



WCIF 2014

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Touch Technology: Present and Future

Must use exact
file name
capitalization!

File Download: www.walkermobile.com/WCIF_FPD_2014_Touch_Technology.pdf

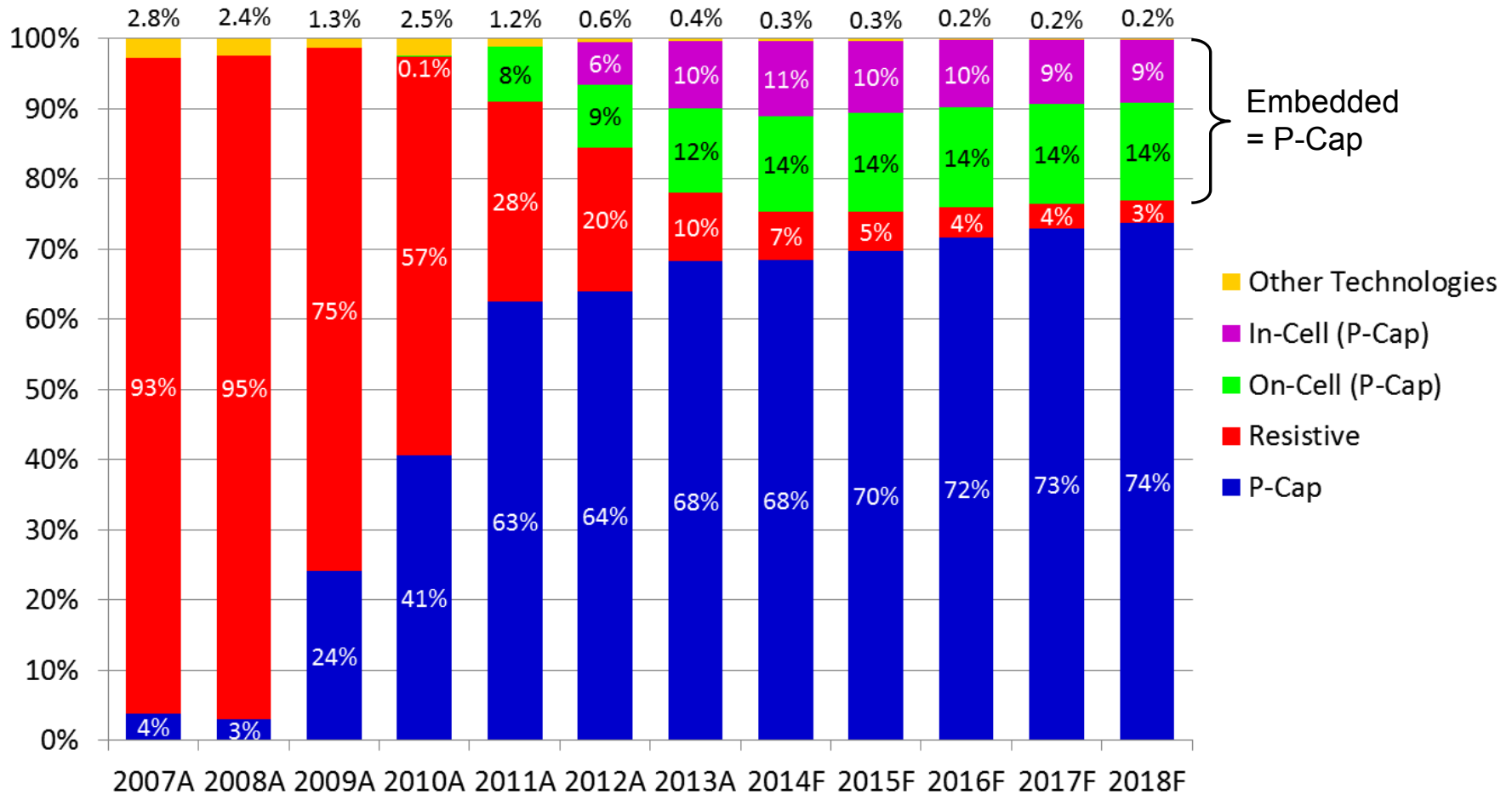
Agenda

- ❖ **Touch Market [4]**
- ❖ **Embedded Touch [3]**
- ❖ **Touch Controllers [7]**
- ❖ **ITO Replacements [6]**
- ❖ **Touch User Experience [1]**
- ❖ **Conclusions [1]**

The opinions expressed in this presentation are those of the author, not necessarily those of Intel Corporation

P-Cap Dominates!

% of Units Shipped



Source: DisplaySearch Touch-Panel Market Analysis Reports 2008-2014 (latest 9-Sep-14)

What About the Other Touch Technologies?

Segment	Technology	2014	2015	2016	2017	2018
Consumer (94% to 95%)	P-cap & Embedded	97%	98%	99%	99%	99%
	Resistive	3%	2%	1%	1%	1%
	Other*	0.2%	0.2%	0.1%	0.6%	0.5%
Commercial (6% to 5%)	Resistive	78%	76%	67%	60%	54%
	P-cap	19%	21%	30%	38%	44%
	Other*	3%	3%	3%	2%	2%

* Other = Acoustic, digitizer, infrared, optical imaging, surface capacitive, in-glass optical

❖ **Reality is that other touch technologies are an insignificant part of the market, even in commercial**

Source: DisplaySearch Quarterly Touch-Panel Market Analysis Report 3Q-2014

What About New Touch Technologies?

- ❖ **Any new touch technology that wants to compete with p-cap must equal or better p-cap in at least the following capabilities:**
 - ◆ Robust multi-touch
 - ◆ Very light touch (swipes)
 - ◆ Zero-bezel (borderless)
 - ◆ Very durable
 - ◆ Excellent optics

- ❖ **There's nothing on the horizon that looks promising**

The Last Frontier of Consumer-Electronics Touch

❖ Notebooks!

- ◆ DisplaySearch forecasts that touch penetration in all sizes of notebooks will reach only 18% by 2018* (they're wrong!)
 - Intel has 30,000 touch-notebook users (true, they didn't have to pay for the touch themselves) and their feedback is very positive
 - Once touching smartphones and tablets becomes automatic, it feels odd not to be able to touch notebooks
 - Notebook touch-panel cost has dropped ~50% during the last 18 months
 - Many touch-panel makers see notebooks as the next big opportunity

❖ The author believes that by 2018, two-thirds of all notebooks will be touch-enabled

* Source: DisplaySearch Quarterly Mobile PC Shipment & Forecast Report 3Q-2014

Embedded Touch...1

❖ Embedded touch defined

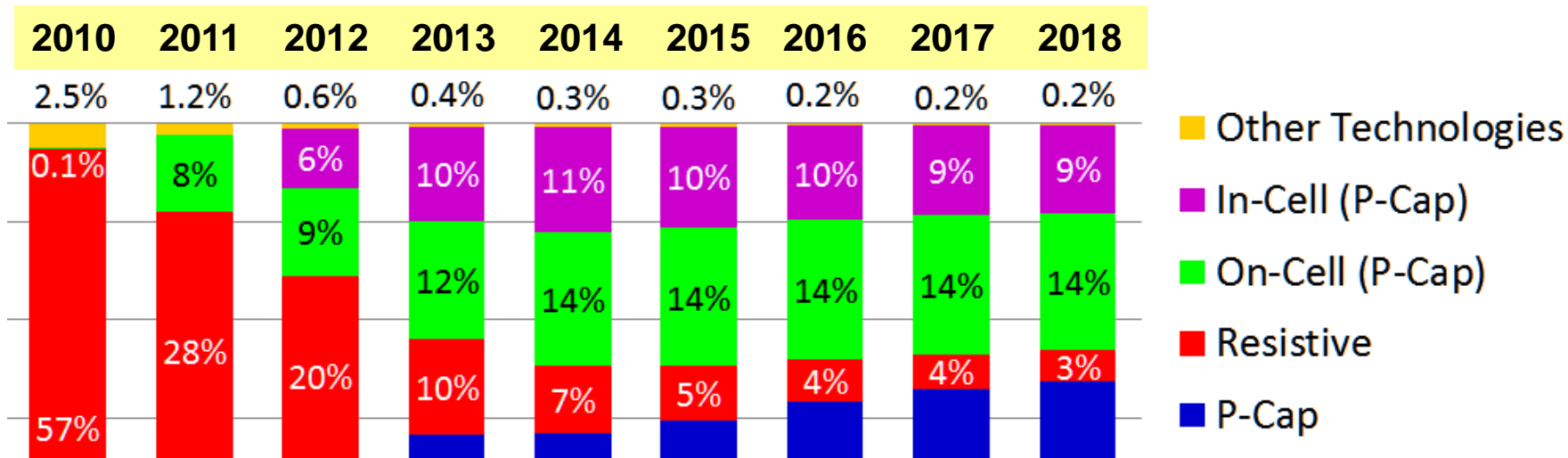
- ◆ Touch supplied by a display-maker, not a touch-panel maker
- ◆ Forms: In-cell, hybrid in-cell/on-cell, and on-cell
- ◆ Cost: Touch is never free; it's all about who gets the \$\$\$ [1]

❖ It's definitely growing

- ◆ Every major display-maker is shipping (or has developed) embedded touch
- ◆ But, because competition between the display-makers and the touch-panel makers is intensifying, the display-makers are disclosing much less information about new developments in embedded touch

[1] See "[Embedded Touch: The Touch-Panel Makers vs. The Display-Makers](#)"

Embedded Touch...2



Source: DisplaySearch Touch-Panel Market Analysis Reports 2008-2014 (latest 9-Sep-2014)

❖ DisplaySearch forecasts that on-cell will beat in-cell

- ◆ Least impact on LCD module design and production
- ◆ Already the default standard for OLED mobile displays
 - AUO showed “in-cell OLED” at SID Display Week 2014
- ◆ 23% embedded total probably underestimates OLED penetration

Embedded Touch...3

❖ Updates

- ◆ Japan Display (JDI) says that they have solved all the problems in developing a 10-inch hybrid in-cell/on-cell display are ready to start production
 - They're delaying introduction "to make sure that it is a fully differentiated solution"
- ◆ JDI says they can also make a 13.3" embedded-touch display for use in touch notebooks
 - They don't participate in that market and think that it's too small
- ◆ Touch & Display Driver Integration (TDDI) is growing, with at least three suppliers now providing it
 - However, it really isn't a general-purpose solution since each TDDI chip is unique to a particular display resolution and driving method

Touch Controllers...1

- ❖ In the last 18 months, the touch industry has developed four important p-cap touch-enhancements
 - ◆ Hover
 - ◆ Glove-touch
 - ◆ Water resistance
 - ◆ Fine-tip (1-2 mm) passive stylus

- ❖ All of these enhancements are now being rolled out in consumer-electronics products



Photo by author

Touch Controllers...2

- ❖ **Passive stylus with 1-2 mm tip (including #2 lead pencils) has arrived, and it's finally “good enough”**

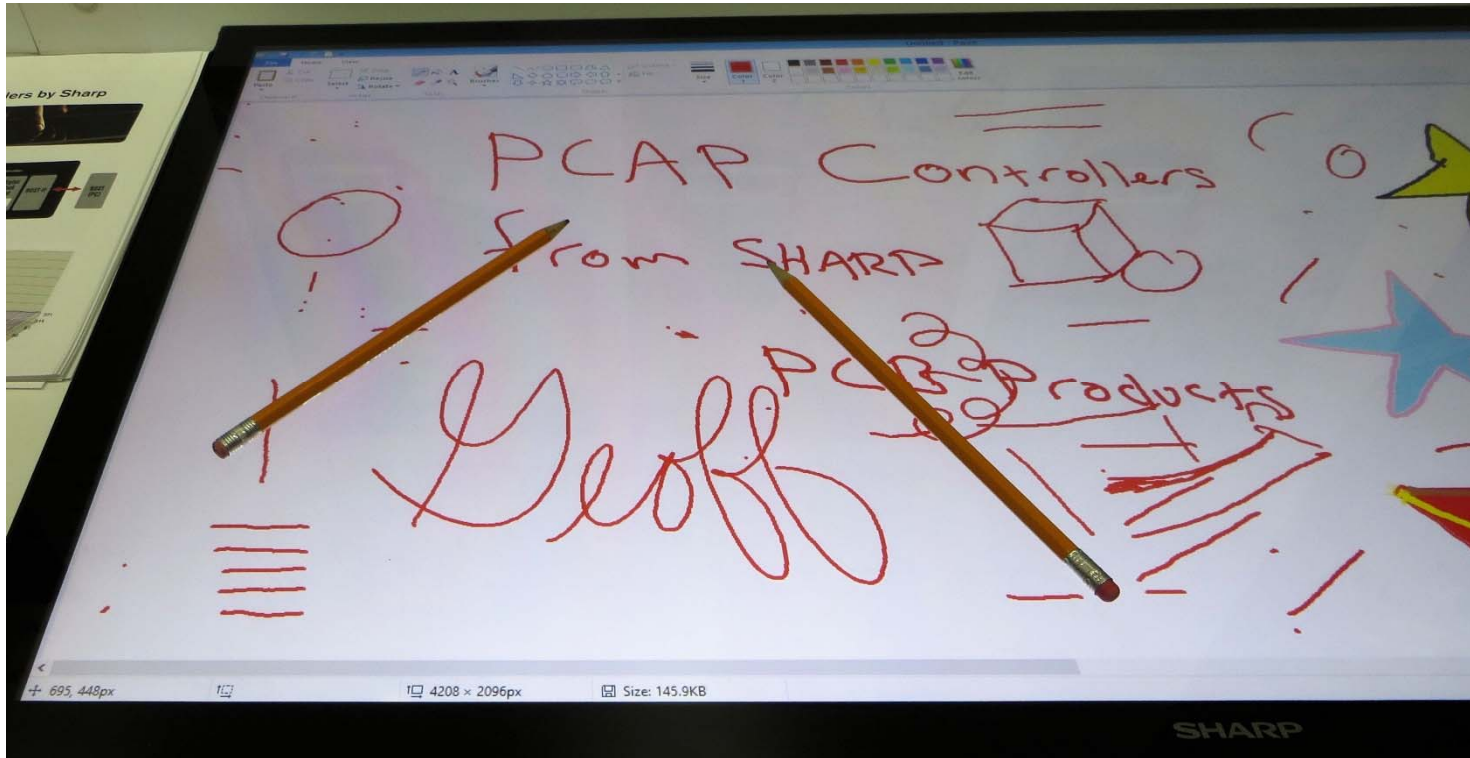


Photo by author

Touch Controllers...3

- ❖ But what about active stylus?
- ❖ Key impediments to widespread adoption include the following:
 - ◆ Competition between suppliers over architecture (IP) rather than user experience (UX)
 - ◆ Lack of any stylus interoperability between suppliers
 - ◆ Expensive, single-source, hard-to-buy replacement styli
- ❖ Something's coming in the industry that could eliminate all of these impediments...
 - ◆ But I can't talk about it yet...

Touch Controllers...4

❖ There are two ways of emulating “mouseover” on a touch-panel

- ◆ Hover over something to see it change, then touch to select
- ◆ Press lightly on something to see it change, then press harder to select

❖ The touch-industry is moving towards hover

- ◆ Nobody has been able to implement pressure-sensing in a way that works well and that OEMs are willing to implement

Touch Controllers...5

❖ What can you do with hover?

- ◆ Enlarge small links when you hover over them
- ◆ Make a passive stylus seem to hover like an active stylus
- ◆ Magnify an onscreen-keyboard key as you approach rather than after you've touched it
- ◆ Preview interactive objects such as an array of thumbnails
- ◆ Use multi-finger gestures for more complex operations
- ◆ And more...

❖ Startup: ZRRO

- Multi-finger hover detection

Touch Controllers...6

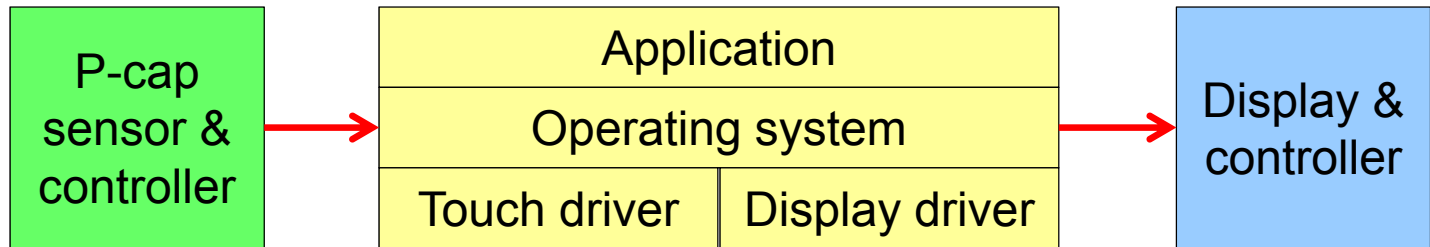
❖ True absolute-pressure sensing is coming

- ◆ Apple has implemented a method of pressure (force) sensing in the Apple Watch
 - Apple Website: “[Force-sensing] is the most significant new sensing capability since multi-touch” (this will help raise consumer awareness)
 - However, it doesn’t look very scalable to larger screens
- ◆ Startup: **Cambridge Touch Technologies** (in stealth mode)
 - An elegant, scalable, and manufacturable method of adding high-quality pressure-sensing to any p-cap touch-panel stack-up, without changing any characteristic of p-cap
- ◆ Startup: **NextInput**
 - Force-sensing using an array of organic transistors where pressure changes the gate current

Touch Controllers...7

❖ Other potential improvements in touch functionality

- ◆ Latency (time between touch and visible response)
 - Startup: [Tactual Labs](#)

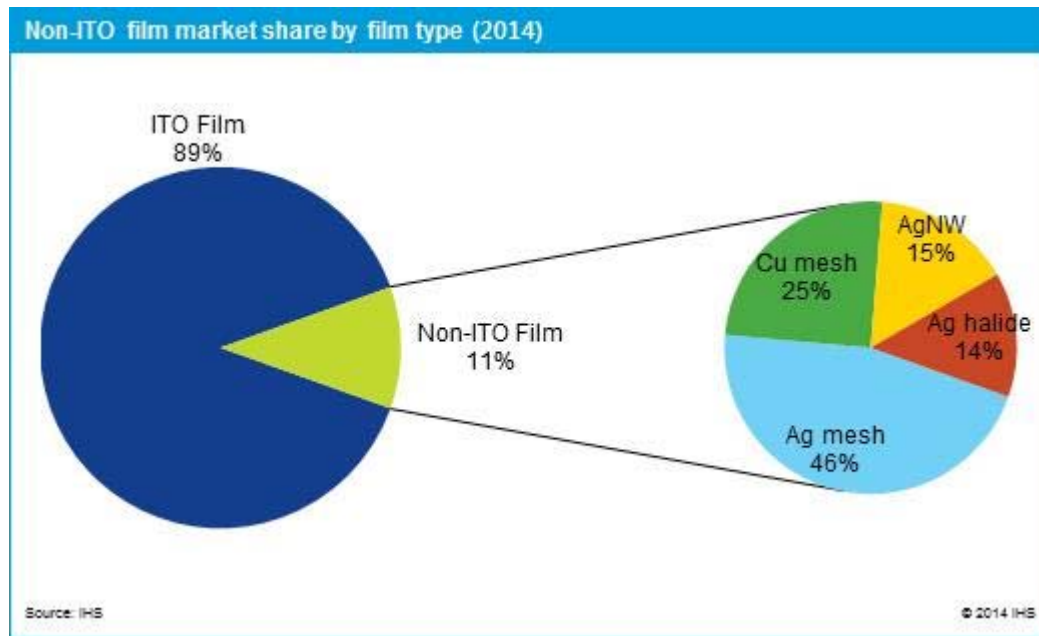


- ◆ Adaptive behavior
 - For example, as the environmental noise-level increases, reduce the number of supported touches and the touch report-rate
- ◆ “Image” touch
 - Report and use the entire touch “image”, not just the X-Y coordinates
- ◆ Software integration
 - Intel is working on being able to run the touch-controller algorithms on the GPU

ITO Replacements...1

❖ ITO-replacement materials are having a definite market impact

◆ See the latest IHS market report



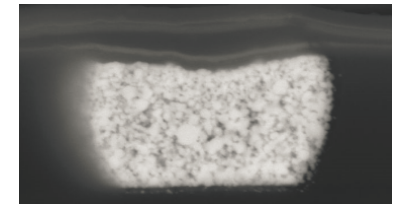
- ◆ Mesh (silver & copper)
- ◆ Silver nanowires
- ◆ Carbon nanotubes (CNTs)
- ◆ Conductive polymers
- ◆ Graphene

- ◆ ITO replacements increase performance and reduce cost
 - Both unit cost and CAPEX

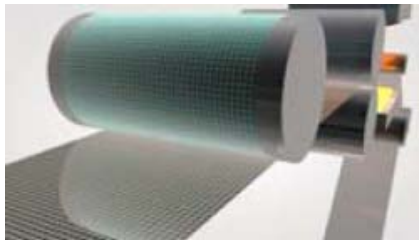
ITO Replacements...2

- ❖ **Printing** metal-mesh is going to beat litho & laser
- ❖ **O-film is the leader** (author's opinion)
 - ◆ Largest touch-module maker in China, #3 globally
 - ◆ Like “the TPK of film”; innovative and aggressive
- ❖ **New roll-to-roll printing method**
 - ◆ “Hybrid printing” or “micro-imprinting”

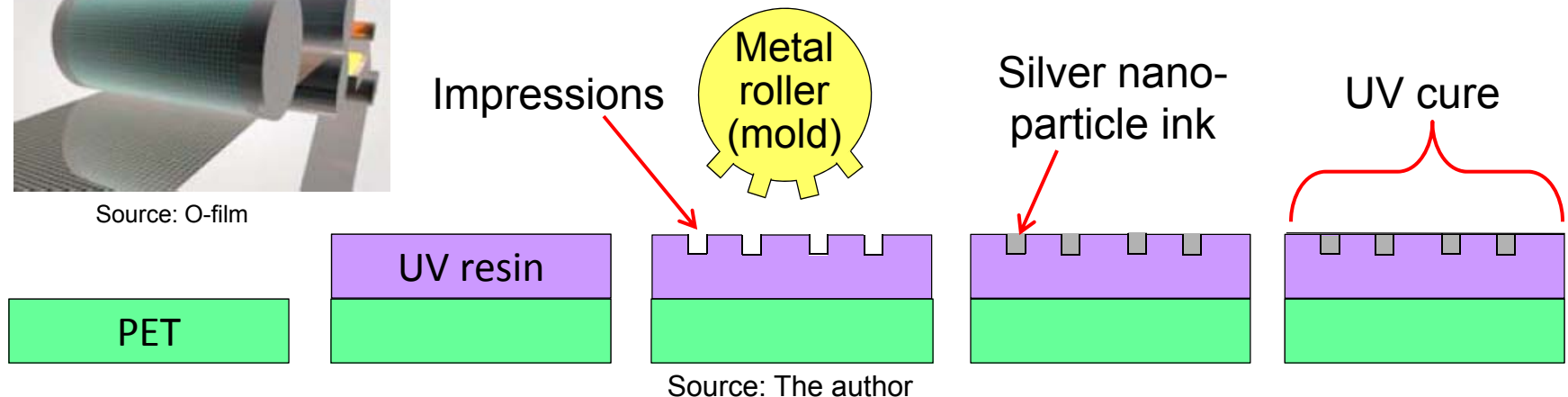
Source: O-film



Cross-section of embedded metal line



Source: O-film



ITO Replacements...3

❖ O-film technical details

- ◆ Additive process with little waste
- ◆ $< 2 \mu\text{m}$ line width
- ◆ $< 10 \Omega/\square$
- ◆ Randomized mesh design
 - “Sparkle” is still a problem when using randomized mesh design
- ◆ Top surface of embedded metal line is blackened & sealed
- ◆ Embedded metal reduces haze and eliminates peel-off
- ◆ Producing $> 1.5\text{M}$ touch-panels per month (size not stated)

ITO Replacements...4

❖ But metal mesh isn't perfect...

- ◆ Not all mesh suppliers have solved the moiré problem
- ◆ Not all mesh suppliers can achieve “invisible” mesh
- ◆ Not all mesh suppliers can deposit and pattern in one process

❖ The industry still has a lot of learning to do

ITO Replacements...5

❖ Other ITO replacements

- ◆ Silver nanowires (AgNW) are still a serious competitor to metal mesh
 - The TPK/Cambrios/Nissha joint venture will eventually make AgNW an even more serious competitor when they finish development of deposition and patterning in a single process
- ◆ Carbon nanotubes (CNT) are in the market, but not very big
 - CNTouch in China is a surprisingly strong (but totally invisible) competitor at the low-end
- ◆ Conductive polymers (PEDOT) are in the market, but not very big
 - Heraeus (partnered with Kodak) is a significant supplier

ITO Replacements...6

- ❖ **The secret to success in ITO replacements is vertical integration (like O-film)**
 - ◆ The author is not convinced that ink-makers & film-coaters are ever going to be significant players in the business

The #1 Touch User-Experience Trend

❖ Touch still doesn't “**just work!**” all the time

- ◆ Missed touches
- ◆ Unintended touches

❖ Why?

- ◆ Other than environmental issues, the #1 reason is bad app programming, not bad touch-panels (author's opinion)

❖ You don't believe it?

- ◆ Download “[Touch Explorer](#)” by Synaptics from Google Play and see if you can make the touch-panel on your Android smartphone or tablet fail to respond properly

Conclusions

❖ Touch is continuing to evolve

- ◆ P-cap controller-makers are continuing to innovate, although it's getting more difficult to find areas that consumers care about
- ◆ The battle between the display-makers and the touch-panel makers is continuing with no clear winner in sight
- ◆ Touch startups are plentiful (4 examples in this presentation)

❖ The two biggest threats

- ◆ Insufficiently knowledgeable app-programmers
- ◆ Touch is maturing, which will eventually lead to commoditization



Thank You!

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Must use
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Backup Slides

Large-Format (>30”) Touch...1

❖ Large-format touch has more competing technologies

- ◆ Multi-touch infrared (IR) has replaced traditional (single-touch) IR
- ◆ Camera-based optical has dropped substantially with the exit of NextWindow (SMART Technologies) from the market
- ◆ Startup: [Sentons](#) is taking a new approach to bending-wave
- ◆ Startup: [RAPT](#) is taking a new approach to in-glass optical
- ◆ P-cap with metal mesh is a threat to all other large-format touch technologies
 - Commonality of user experience (UX) with the 3 billion p-cap units shipped since 2007 may be the driving force
 - Cost, complexity, and small market-size are the impediments

Large-Format (>30”) Touch...2

❖ BUT, it's possible that the large-format touch market might start shrinking:

- ◆ Interactive media walls – touch is very necessary 😊
 - MultiTaction makes the best vision-based touch used in interactive media walls today (author's opinion)
 - ◆ Point-of-information – touch still seems necessary 😊
-
- ◆ Digital signage – interaction via smartphone 😞
 - ◆ Education – interaction via tablets (including multi-user!) 😞
 - ◆ TV – interaction via mobile devices 😞
 - ◆ Horizontal home-gaming tables – will they ever exist? 😞
 - ◆ Other large-format applications?? 😞