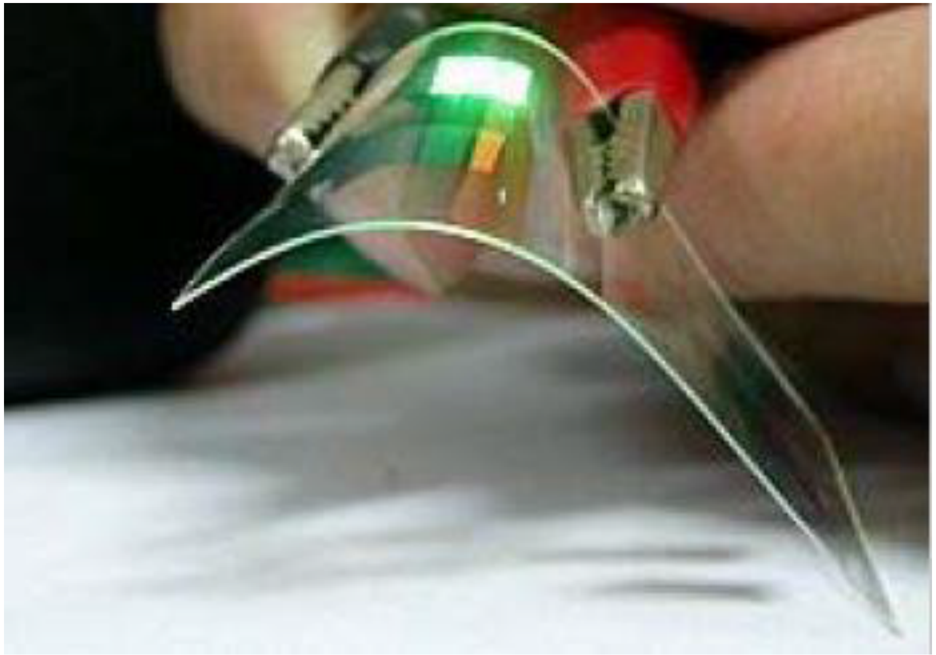
Manufacturing of Flexible Organic LED

Yasmine Badr

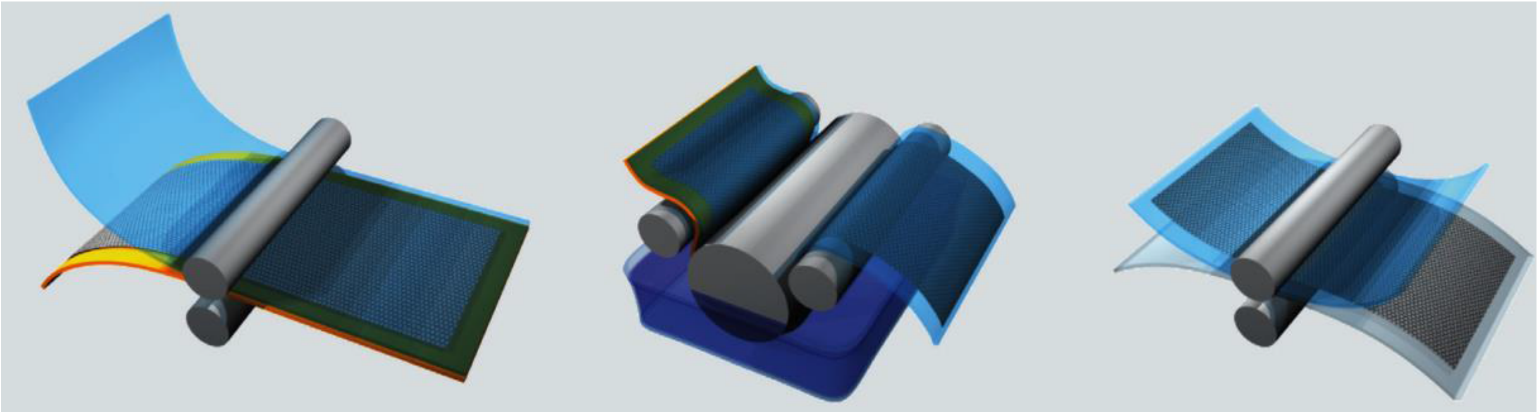
07/21/2015

Flexible OLED



Demonstration of a flexible OLED device.
Photo: General Electric

Roll to Roll processing (R2R)



R2R processing of graphene film for flexible touchscreen displays [1]

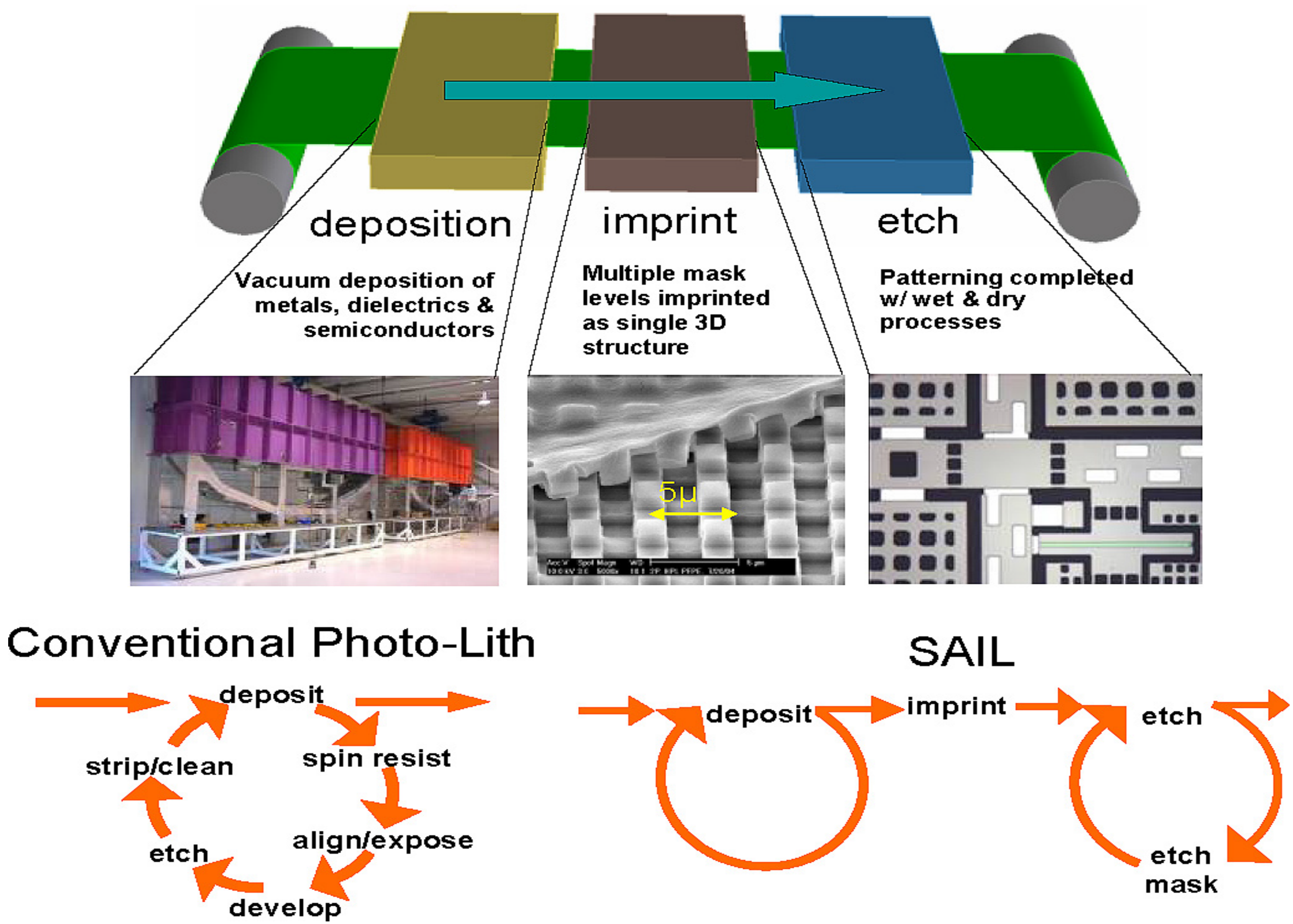
Advantages of R2R processing[2]

- Enables high-throughput low-cost manufacturing
  1. Faster: Continuous steady-state processing can eliminate the transients and latency that exist in conventional batch processing
  2. A rolled-up web prevents any particulates from entering the devices➔ reducing the cleanroom requirements.
  3. Size of substrate scales up only with the width of the web rather than the width and length so that equipment scaling is also one-dimensional

Disadvantages of R2R [2]

- In a high-throughput process:
  - patterning and alignment can be difficult,
  - and process monitoring on a moving web becomes more complicated

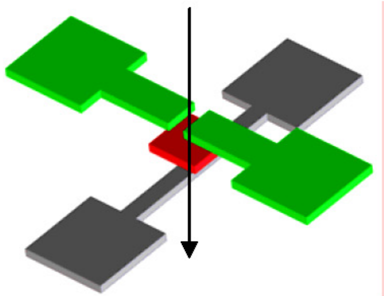
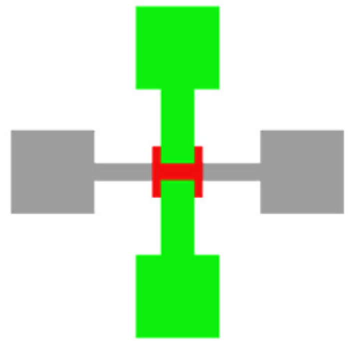
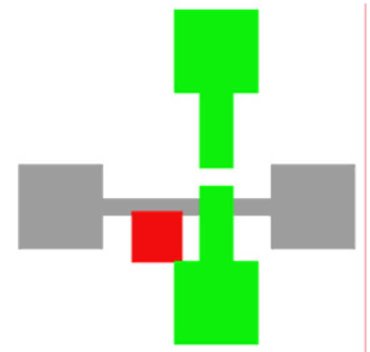
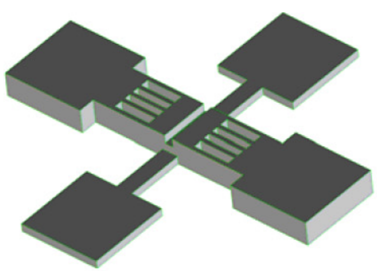
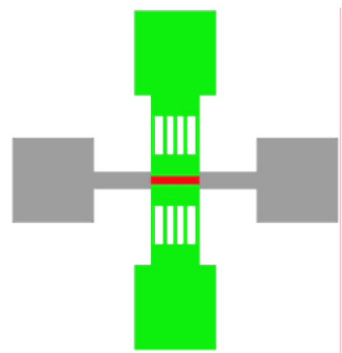
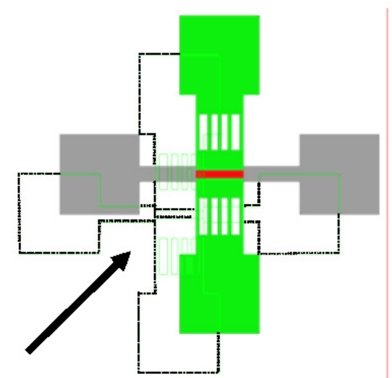
Self-aligned Imprint lithography (**SAIL)**



SAIL

- By HP, manufactured prototype
- SAIL solves the problem of precision interlayer registry on a moving web
- Encodes all the geometry information required for the entire patterning steps into a monolithic 3D imprint with discrete thickness modulation.
- Imprint lithography
- Defect and yield are major issues

SAIL is Misalignement-proof

Photolithography	 Multiple masking and alignment steps required	 Different mask used to pattern each layer	 Process induced distortion of 1000 ppm results in 100 µm misalignment over 10 cm web
SAIL	 Multiple patterns and alignments encoded into thickness modulations of a monolithic masking structure	 Single mask used multiple times to pattern all the layers	 No misalignment because mask distorts with substrate

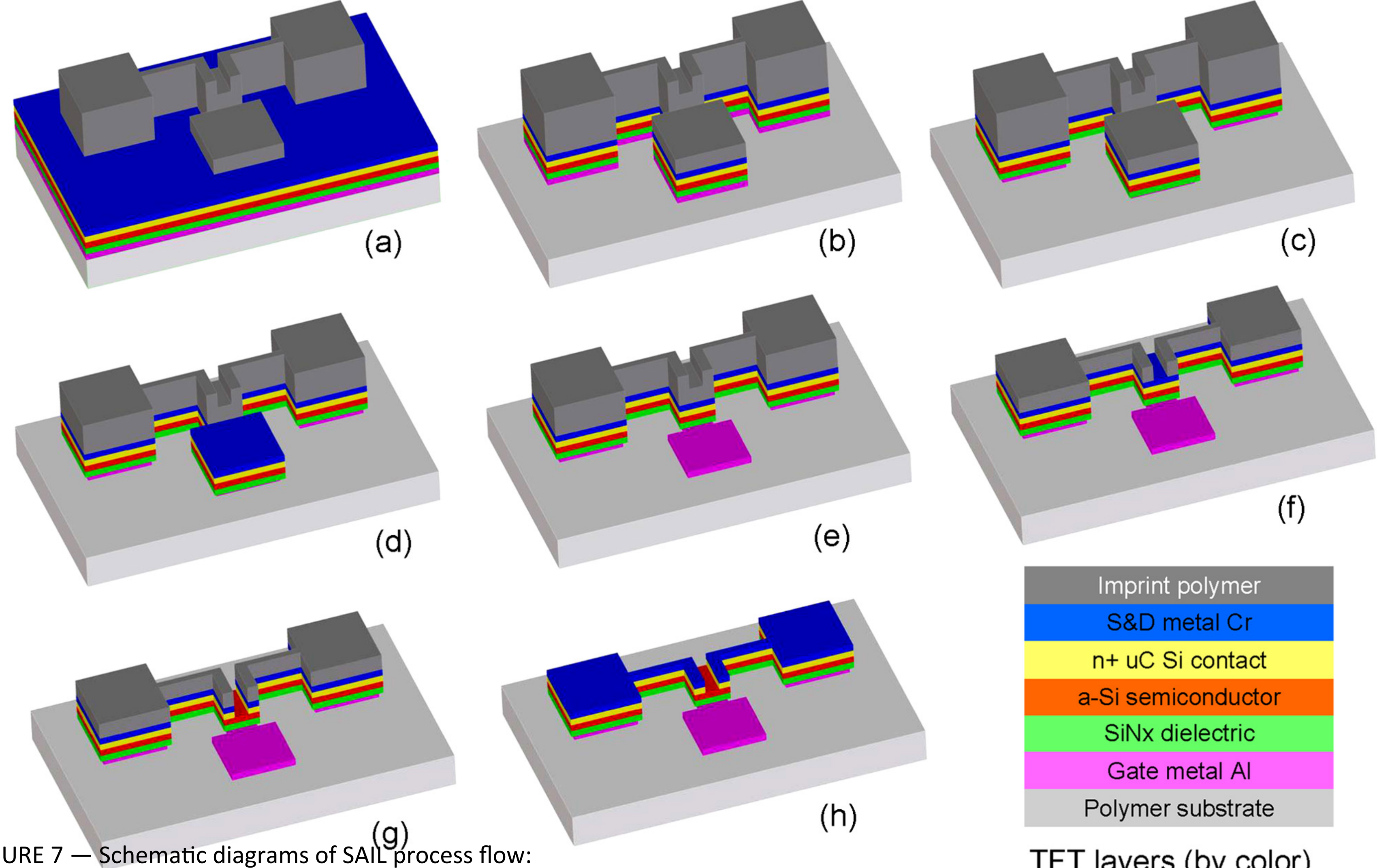
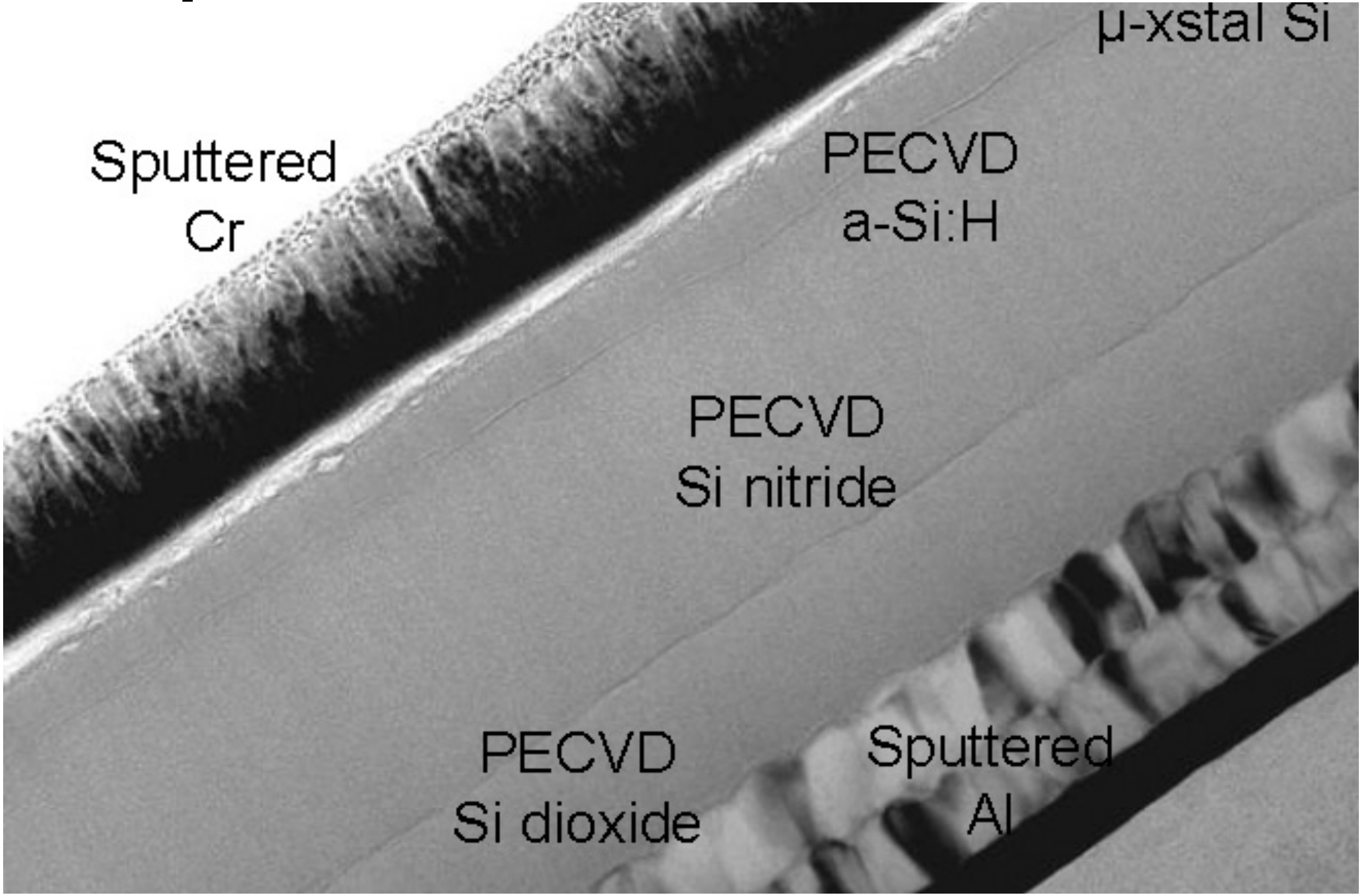


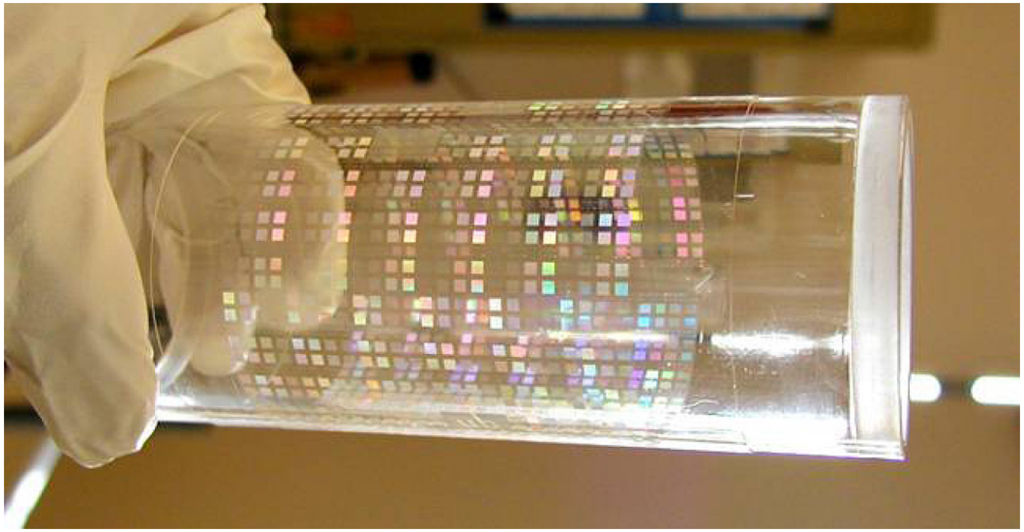
FIGURE 7 — Schematic diagrams of SAIL process flow:
(a) 3-D polymer mask that contains all the information for patterning is imprinted onto pre-deposited full TFT stack,
(b) stack materials are etched using various selective etching steps, isolating device from the surroundings,
(c) bottom metal underneath the crossover fuse area is separated by means of isotropic undercutting,
(d) imprint mask is etched and thinned down until the surface under the next lowest level is exposed,
(e) stack materials are etched down to the bottom-metal defining gate pad, (f) imprint mask is thinned down so that the channel is exposed,
(g) top metal and n+ layers are etched, opening a-Si in the channel area,
(h) with removal of the remaining polymer mask, fabrication of a TFT device is completed

1.Deposition



2.Imprint Lithography

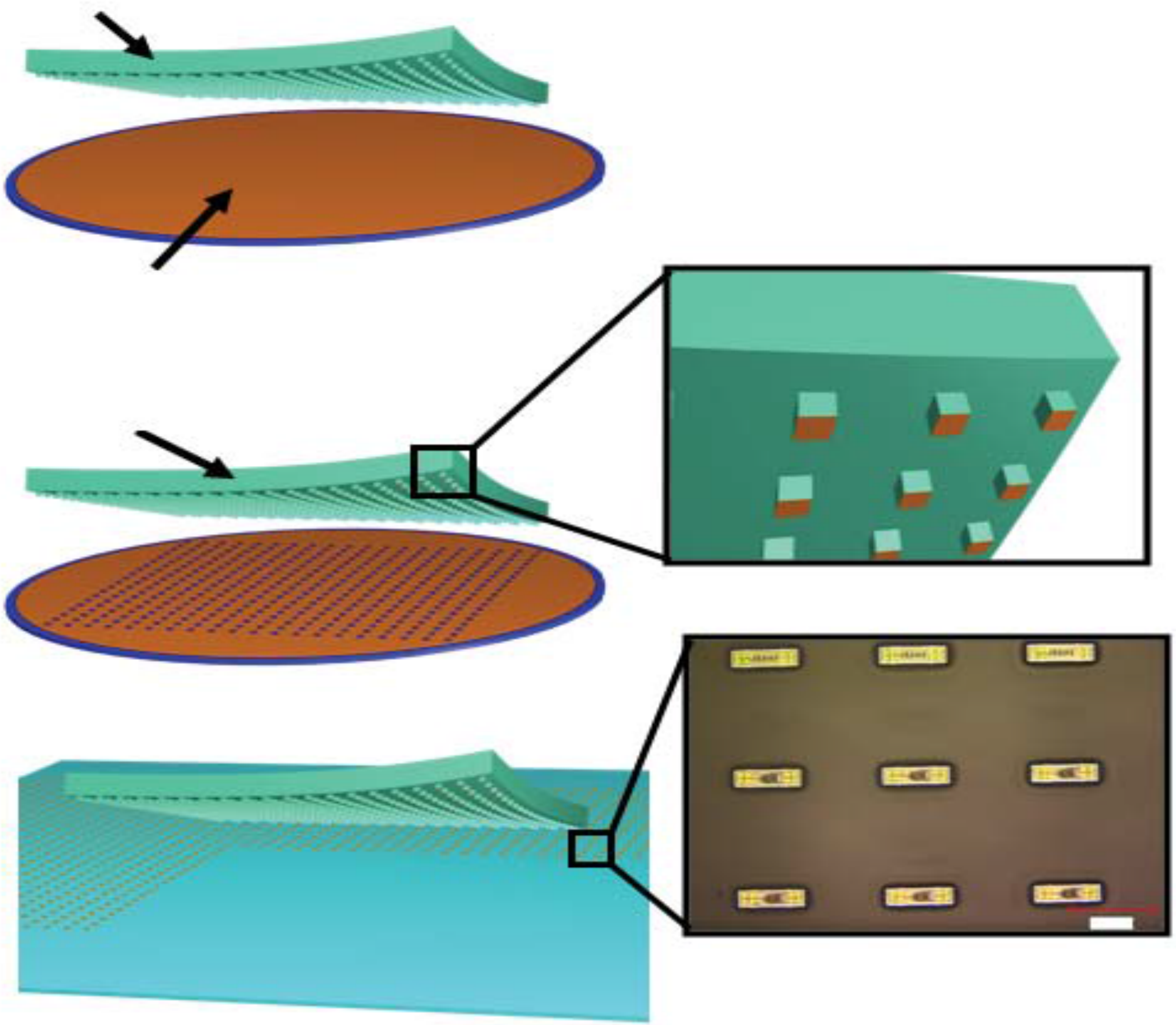
- Capable of producing features less than sub-100 nm on plastic substrates.



Elastomeric imprint stamp wrapped around UV-transparentquartz roller, through which UV light passes to cure the imprint polymer

3. Self-aligned etch

Other manufacturing method: Transfer printing [3]



References

[1] Jeffrey D. Morse, "Nanofabrication Technologies for Roll-to-Roll Processing", Report from the 1287 NIST-NNN Workshop, September 2011, via URL

[2] Kim, Han-Jun, et al. "Roll-to-roll manufacturing of electronics on flexible substrates using self-aligned imprint lithography (SAIL)." *Journal of the Society for Information Display* 17.11 (2009): 963-970.

[3] Bower et al.; Transfer-Printed Microscale Integrated Circuits for High Performance Display Backplanes; IEEE TRANSACTIONS ON COMPONENTS, PACKAGING AND MANUFACTURING TECHNOLOGY,2011