Electronics via Imprint

CIKC / IeMRC Plastic Electronics

15 March 2011

© 2011 PragmatIC Printing Ltd
About PragmatIC Printing

• Founded in 2010 by:
  – Scott White (Chief Executive Officer)
    • Experienced serial technology entrepreneur in Australia, US and UK
    • Founder/director of 4 previous start-ups – 3 acquired, 1 still growing
  – Richard Price (Chief Operating Officer)
    • Over 15 years’ experience in printed electronics, materials & chemistry
    • Tech transfer and bus dev track record with multiple start-ups
  – Philip Hudson
    • Former CEO of De La Rue Holographics and founder of Optaglio
    • Chairman of International Hologram Manufacturers Association

• Acquired printed electronics business of Nano ePrint
  – Unique device IPR including planar nano-diodes and transistors
  – Proven process using imprint with thin film semiconductors

• HQ and lab in Cambridge, U.K.
  – Core R&D team ex Plastic Logic, CDT, Plasmon, CIKC, ICL
Printed Logic Challenges

• Feature size, performance and cost
  – Most printing processes developed for >10μm features
  – Electronics requires smaller features to improve performance
  – Smaller features also reduce footprint, material use and circuit cost

  *PragmatIC’s imprint process combines the benefits of simple R2R-compatible printing with a proven ability to achieve both micron & sub-micron scale features with high yield*

• Registration and alignment
  – Conventional device architectures are complex 3D structures
  – Require accurate alignment between successive patterning steps

  *PragmatIC’s novel planar & self-aligned device architectures dramatically simplify manufacturing by reducing the number of process steps and minimising registration requirements*
Electronics via Imprint

• The oldest form of printing!
  – Clay imprints from stone stamps ~4000BC
  – Cylinder seals in recorded use ~2000BC

• Well-established use in security printing roll-to-roll
  – Feature sizes ~10μm typical for optical microstructures
    (e.g. holographic images)

• Nano-imprint also proven
  – Feature sizes <10nm demonstrated

• PragmatIC imprinted electronics
  feature size 100nm – 10μm

© 2011 PragmatIC Printing Ltd
Imprint Process

- Creates patterned 3D structures by imprinting with a featured stamp
  - Thermal imprint feasible at temperatures suitable for most plastic substrates
  - UV imprint at room temp

- Range of process options
  - Direct embossing into functional material layer
  - Patterning a resist for subsequent pattern transfer (c.f. photolithography)
  - Pre-patterning a substrate for selective deposition

Source: T. Balla, University of Southampton (2009)
Imprint Stamp

V1 = 380 nm
H1 = 244 nm
H2 = 375 nm

Mag = 50.00 K X
300nm
EHT = 2.00 kV
WD = 4 mm
Signal A = InLens
Photo No. = 1431
Date: 4 Dec 2009
Time: 13:00

© 2011 PragmatIC Printing Ltd
Imprinted Features

© 2011 PragmatIC Printing Ltd
Novel Device Architectures

**Conventional Thin Film Transistor (TFT)**
- Complex 3D structure
- Multiple material layers
- Multiple process steps
- **Challenging to print**
- **3D imprint enables self-aligned structures**

**PragmatIC Planar Nano-Transistor (PNT)**
- Simple planar 2D structure
- Single semiconductor layer
- Single patterning step
- **Requires sub-μm features**
- **Nano-imprint enables ultra-small devices**

© 2011 PragmatIC Printing Ltd
Reducing Footprint

> 1000 devices
in < 1mm²
Initial Applications

Low cost, non-invasive printed logic label

- Easy assembly on polyester, paper or card
- Transparent, ultra-thin and flexible

PratmatIC’s printed logic label enables simple, low-cost interactive consumer products or packaging

Demand for electronic smart packaging devices $7.7bn by 2020
[IDTechEx]
Application Areas

Security Printing
- Brand protection
- Document authentication

Consumer Goods
- Brand enhancement
- Smart packaging

Novelty Products
- Greeting cards
- Toys and games

Prototyping projects plus technology licensing
Prototyping projects with large multi-nationals
Prototyping project with Tigerprint (Hallmark)

© 2011 PragmatIC Printing Ltd
Summary

• Unique platform for printed logic
  – Patented device architectures using proven imprint process
  – Higher density and performance than other printing techniques
  – Simplified manufacturing with potential for ultra low cost

• Compelling market opportunity
  – Potential in multiple billion dollar market segments
  – Customer-led prototyping projects to validate initial applications

• Licensing technology for industrial process scale-up
Thank You

www.pragmaticprinting.com

© 2011 PragmatIC Printing Ltd