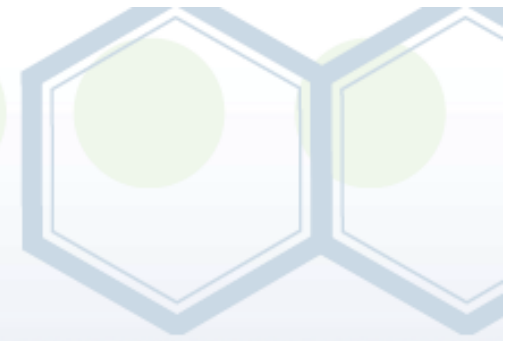




*“Perspective of a Start-up
that has moved thru Scale-up
into Commercialization”*

David J. Arthur, CEO
SouthWest NanoTechnologies, Inc.
<http://swentnano.com>



*The New Steel?
Enabling the Carbon
Nanomaterials Revolution:
Markets, Metrology, Safety,
Scale-Up*

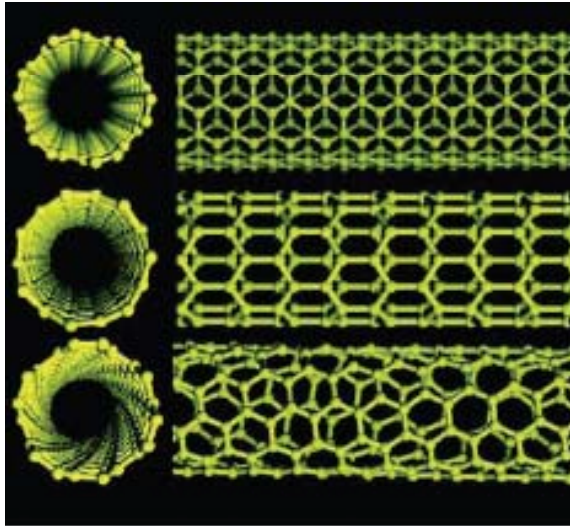
NIST Workshop
Gaithersburg, MD
Feb. 28 – Mar 1, 2011



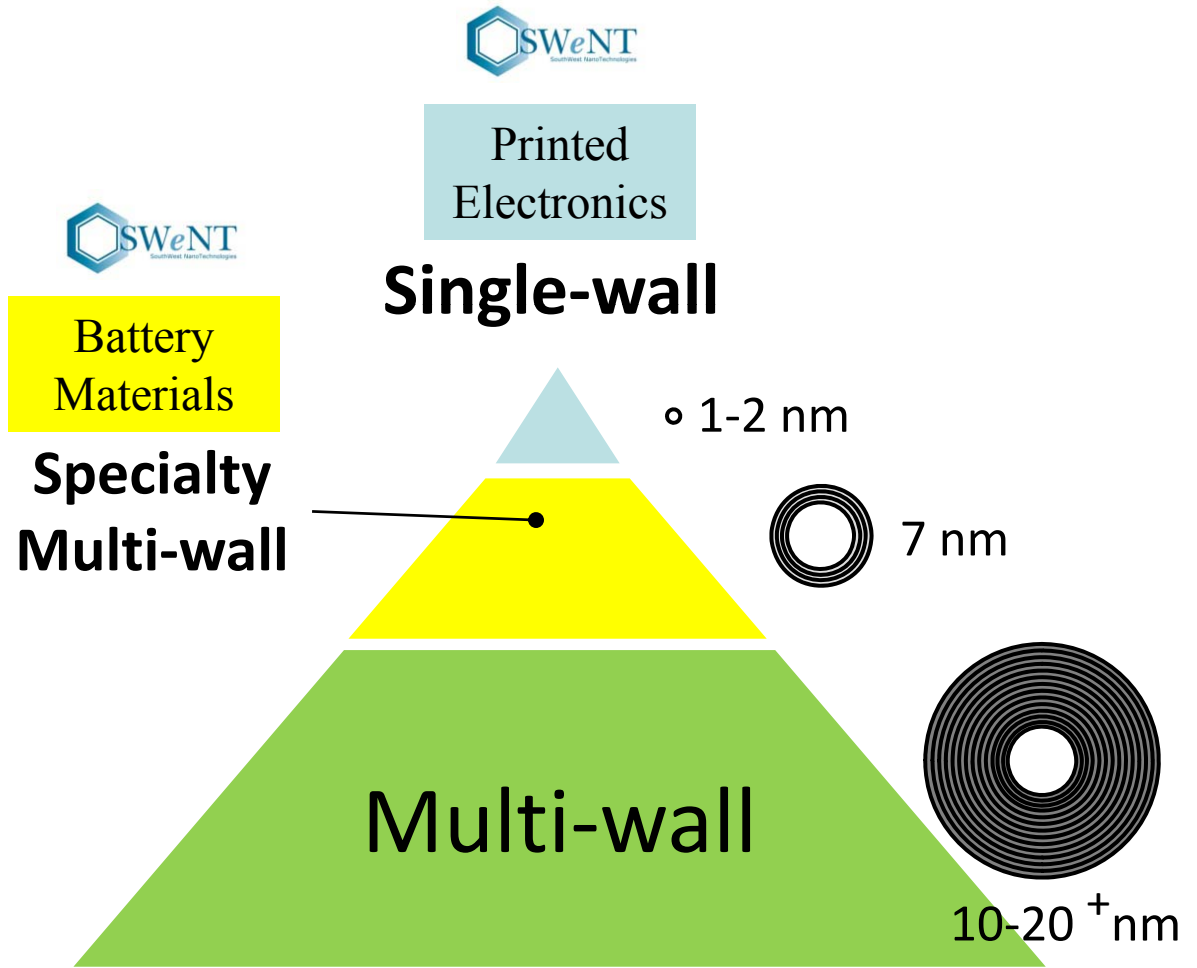
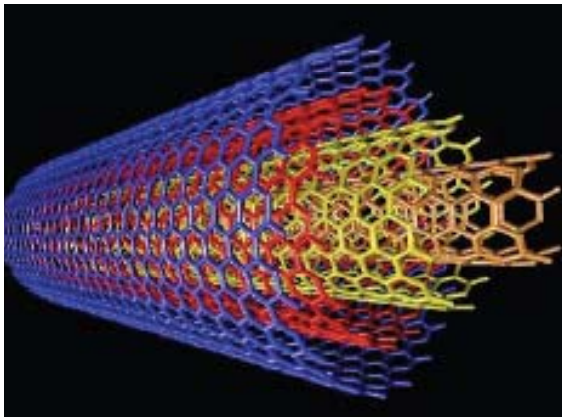
Carbon Nanotubes (CNT)



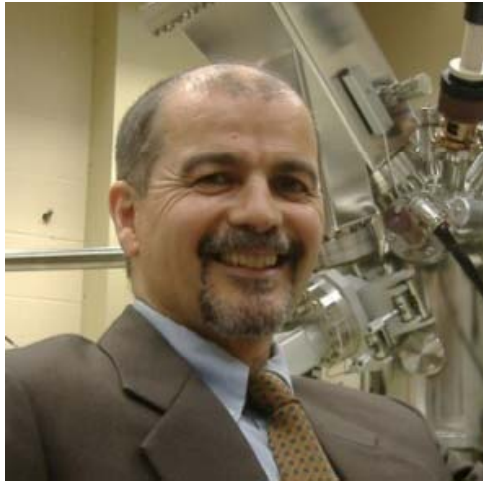
Single-wall



Multi-wall



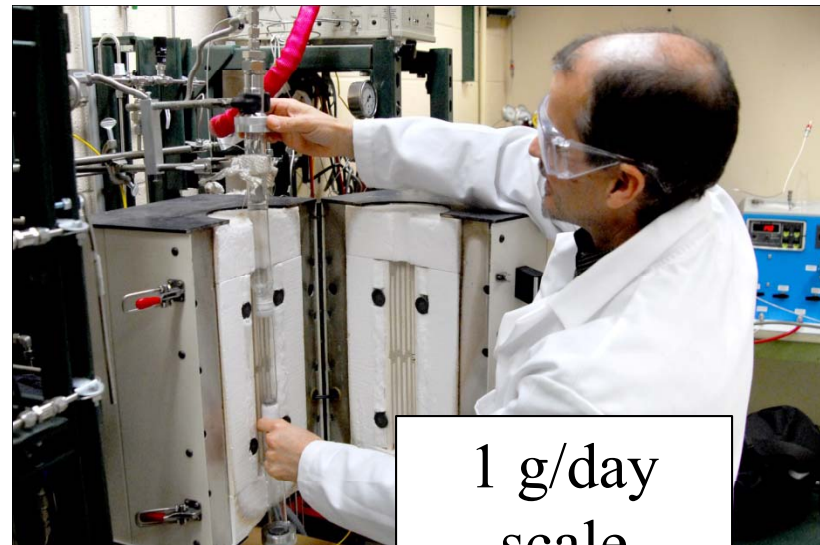
Start-up:



Founded by Prof.
Daniel Resasco in
2001

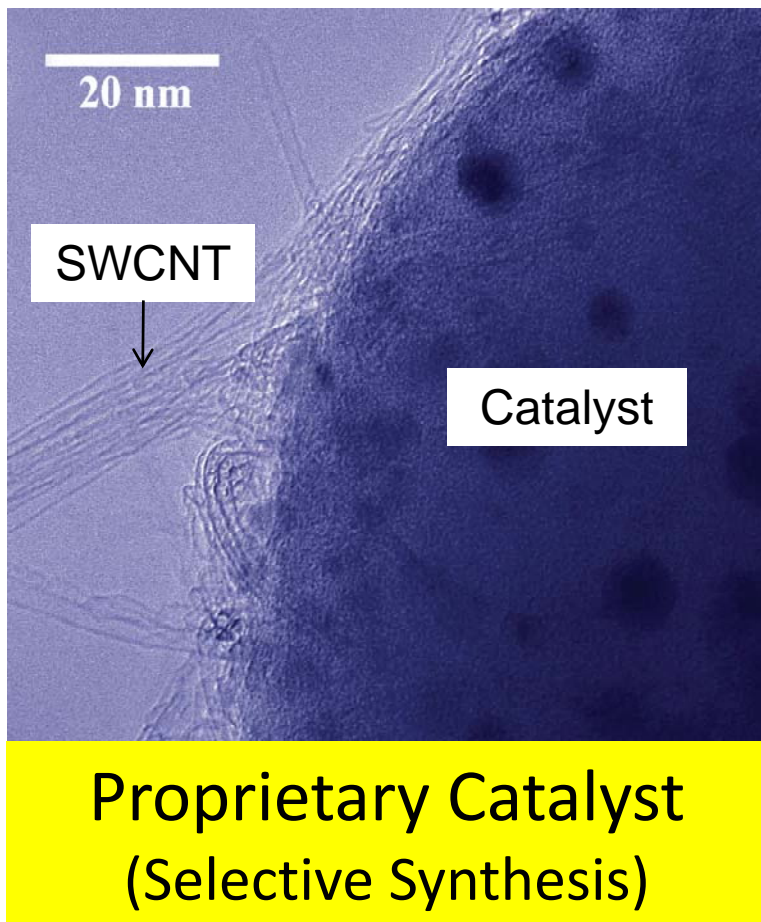


CNT Pilot Plant circa 2005

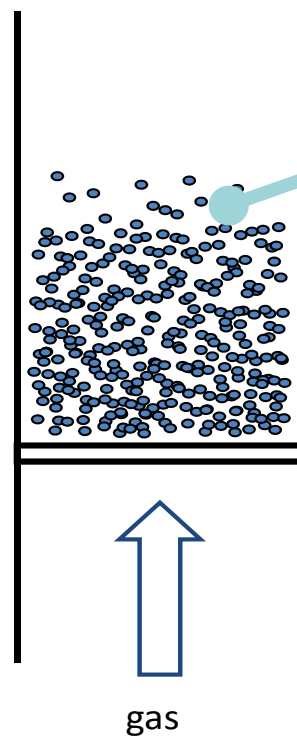


1 g/day
scale

CoMoCAT[®] process



Fluidized Bed
(Inherently Scalable)



Uniform
Heat and
Mass
Transfer

30 patents
issued

Scale-up:



New CNT Production Plant,
Fall 2008



Norman, OK

100 ~
10,000
g/day scale



Fluidized Bed Reactors

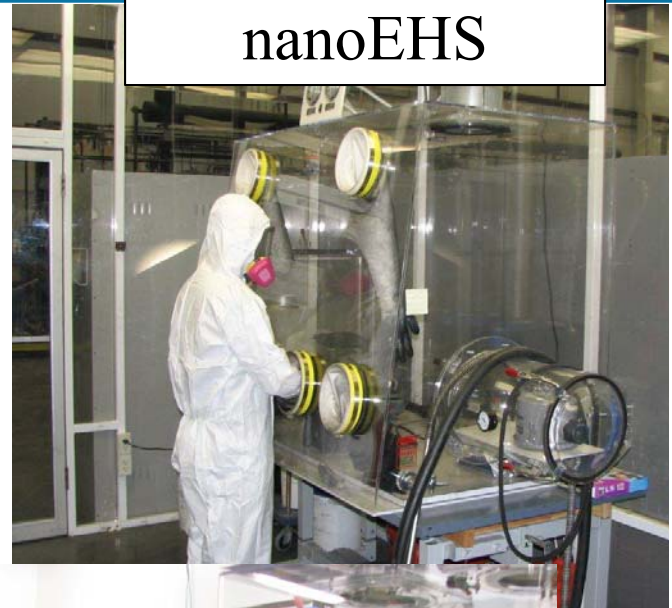
Scale-up (cont'd):



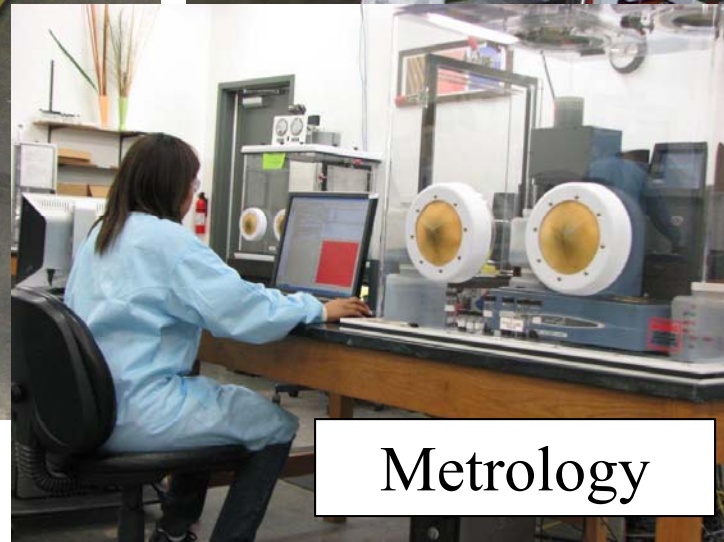
Industrial Scale Purification



nanoEHS



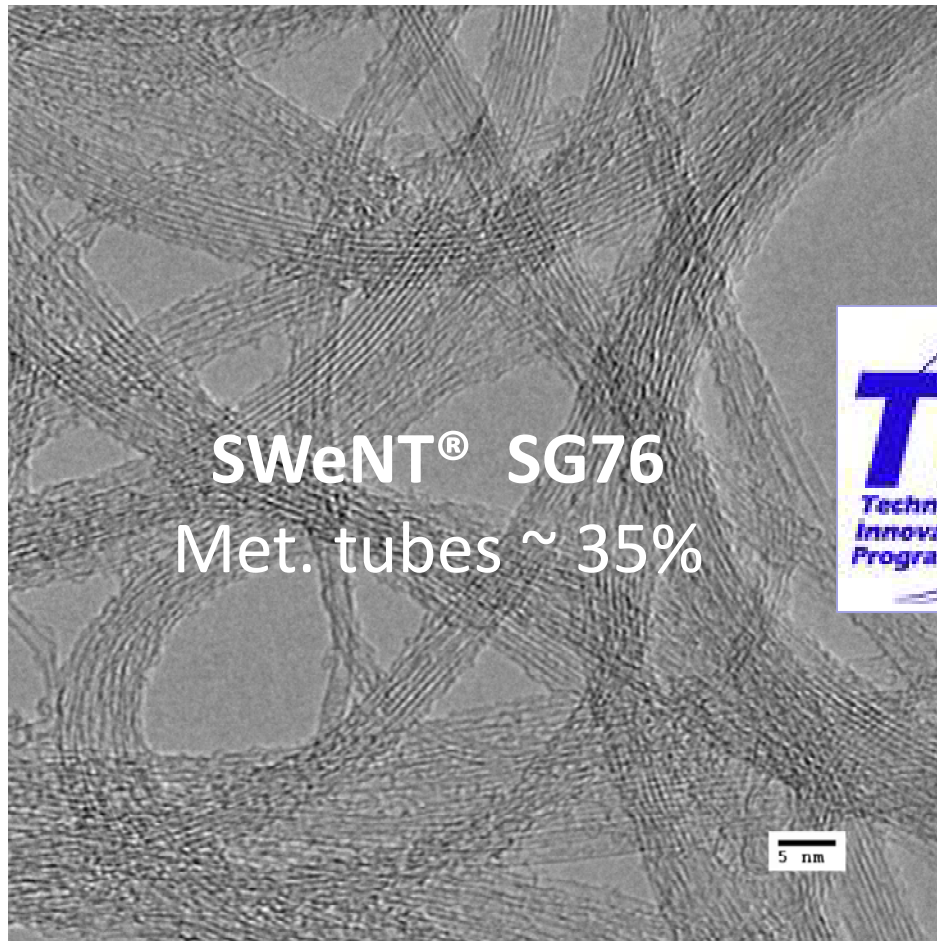
Metrology



Single-wall CNTs



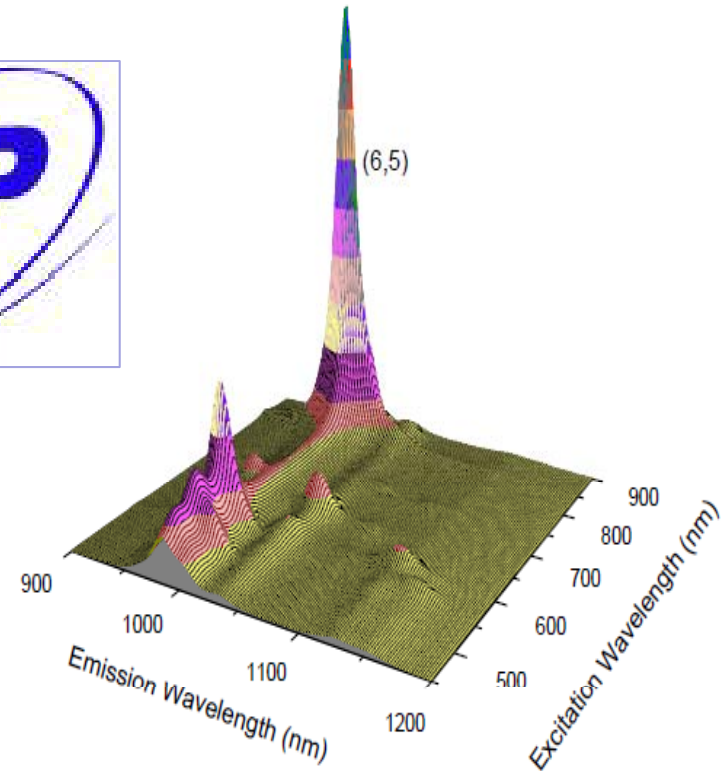
Conductive & Semiconducting Grades



SWeNT® SG76
Met. tubes ~ 35%

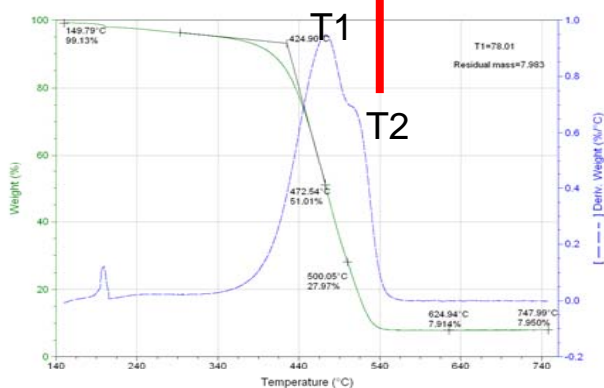
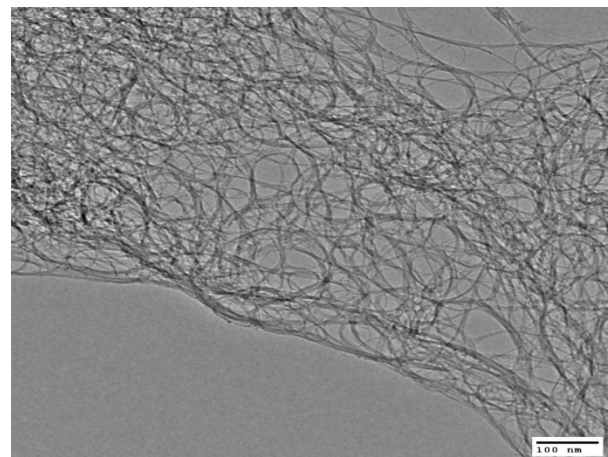
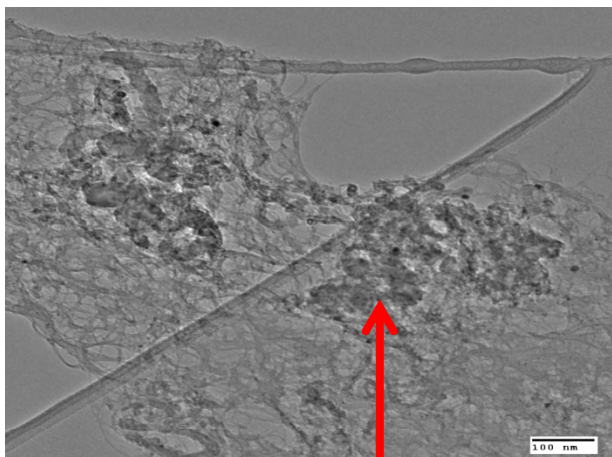


SWeNT® SG65+
Met. tubes ~ 5%

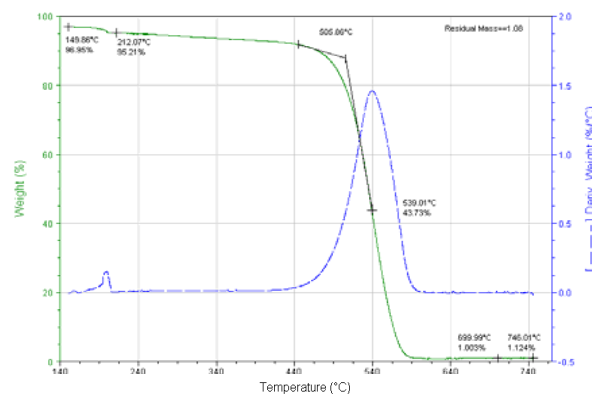


↑ Quality:

Process Improvements in Synthesis & Purification

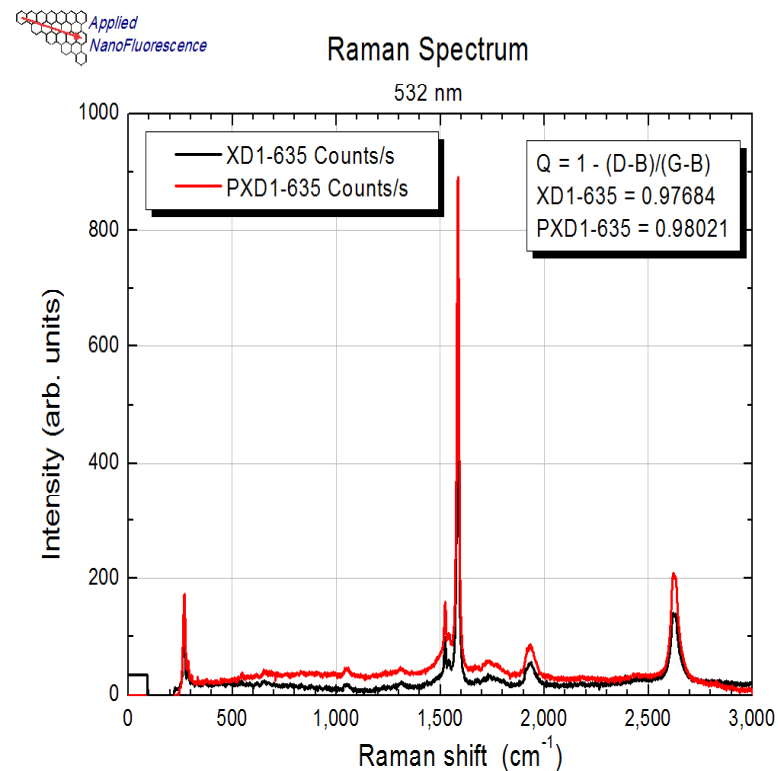
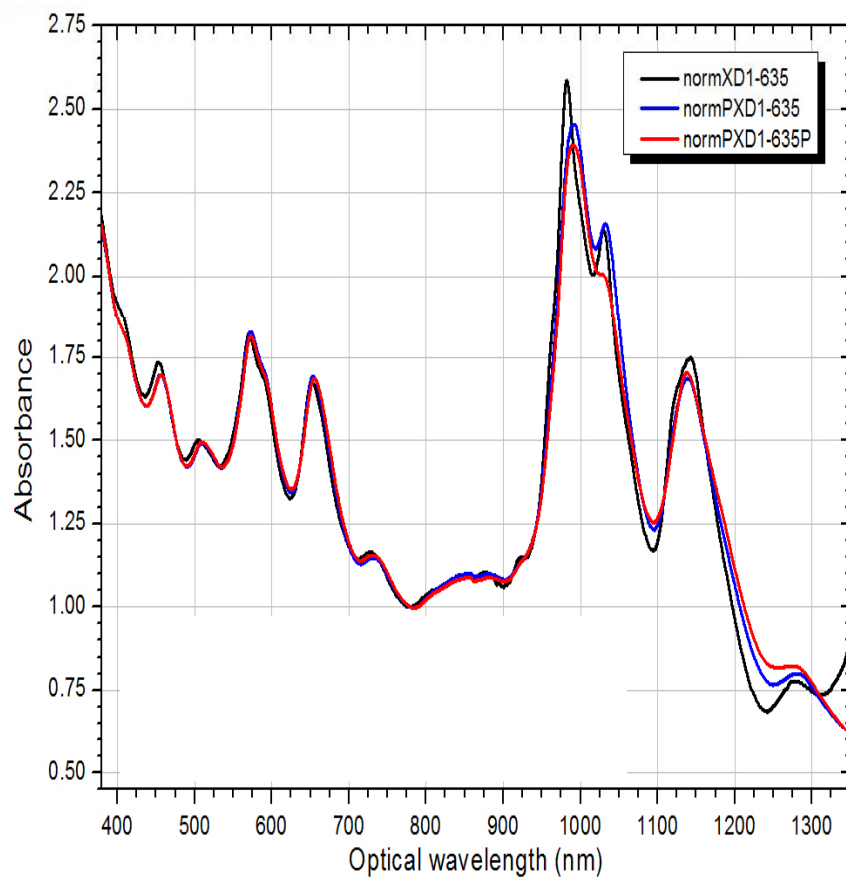


8 wt%
residue



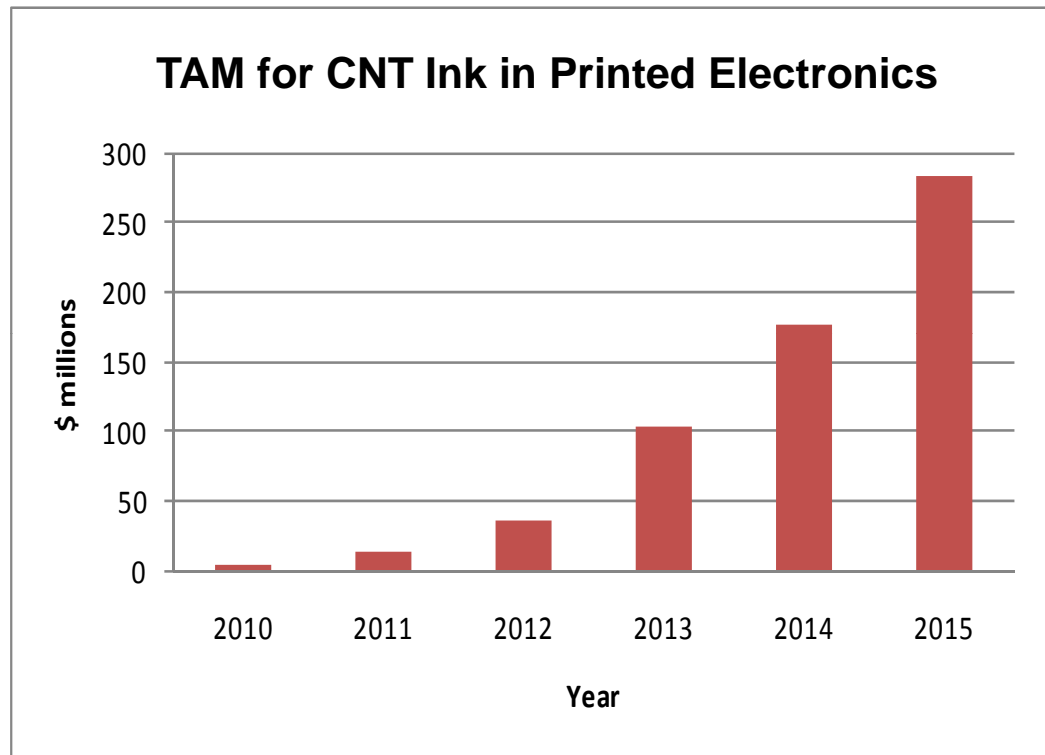
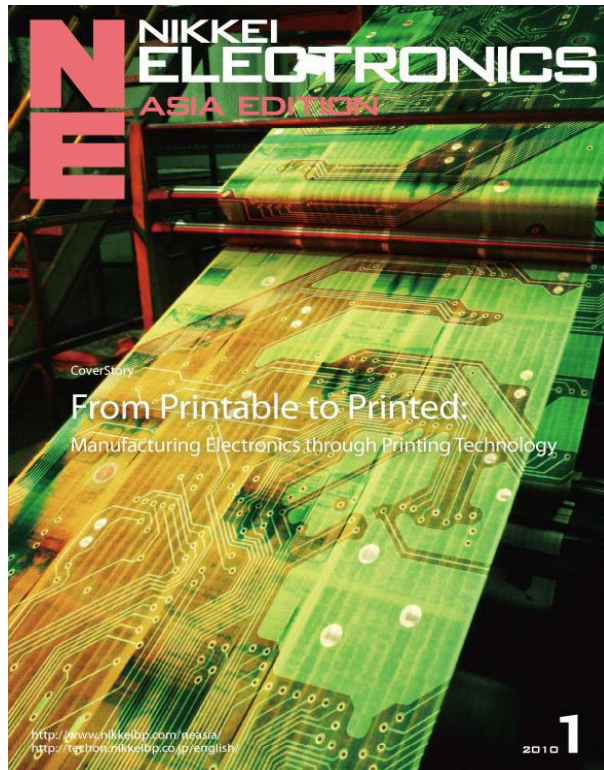
1 wt%
residue

↑ Quality (cont'd):

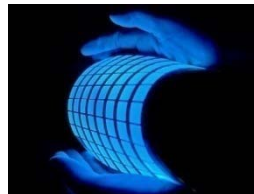


... Without evidence of tube damage.

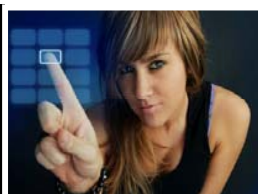
Printed Electronics



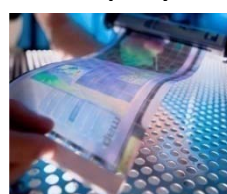
Lighting



Touch



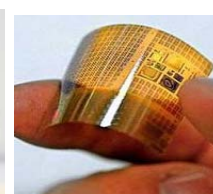
Displays



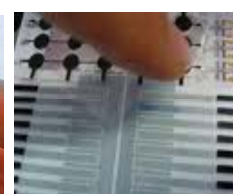
TFTs



RFID



Sensors



Where is the market going?

- ✓ Thinner, Lighter.
- ✓ Large display area.
- ✓ Flexible, Rugged.
- ✓ Touch interface.
- ✓ Lower cost.
- ✓ Short cycle time.

Glass → Plastic

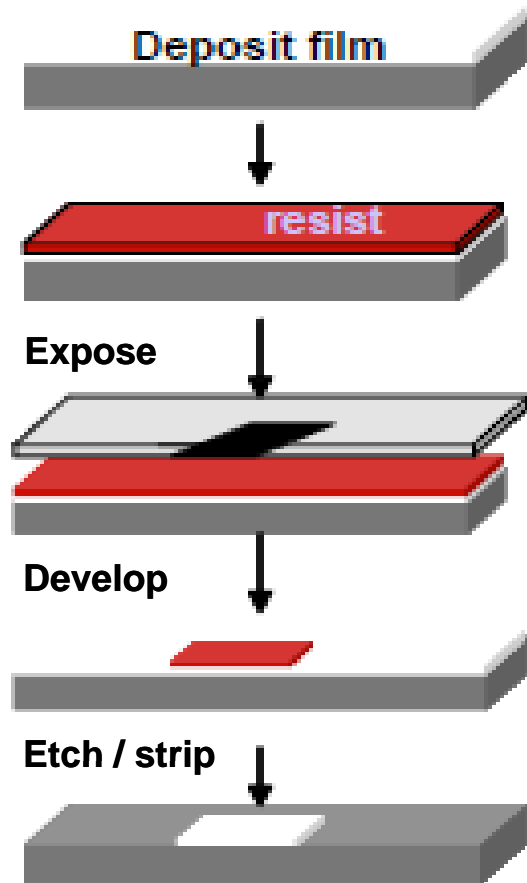
ITO, Si → Organic

Printed Electronics

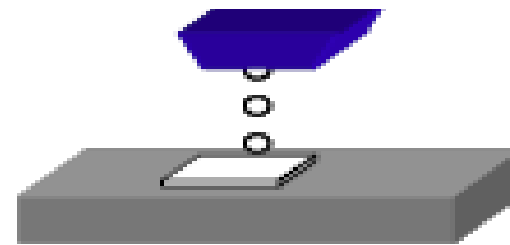
Why print electronics?



Subtractive Process (Photolithography)

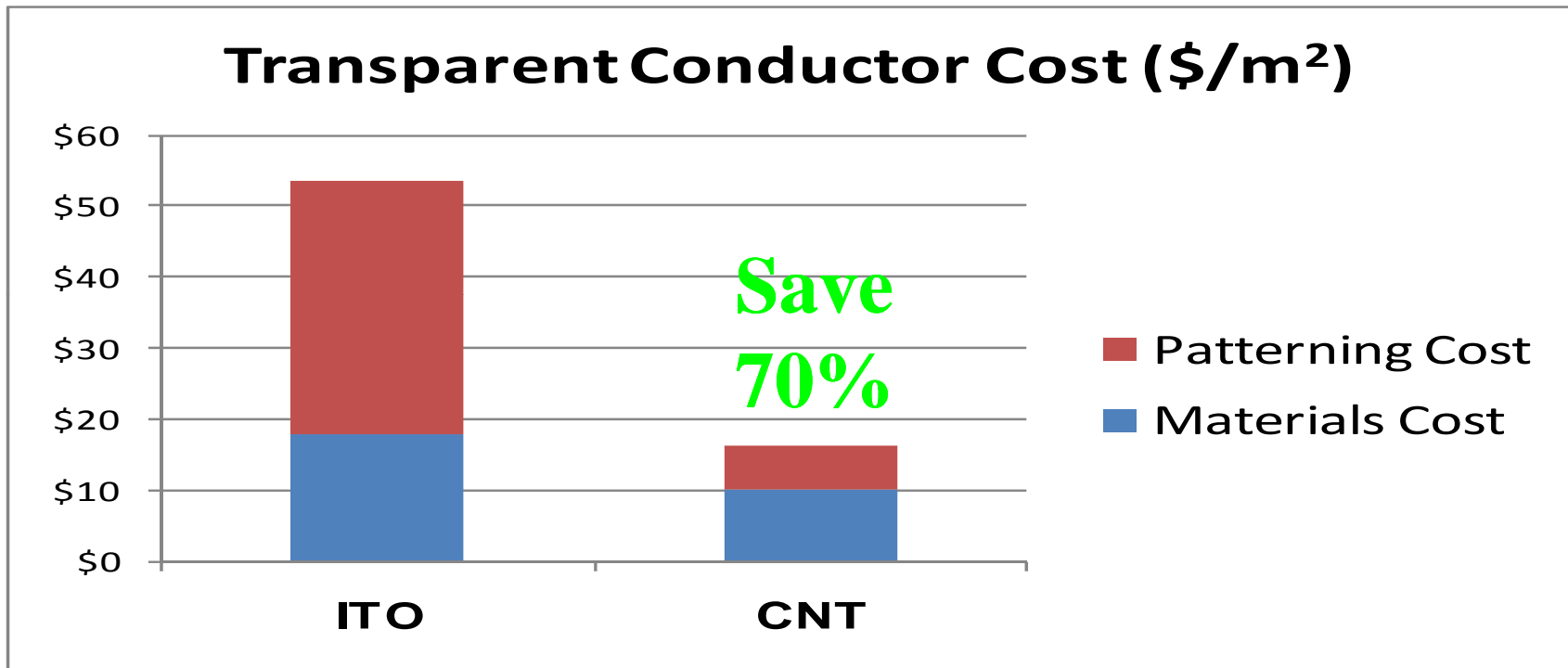


Additive Process (Printing)



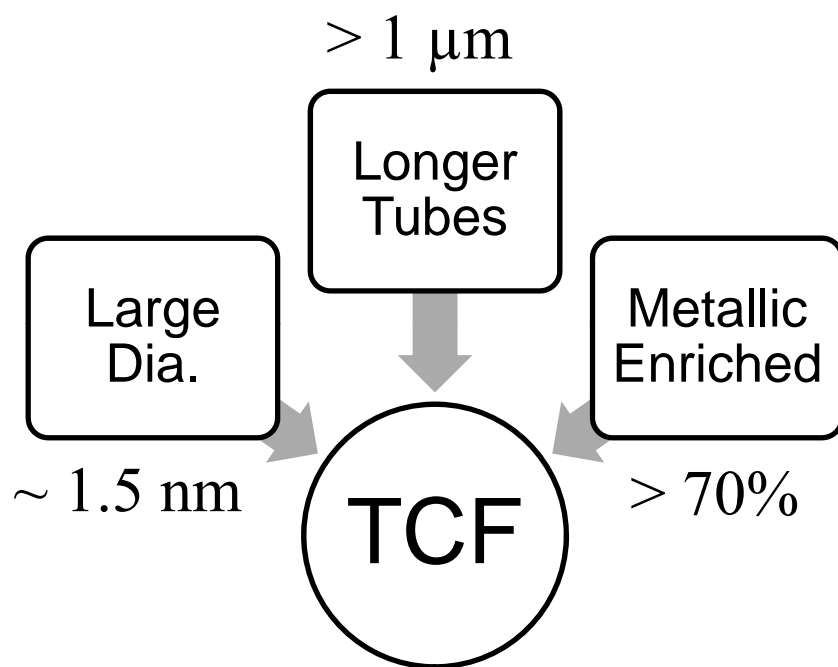
- ✓ Less steps.
- ✓ Less waste.
- ✓ Lower cost.
- ✓ Short cycle time.

Lower Cost Transparent Conductors:

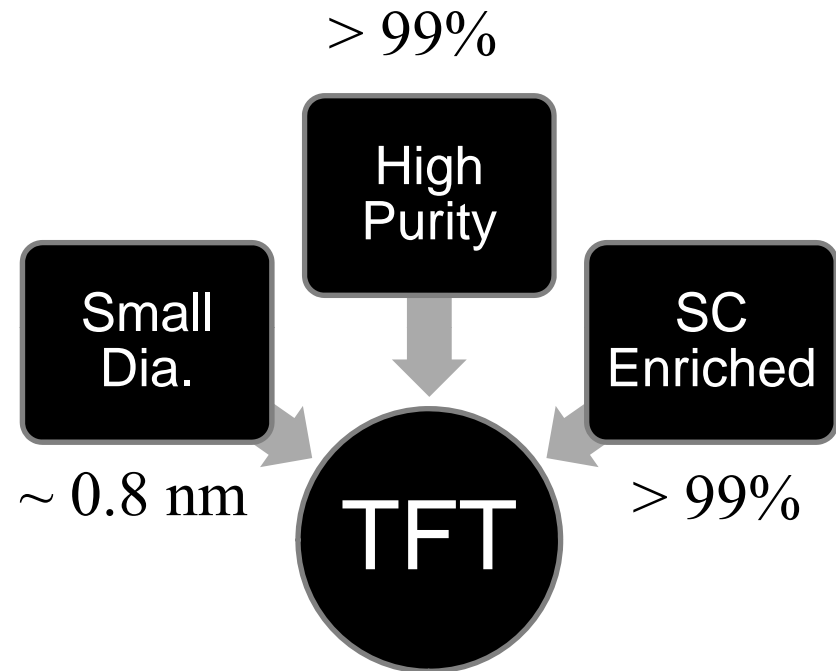


Big incentive to switch to CNT for Touch sensors:
Cost can be reduced by at least 10%. Cycle time can be reduced from 1 week to 1 day.

Performance:

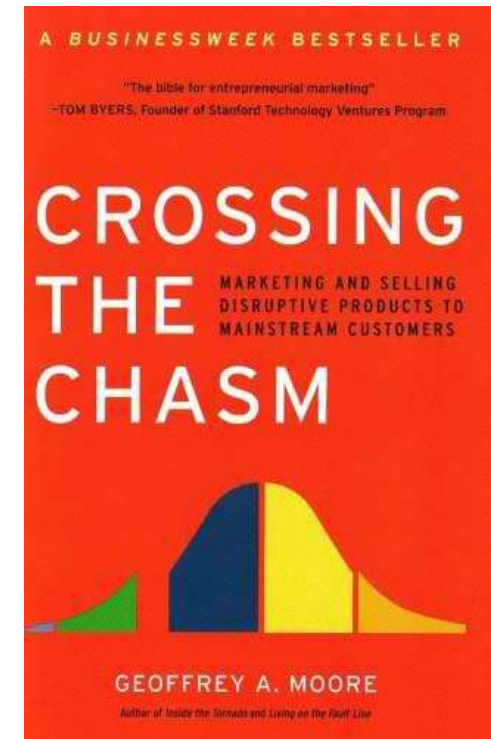
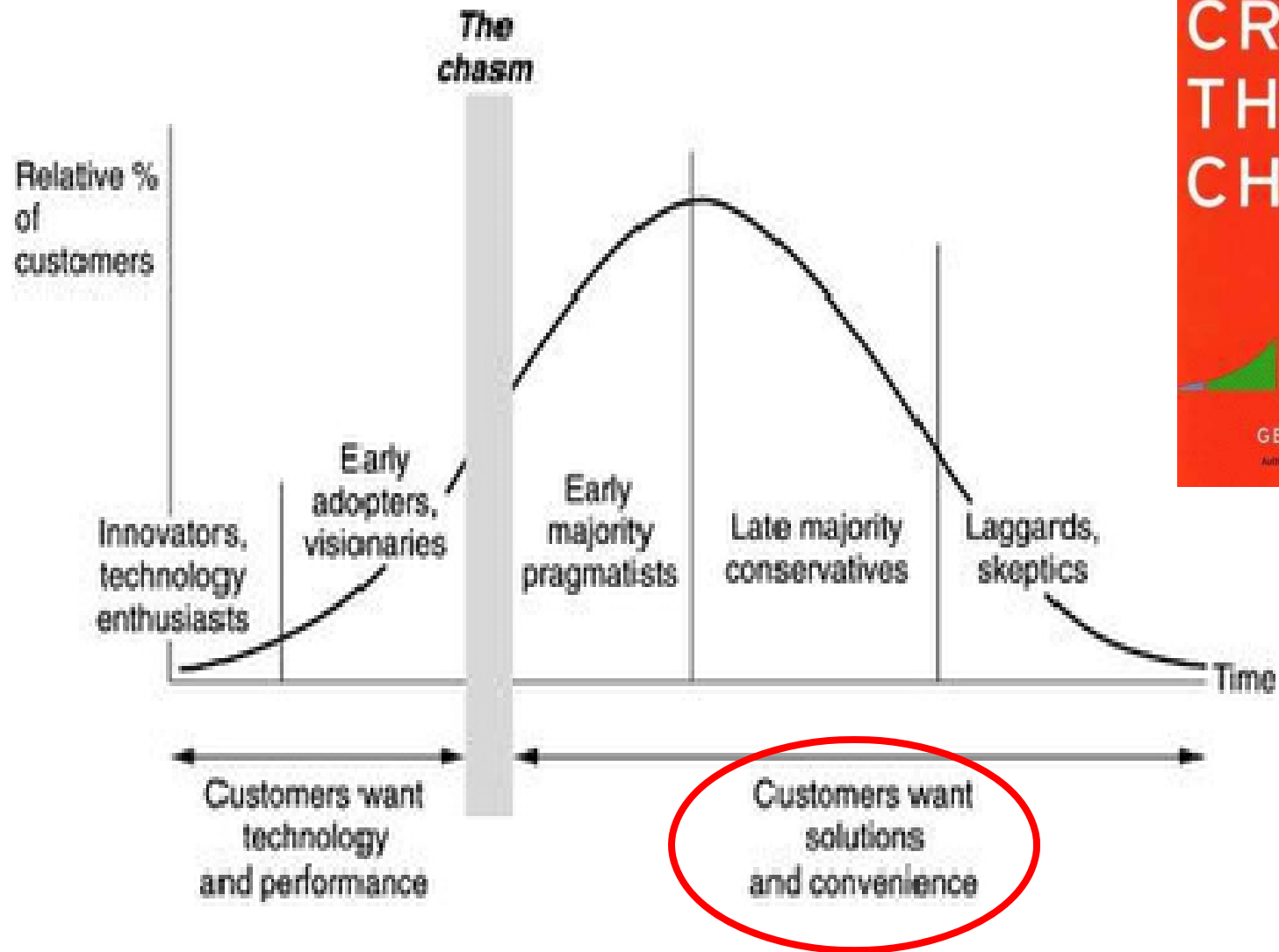


< 100 Ω/sq
> 90% VLT

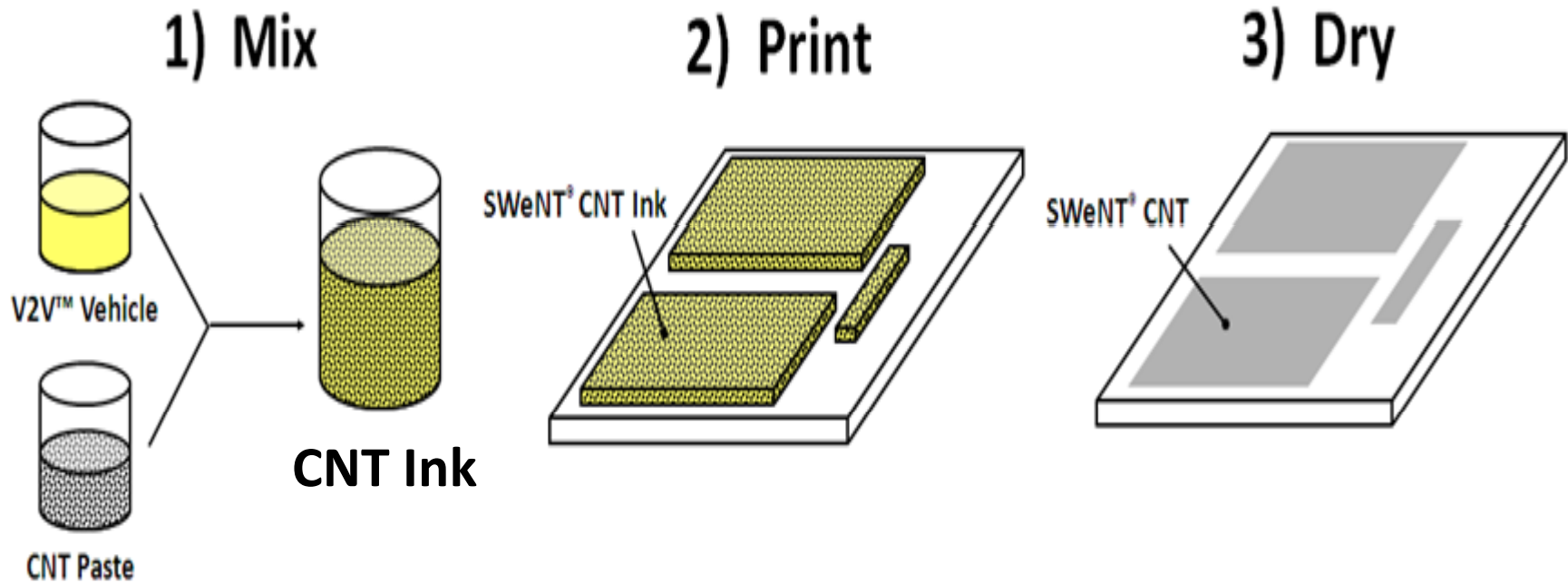


Mobility > 10 $\text{cm}^2 \text{V}^{-1} \text{s}^{-1}$
On/Off > 10^5

Commercialization



V2V™ Ink Technology*



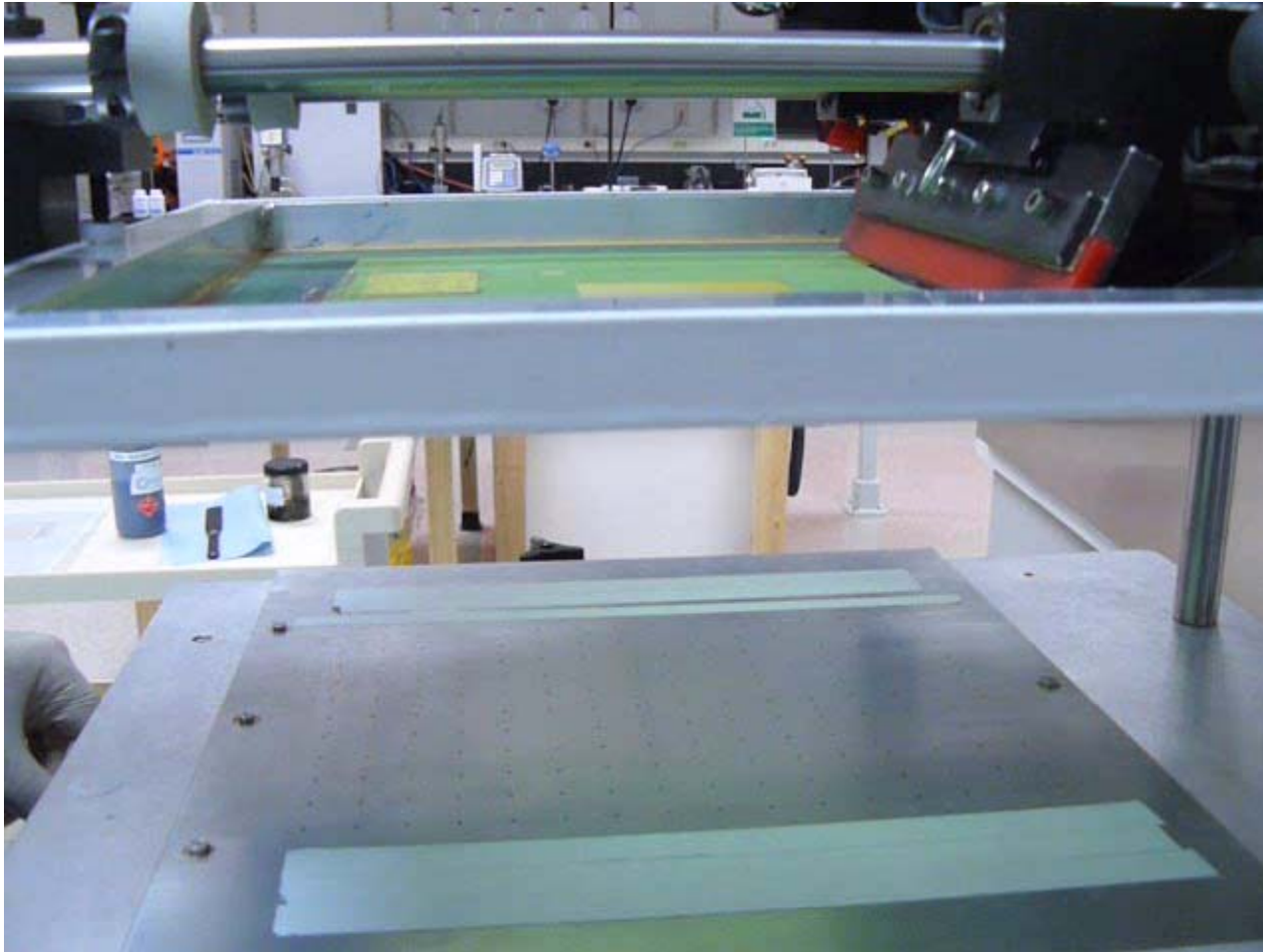
CNTs can be printed using Standard Industrial Printing Equipment

* Patents pending

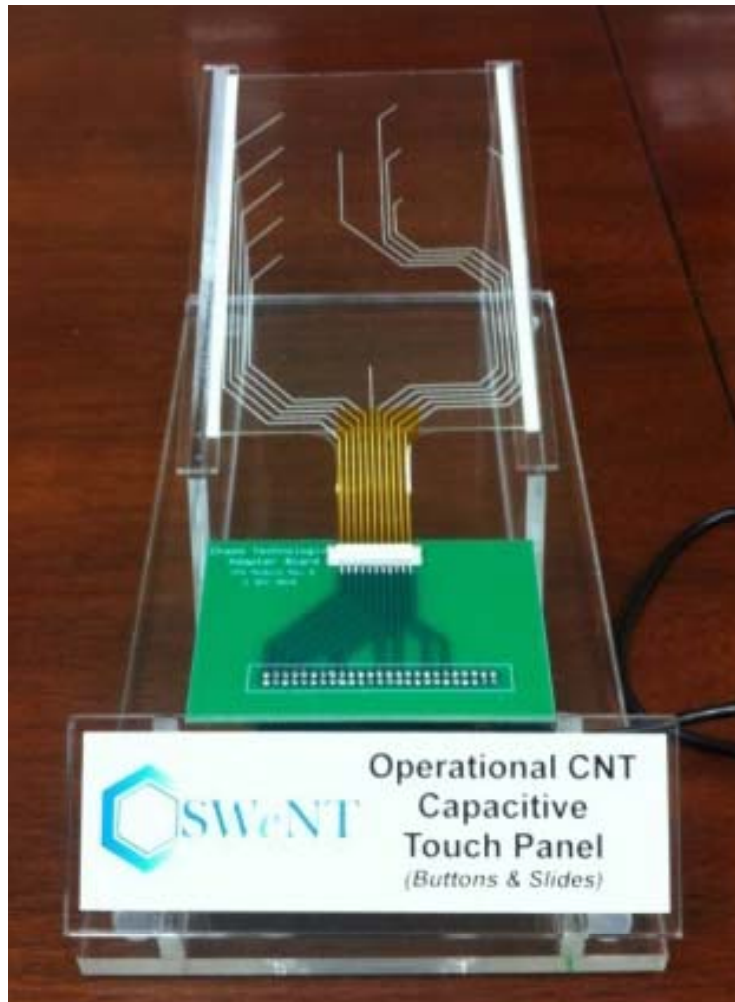


Screen Printing Demo

(using V2V™ ink)



Apps Dev is Key!



Applications Development Center



Canton, MA

What are the Barriers?



- Performance
 - Metrology
 - Quality Improvement
- Easy & Safe to Use
 - Inks
 - nanoEHS
- Supply Chain
 - Apps Dev
 - Strategic Alliances (Global)



Thank you



Q&A