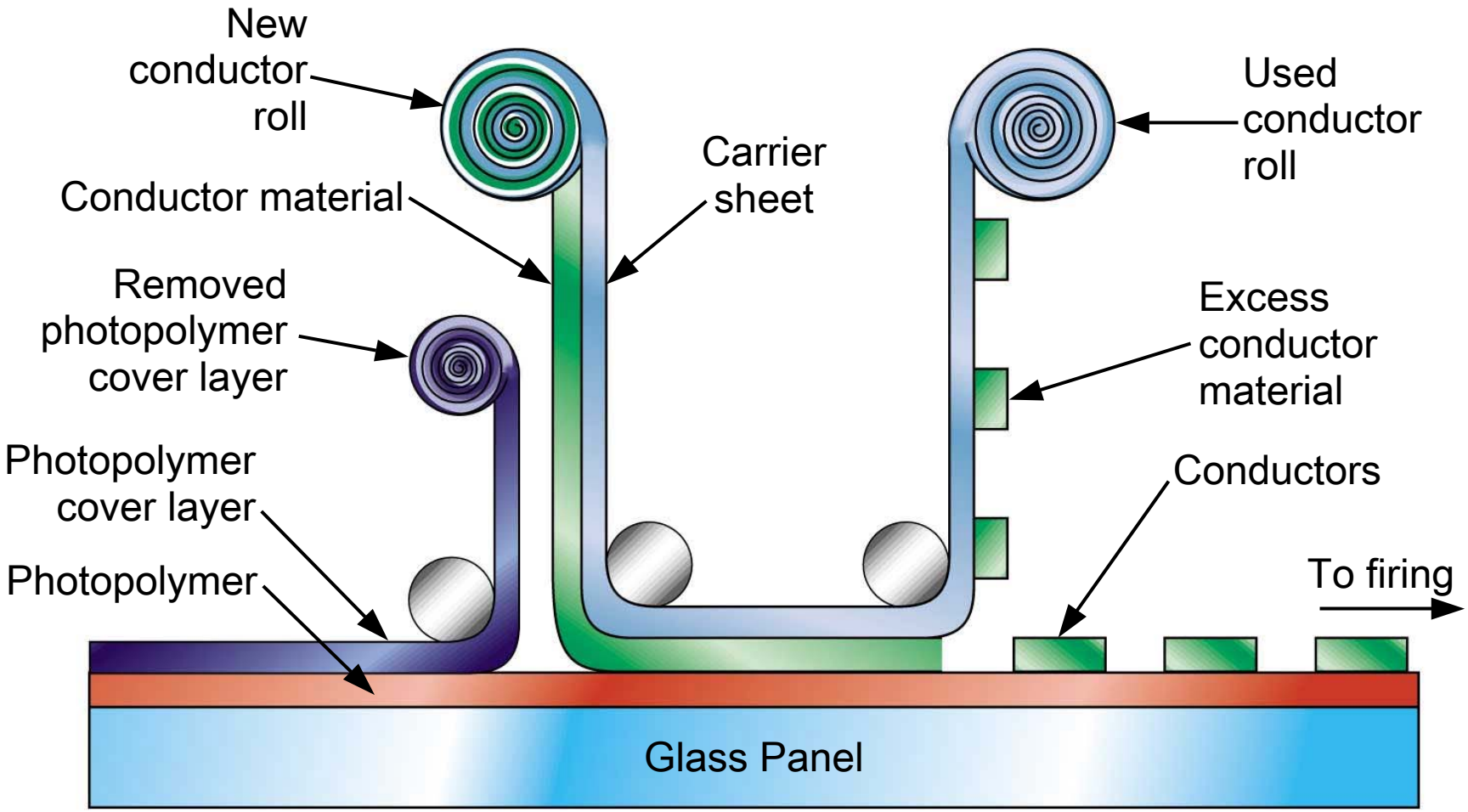
Transfer Materials Technology (TMT)



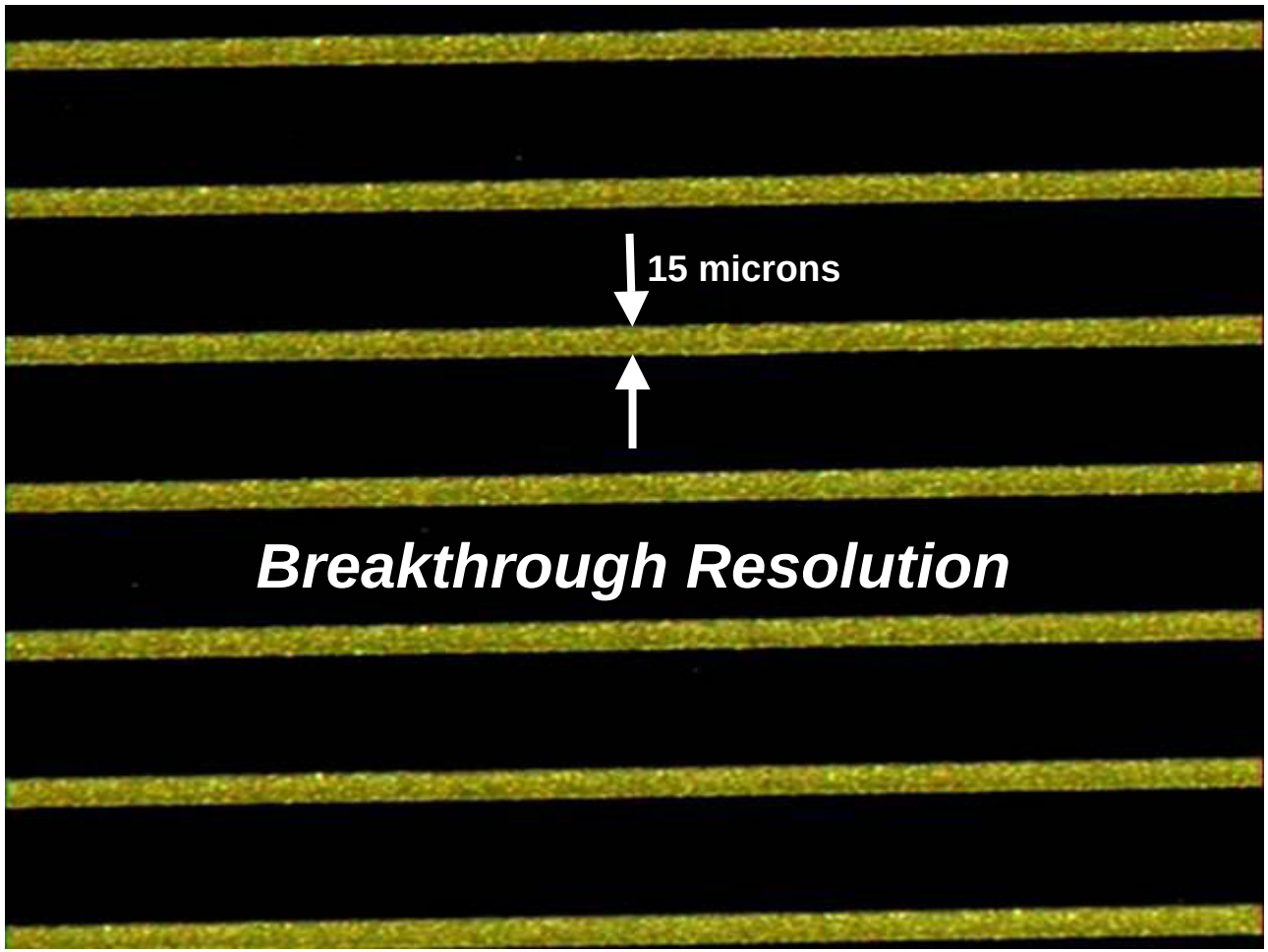
Benefits of TMT

- Dry process
- Higher productivity
- Smaller footprint
- Lower capital cost

How TMT Works



TMT Makes the “Key Ingredient” Even Better



Thank You!