The State of Projected-Capacitive Touch Technology
Topics

- Market
- Cost
- P-Cap Constructions
- ITO Replacements
- In-Cell & On-Cell Touch
- Stylus
- Interests
DisplaySearch’s 4Q-2012 touch module forecast for phones, tablets, notebooks, and AiOs

- 83% p-cap in 2012 in various forms
- 2018 forecasted touch penetration is 95%, 100%, 37% and 23%
What About Ultrabooks?

- 140 designs currently under development, ~30% touch
- Touch in hybrids ("convertibles") = obvious
- Touch in clamshells = less obvious

What does it take to drive touch into clamshells?
- Lower cost
- Touch apps that create consumer pull
- Touch that’s easier or more convenient than alternative input methods
- Touch that feels natural and responds quickly
- Touch that’s fun and satisfying
- Windows 8
Cost...1

- Total cost of touch module installed in an Ultrabook
  - Cover glass, lamination, shielding (if needed), controller, etc.

- Walker’s rule of thumb
  - Total touch cost of <5% of BOM is a no-brainer
  - Assuming $500 BOM for $900 13.3” Ultrabook, 5% is $25
  - TODAY’s cost is $55 to $85 (11%-17%), depending on configuration
What’s going to reduce the cost of touch in an Ultrabook?

- ITO replacements
- Simpler/better/easier (re-workable) lamination
- Process simplification
- Supply-chain simplification (display integration)
- Yield improvements at every step
- Elimination of glass (eventually)
Let’s talk about yield for a moment…

- Yield can be for a single step
- Yield can be for an entire process (ITO deposition to final assembly)
- Yield varies by the nature of the process
- Yield varies by the skill & experience of the operators
- Yield varies over time (learning curve; material & process changes)
- Yield for exactly the same thing varies widely by company

Consider all of this the next time you hear someone quote a yield number…
P-Cap Constructions

- P-cap sensors today exist in many different constructions, but all the variety is really only about a few things
  - Thinness
    - OGS (ITO deposited on the underside of the cover glass) = same thinness as in-cell construction
    - GF2 = \(~50\) microns thicker
    - GFF = \(~100\) microns thicker
  - Process expertise
    - A supplier tends to stay within their comfort zone
  - Cost
    - Fewer materials and simpler processes = lower cost
  - Yield…
  - IP landscape
ITO Replacements…1

- Top four materials
  - Metal mesh – Atmel is shipping
  - Silver nanowires – Cambrios is shipping
  - Carbon nanotubes (like silver nanowires, but made of carbon)
  - Conductive polymers (still striving to reach the goal…)

- It’s not really about the **material**, it’s about the **process**
  - All the ITO in a 42-inch TV LCD is ~$3; an Ultrabook is cents
  - ITO = vacuum deposition with photolithography on a fab
  - Metal mesh = print the entire sensor at room temperature
ITO Replacements…2

- The difficulty of new processes is lack of infrastructure
  - Supply chain has to be created from scratch
    - Silver nanowire’s strategy is to stay completely compatible with the existing ITO process, but cost savings are reduced by doing patterning on a fab
  - Establishing multiple sources is difficult

- How much cost are ITO replacements going to save?
  - 30%-50% reduction in the ITO sensor cost is a good target
  - BUT, the sensor is often only 50% to 70% of the total cost, so the actual cost reduction in the installed module is 15% to 38%
    - Not enough, but a good start
In-Cell Touch…1

- **It’s shipping today** in high-volume mobile-phone LCDs
  - Sony Xperia P, HTC EVO Design 4G, iPhone 5

- **All previous in-cell touch technologies failed** and should be considered dead
  - Pressed capacitive, self-capacitive, switch-sensing, light-sensing, etc.

- **The in-cell technology battle is over** (at least for mobile phones); in-cell p-cap has won
  - Invented by Sony and Synaptics
    - Use existing internal **metal** in groups to form drive and sense electrodes; segment the ITO static-shield on IPS displays only if necessary
    - Use VCOM as the drive signal, changing it from **noise** to **signal**
    - Cooperate with the LCD driver chip on timing
The result is a different LCD with minimal mask changes and (ideally) NO additional masks

- The NRE required to develop this different LCD limits in-cell to high-volume applications

Problems in expanding beyond mobile-phone size displays

- Timing is #1
  - Larger screens have more electrodes to be sensed in less time
- Sensing speed is #2
  - Longer electrodes have more resistance & capacitance which slow signals
Will these problems be solved?
- Eventually, like most technical problems (in-cell required ~10 years)
- But because of the development NRE, low-volume LCDs aren’t likely to be targeted for in-cell touch

Will the display industry eventually destroy the touch-panel industry, as suggested in the Market Focus Conference at Display Week 2012?
- The display industry is very likely to win the revenue battle
- BUT, the number of LCDs without in-cell touch will still far outnumber the number with in-cell touch
What About On-Cell Touch?

- On-cell touch has become the standard for OLED, yet it hasn’t become very popular with LCD makers
  - It may not solve enough problems on LCDs
    - It’s still basically like putting a discrete touchscreen on top of the color filter; connectivity is messy with a separate flex and controller
    - Double-sided processing of the color filter/touch sensor is still a problem
  - Some experimentation is in progress with ITO-replacement based touch sensors
In 2007, Steve Jobs famously said, “Stylus, yeeecchh!”

In 2008, Microsoft decided to emphasize the finger in Windows-7 touch over the stylus from the (perceived) failed Tablet PC.

The result is that for the last six years, we’ve been in an artificially pro-finger-touch world.

- Remember the stylus on the Palm PDA and the Handspring Trio?
  - Stylus has been around a LONG time and it’s NOT going away.

Windows 8 may cause stylus to re-emerge and become important again.
Stylus use cases

- Quick sketching
- Artistic drawing
- Taking notes that are converted into searchable text in the background
- Precision pointing device for legacy Windows apps
- Annotation of existing documents
Stylus types for use with p-cap touchscreens

- “Artificial finger”, what most consumers think of as a stylus today
  - $10 at Amazon with a 7 mm conductive-rubber tip and a **very poor UX**

- **Passive metal stylus** with 2 mm tip
  - Latest generation of touch controllers with high SNR supports these, but none are shipping yet

- **Active stylus** with <1 mm tip ➔ most likely to be successful
  - N-trig is the most mature supplier
  - Atmel, Synaptics, Cypress and other p-cap controller suppliers all have them but aren’t shipping yet
  - Wacom (used in the Samsung Galaxy notes) is legacy technology that requires an additional behind-the-LCD sensor
**Interests: Hover & Haptics**

- **Finger-hover** (mouseover) is shipping in the Sony Xperia Sola mobile phone, implemented only in the browser and on the home screen
  - If you have ideas or desires about using finger-hover, I’d love to speak with you!

- **Haptics** doesn’t really exist to any significant extent in tablets or notebooks
  - If you’d like to cooperate in developing a tablet or notebook haptics-application reference platform, I’d love to speak with you!

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