



CANATU

ENERGY, ELECTRONICS AND BEYOND

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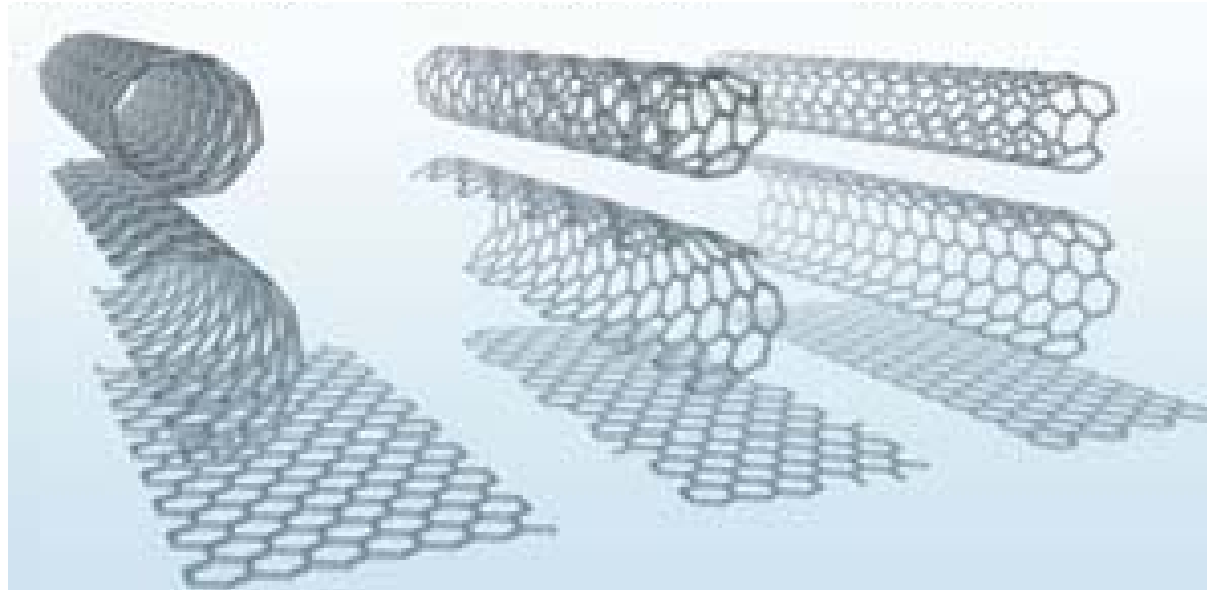
www.canatu.com

Carbon Nanotube Basics

"zig-zag"
(semiconducting)

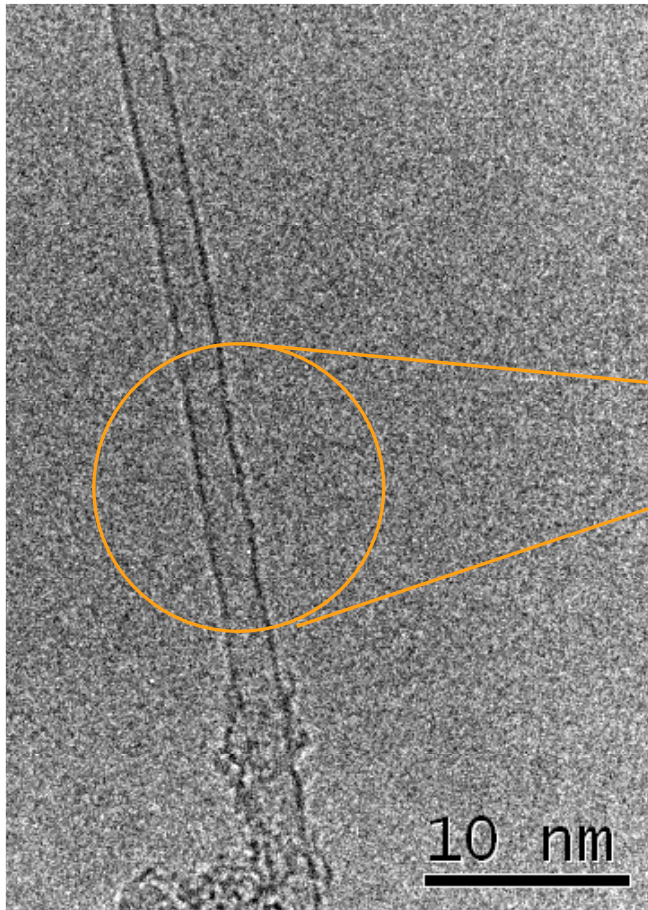
"chiral"
(semiconducting)

"armchair"
(metallic)

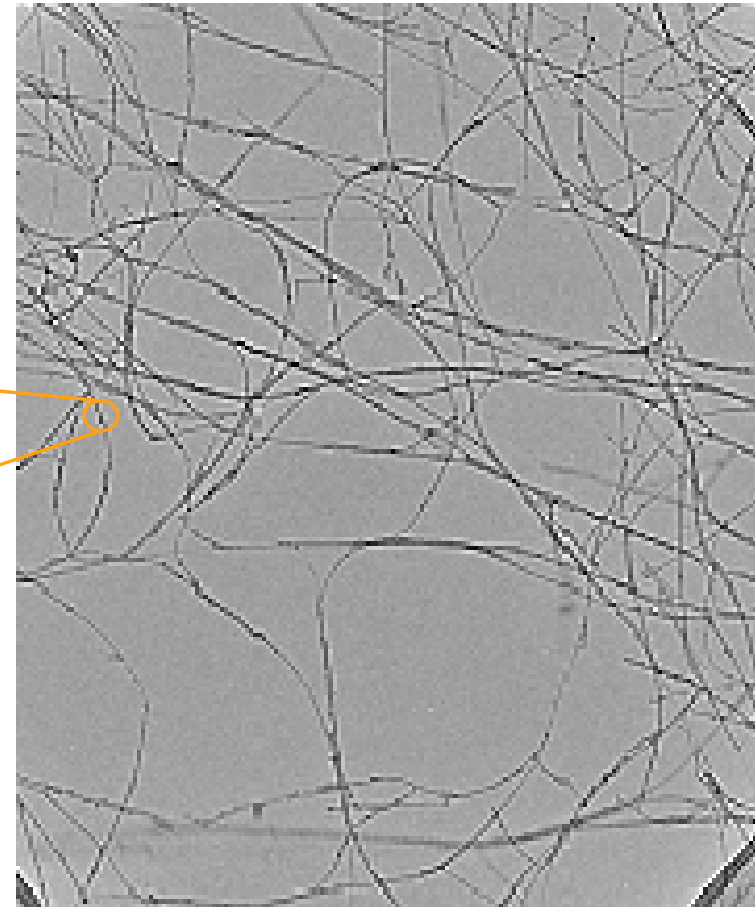


25 times stronger than steel
Half as dense as aluminum
1000 times more conductive than copper
Conducts heat twice as well as diamond
Thermally stable up to 1500 C
Better semiconductor than silicon

Carbon Nanotubes (CNTs) in Fact: Canatu Carbon Nanotubes

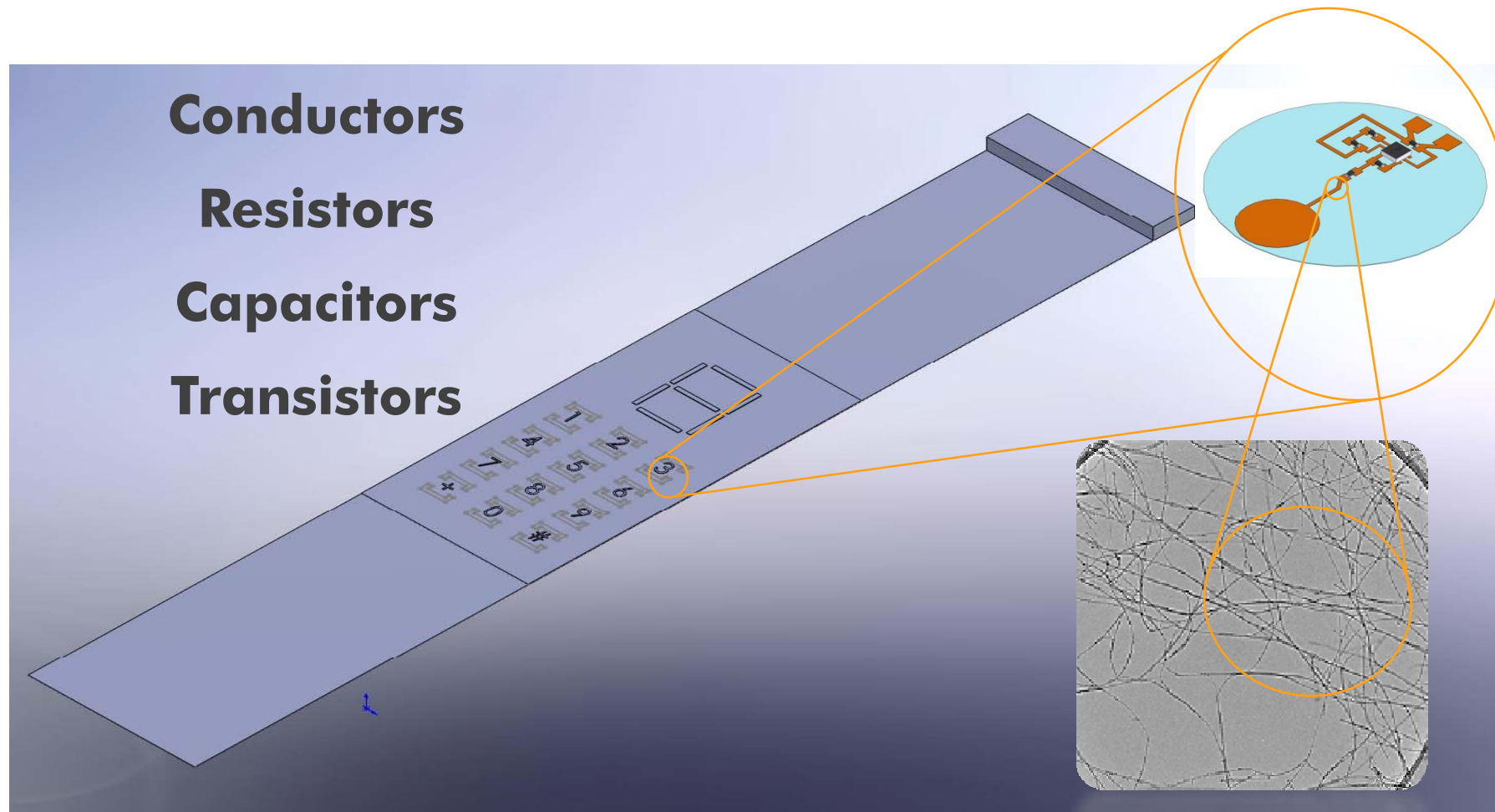


Single Tube



Network of Tubes

Example 1: Flexible/Transparent User Interface



Example 2: Flexible Solar Cells, Displays and Touch Screens

Solar Cell

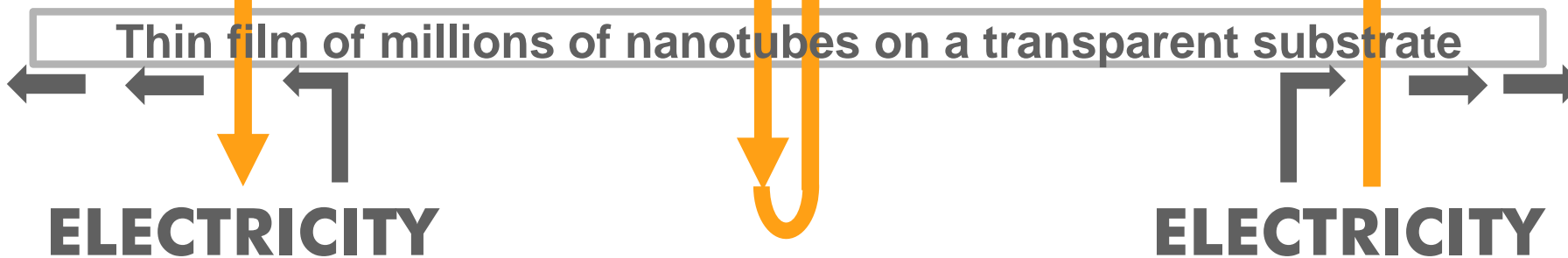
LIGHT

E-Paper, TouchScreen, Haptic

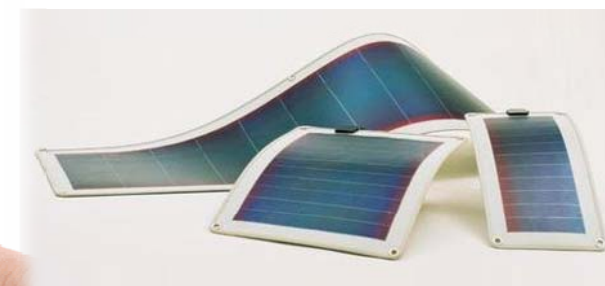
LIGHT

Display

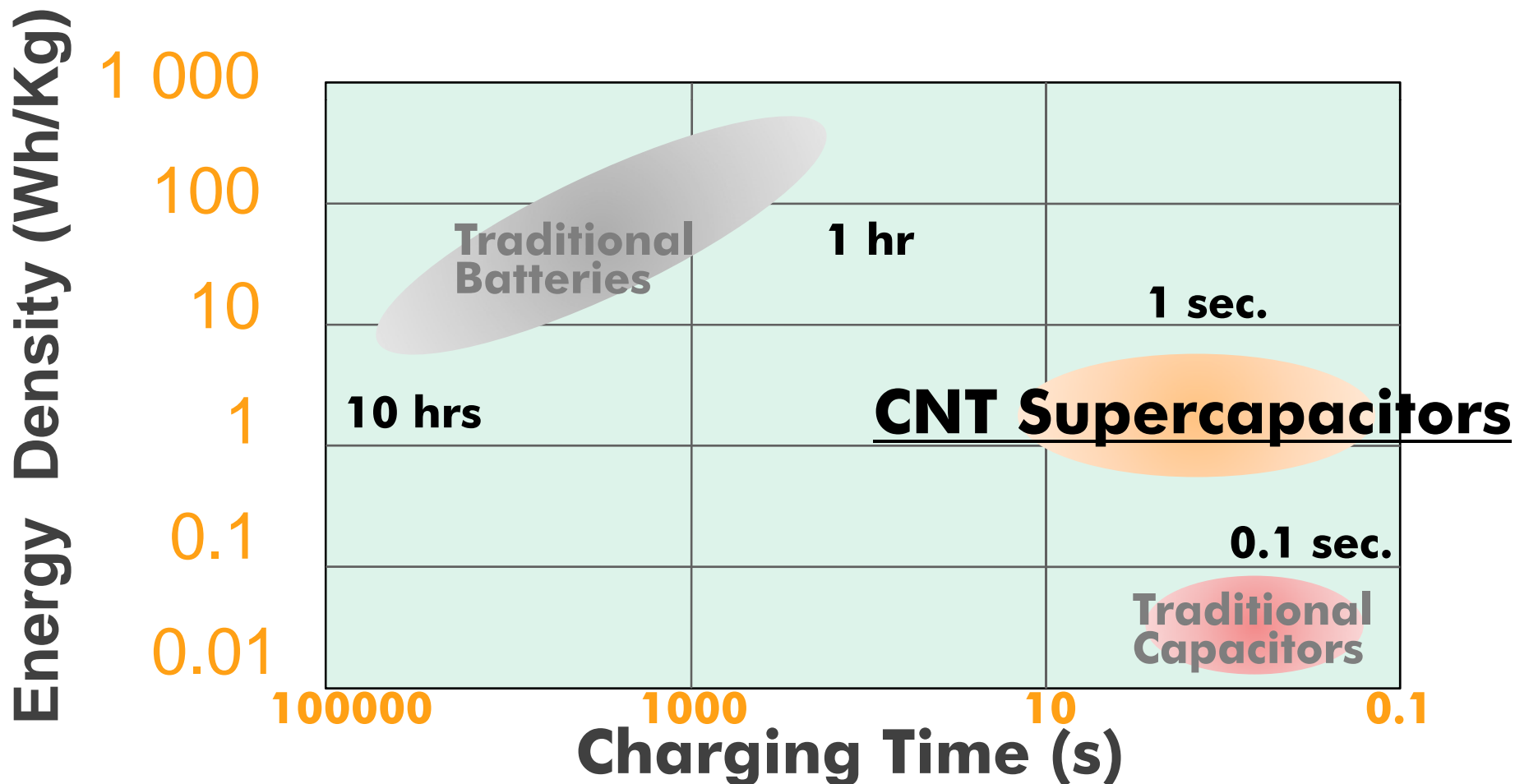
LIGHT



CONDUCTIVE, TRANSPARENT, FLEXIBLE, ROBUST, CHEAP



Example 3: Carbon Nanotube Supercapacitors



CONDUCTIVE, nm PORE SIZE, HIGH SURFACE AREA



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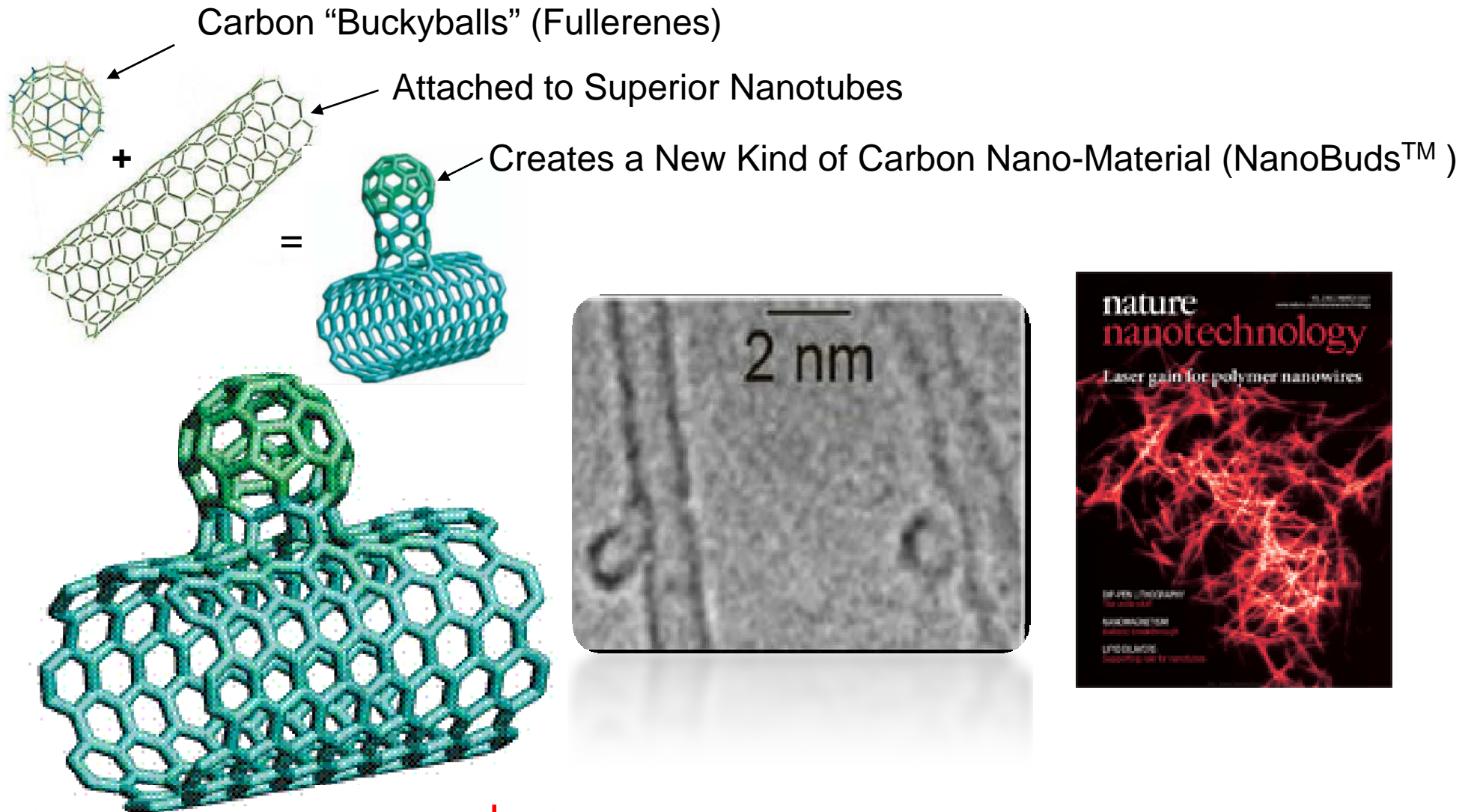
Canatu's Key Innovations

New Materials

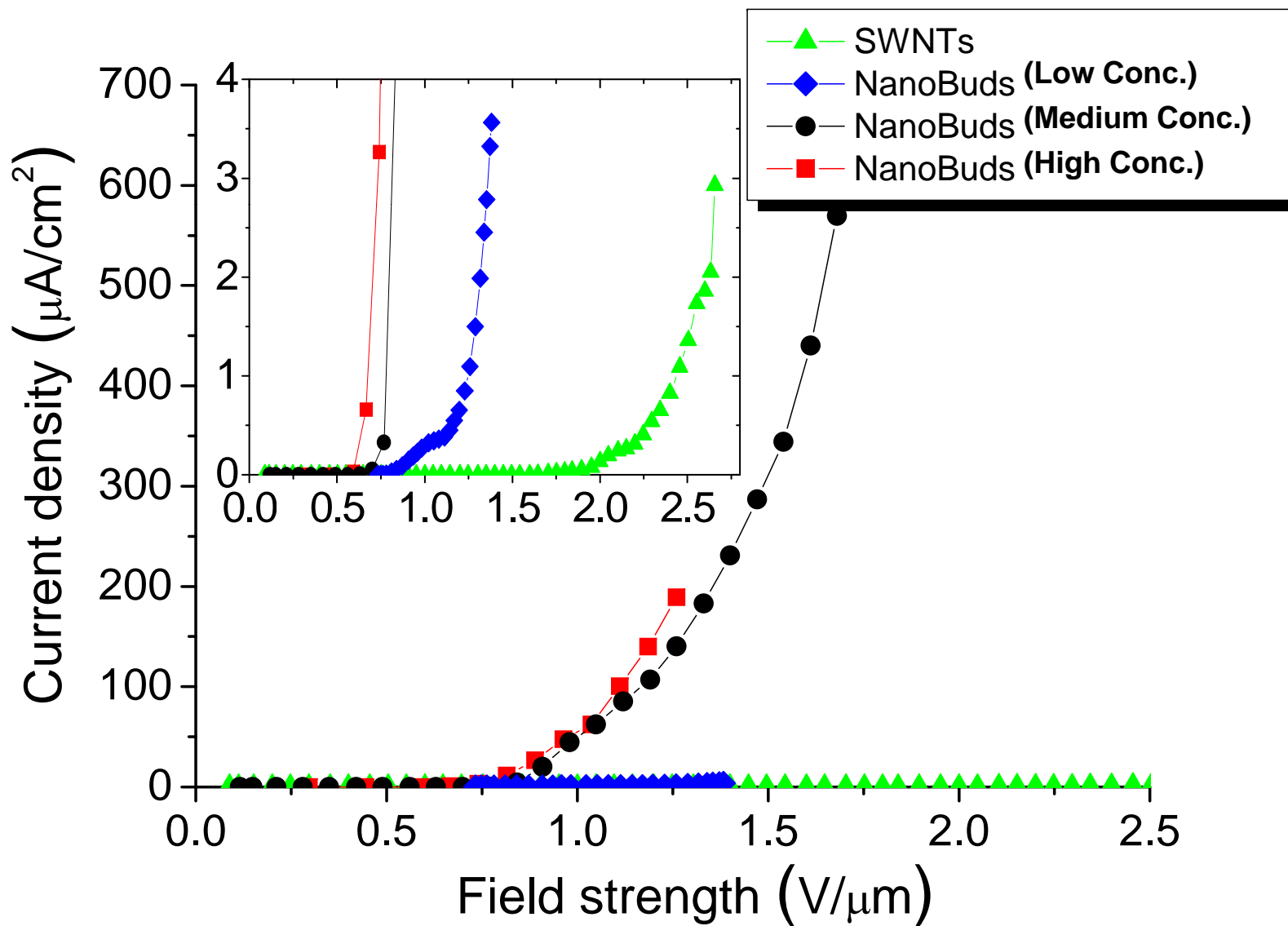
New Material Synthesis Processes

New Device Production Processes

Canatu Invented the Unique Carbon NanoBud™ *

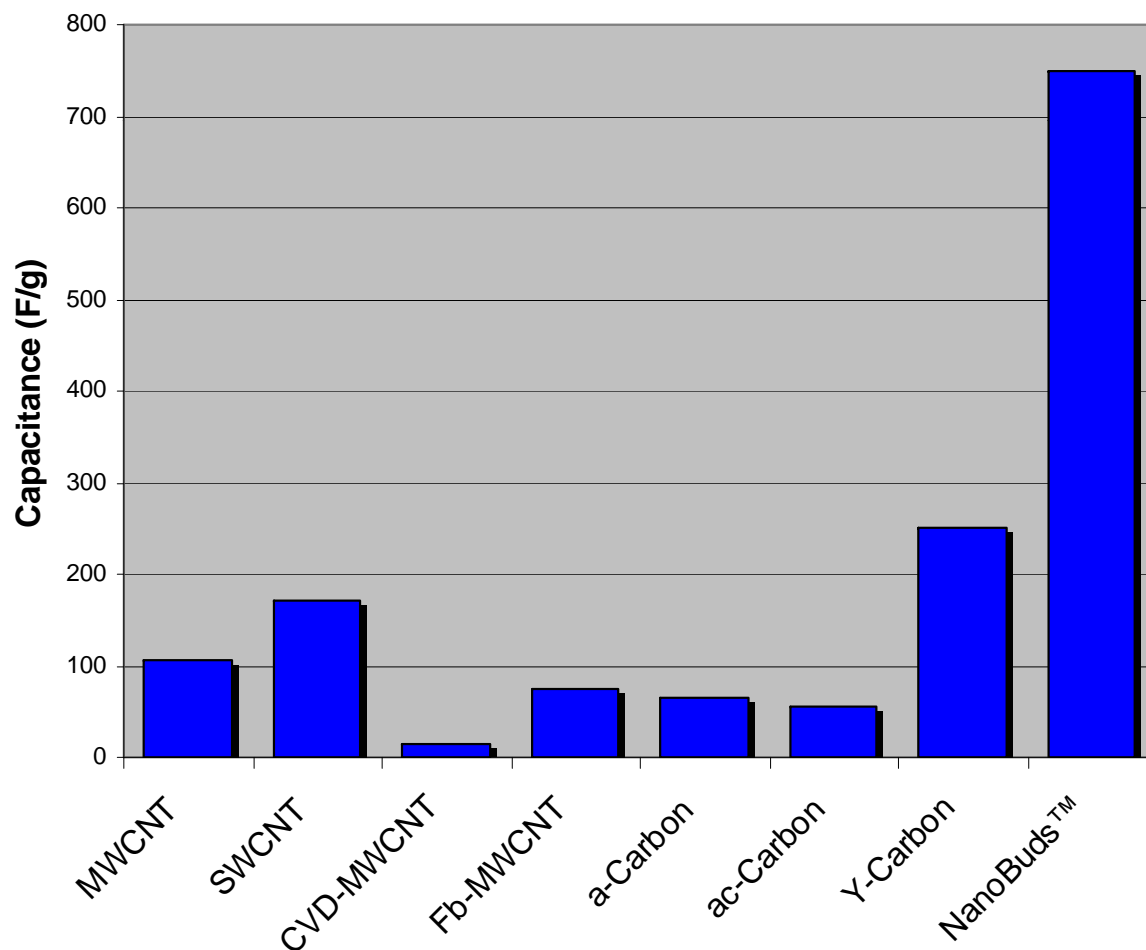


Canatu has the world's best field emitter



A.G. Nasibulin, S. D. Shandakov, H. Jiang, D. P. Brown et .al. E.I. Kauppinen (2007)
Nature Nanotechnology. [2\(3\), 156-161](#) (+[Supplementary Information](#))

Canatu has the world's best super capacitor



Note: Preliminary unpublished data

Abbreviation used:

MWNT: Multi-Wall Nanotubes

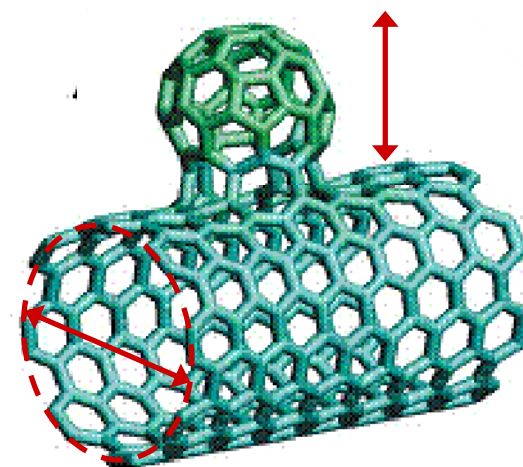
CVD-MWNT: Chemical Vapor Deposited Multi-Wall Nanotubes

Fb-MWNT: Fluidized bed Multi-Wall Nanotubes

SWNT: Single-Wall Nanotubes

a-Carbon: Activated carbon

a-C Cloth: Activated Carbon fiber composites



Example 4: Low Cost, Flexible Solar Cells*



* Patents Pending



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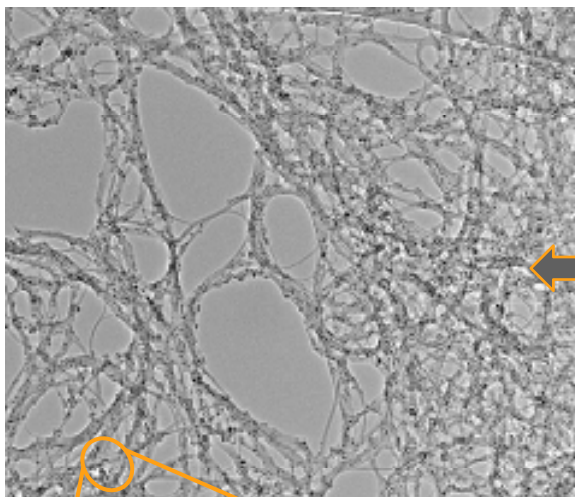
Canatu's Key Innovations 2

New Material Synthesis Processes

Canatu directly produces pure/ready-to-use tubes:

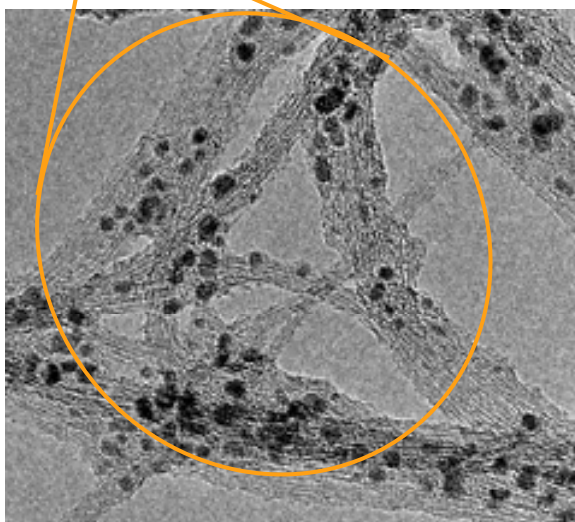
Eliminates traditional expensive purification and processing

Overview

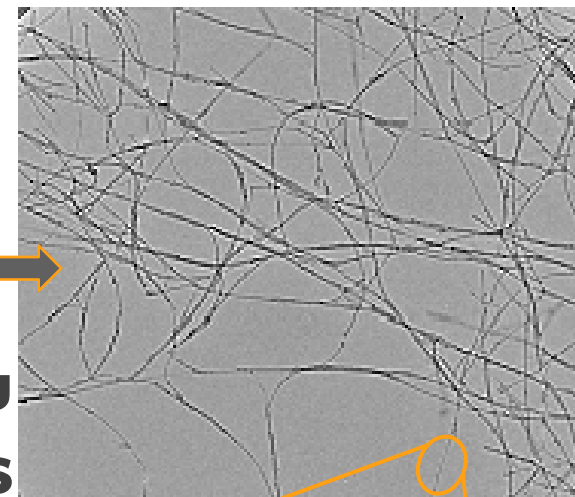


**Competitor
Nanotubes**

- Bundled
- Dirty
- As powder
- Low quality

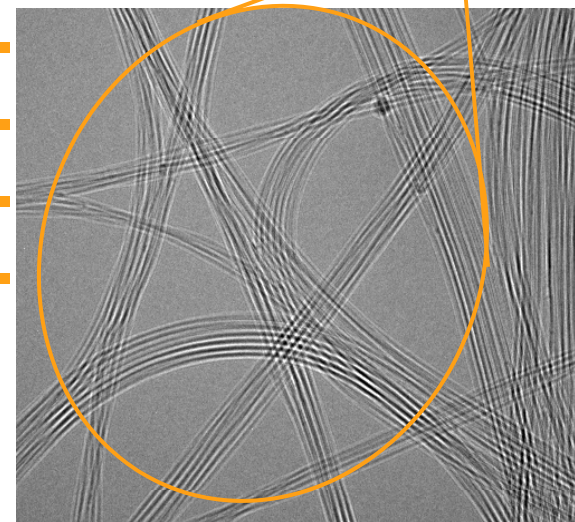


Close-up



**Canatu
Nanotubes**

- Unbundled-
- Clean-
- As Film-
- High quality-





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Canatu's Key Innovations

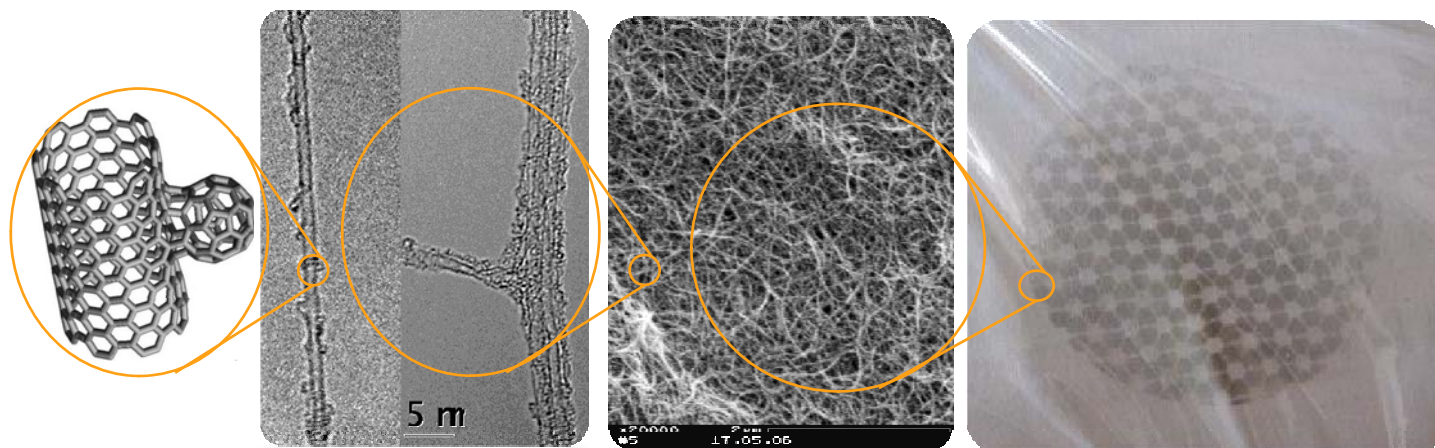
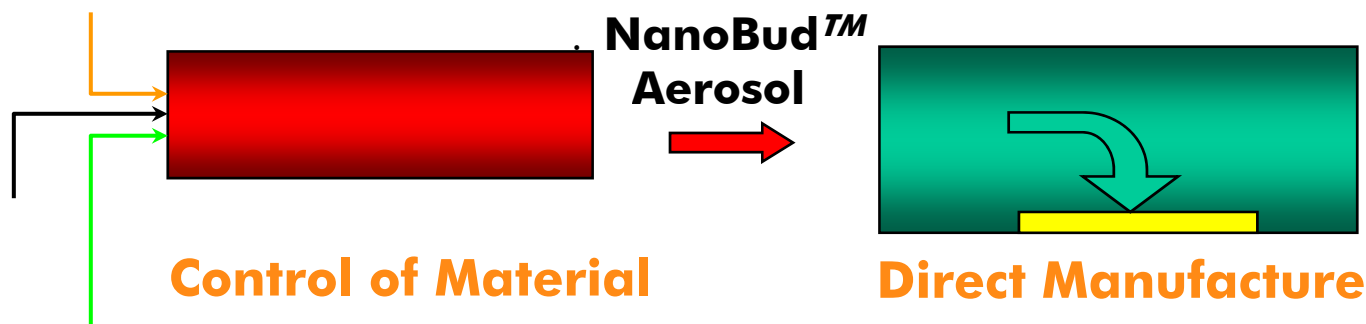
3

New Device Production Processes

Unique Integrated Component Manufacturing = low cost and high quality

Synthesis Process

Deposition Process



NanoBuds™
Angstrom Scale

Tube Bundle
Nano Scale

Deposit
Micron Scale

Patterned Flexible Film
Centimeter Scale

Prof. Morinobu Endo (Shinsu University, Japan)

World's leader in the Carbon Nanotube field & Nobel Prize candidate, says about Canatu...

March 2007: "This novel nano-carbon (NanoBuds™) will attract lots of attention due to its novel electronic properties as well as potential in various applications"

March 2006: "Canatu Inc. has the best process to produce Carbon Nanotubes"





CANATU

Value Proposition

ITO replacement in solar cells, displays and touch screens

Canatu Value Proposition: ITO Replacement

- **Lower Cost**
 - Cheaper raw materials
 - Cheaper production
 - Easier to pattern
- **Higher Quality**
 - Better conductivity
 - Higher transparency and neutral color
 - Higher flexibility and robustness
 - Better chemical/thermal stability
 - More customer specific
- **And ...**



Environmental impact: traditional technology

Example: ITO in Displays and Solar Cells

Raw Material

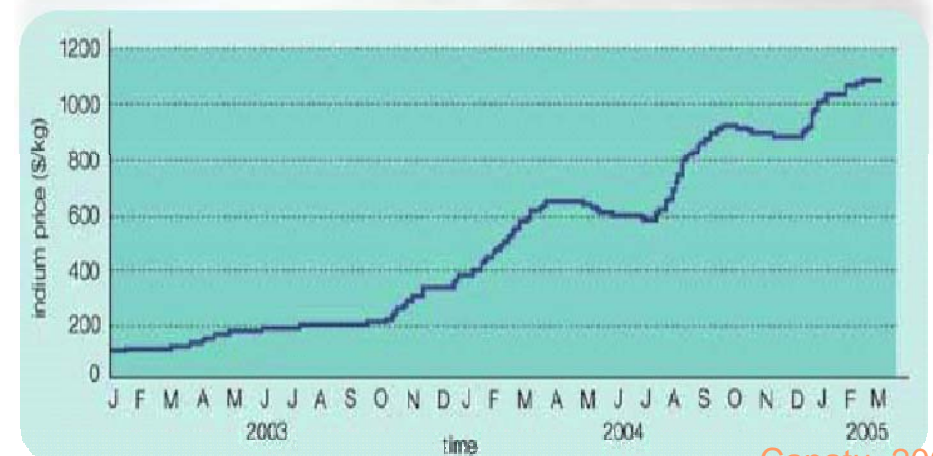
- **Indium (zinc mining byproduct)**
- **Rising demand**
- **Limited resource (China)**

Industrial Process

- **High energy**
- **85% of ITO wasted**

Recycling Process

- **Hazardous**
- **Expensive**



Environmental impact of Canatu Carbon Components



Raw Materials

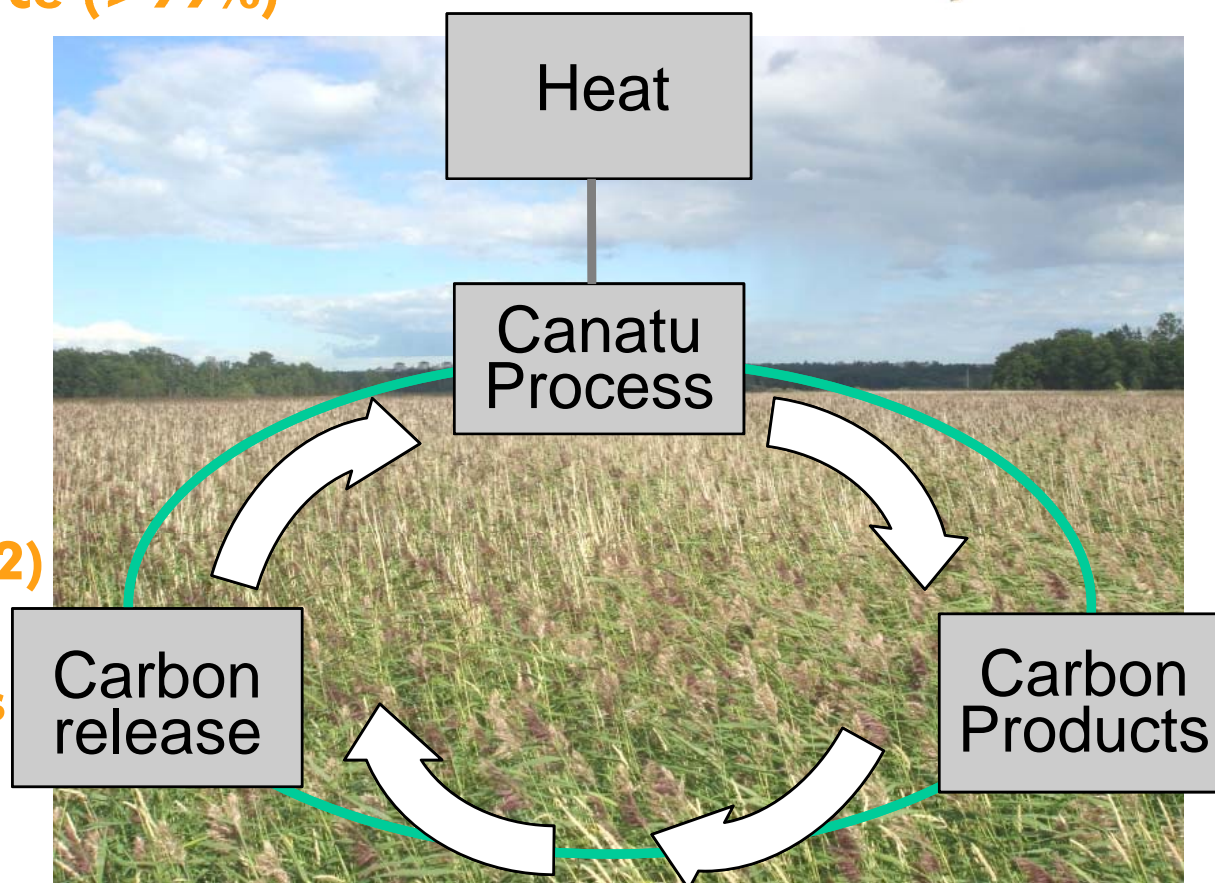
- **Common Carbon source (>99%)**
- **Metal catalyst (<1%).**

Industrial Process

- **Clean**
- **Low energy**

Recycling Process

- **Simple (Heating in O₂)**
- **Waste is a carbon source for new products**





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Status

Canatu is now scaling key processes

Nanotube and NanoBud™ production reactors

- Continuous Production
- 100x in since 2008
- Sufficient for 1 million devices/yr

Homogeneous & Patterned deposition systems

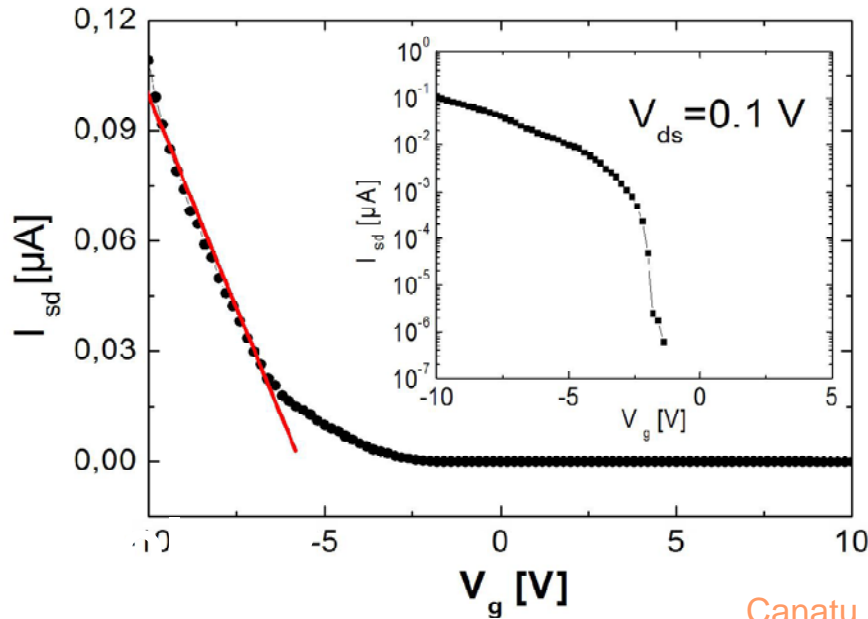
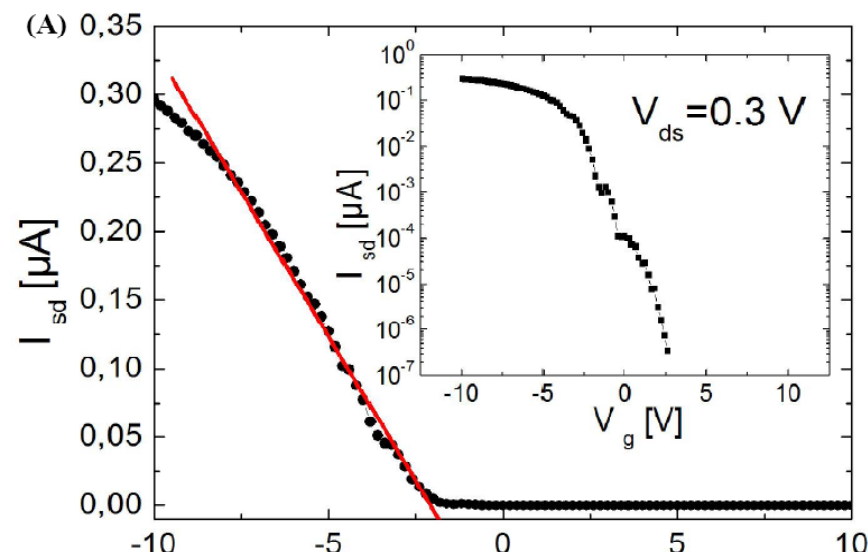
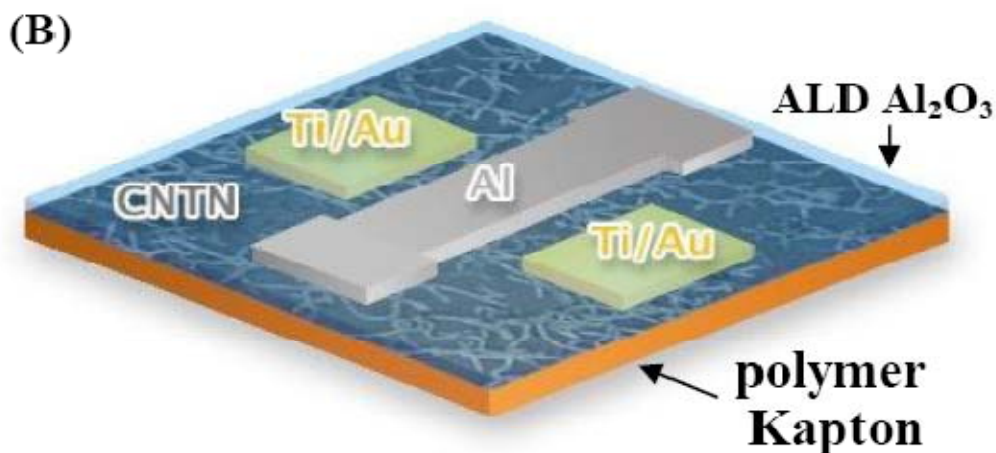
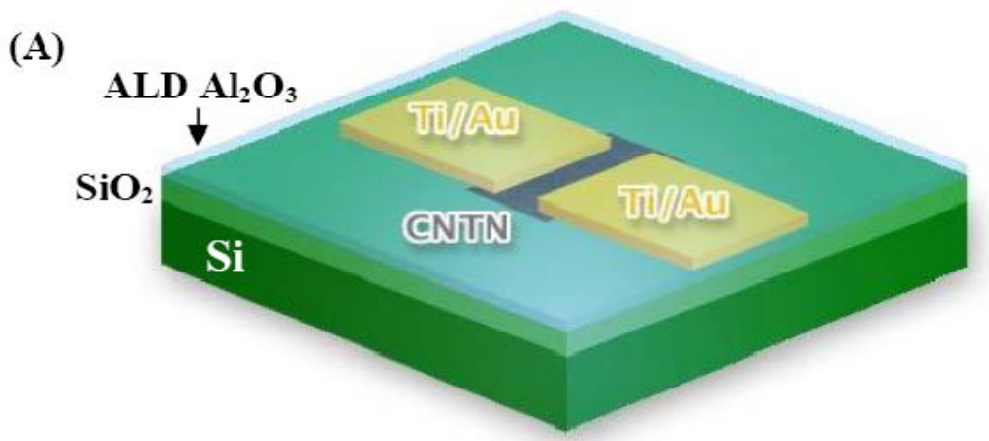
- Continuous Deposition
- 500x in since 2008
- Sufficient for portable devices



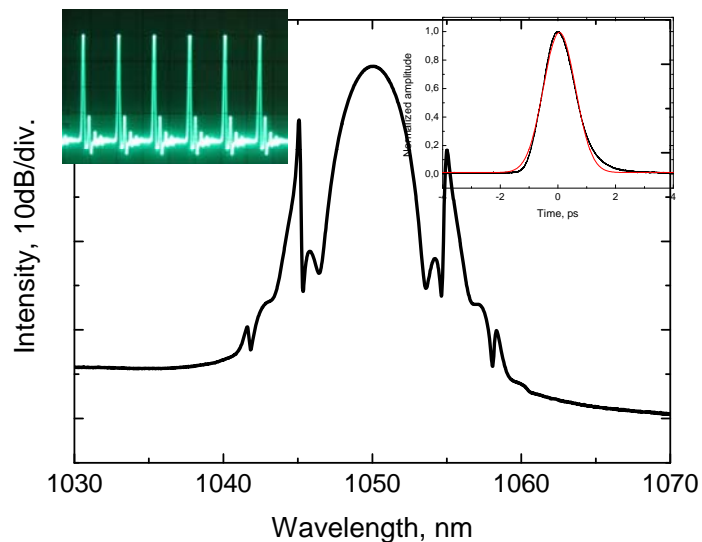
SWCNT FETs on Si and Kapton substrates –

a) on/off = 10^5 , mobility = $5 \text{ cm}^2/(\text{V}\cdot\text{s})$ on Si ($L=W=50 \mu\text{m}$)

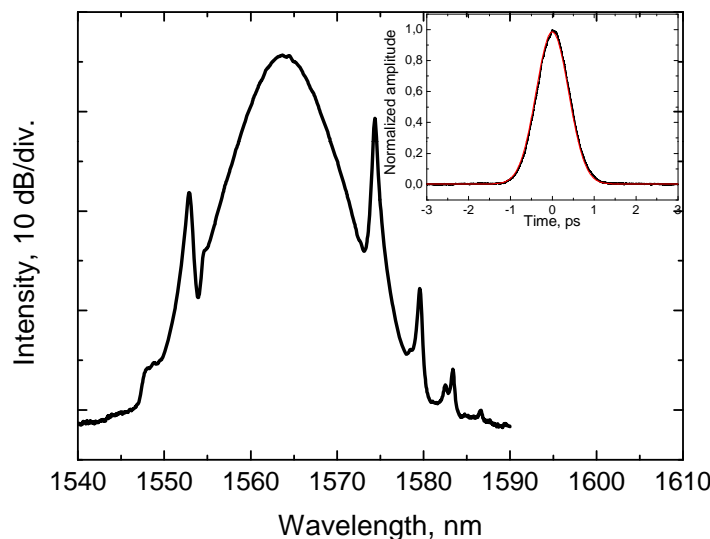
b) on/off = 10^5 , mobility = $1 \text{ cm}^2/(\text{V}\cdot\text{s})$ on polymer ($L=150 \mu\text{m}$, $W=200 \mu\text{m}$)



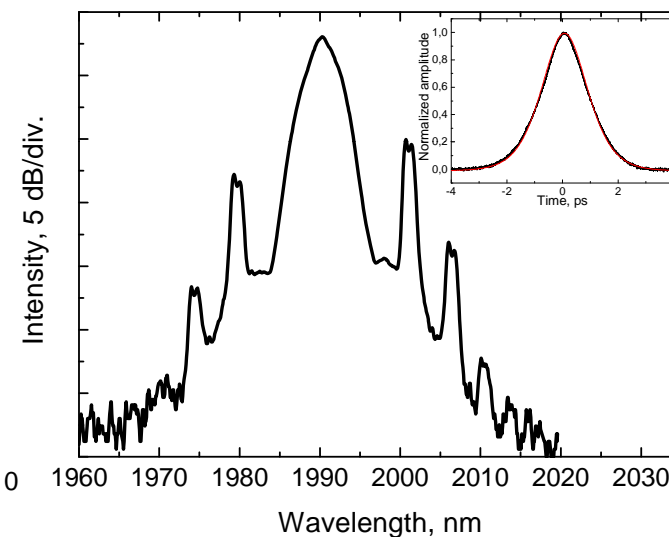
Canatu Saturable Absorbers in Femto Second Pulsed Lasers



Yb-fiber laser



Er-fiber laser



Tm:Ho-fiber laser

	Threshold pump power mW	Repetition rate Mhz	Pulse width ps	Average output power mW
Yb	150	40	0.67	10
Er	30	15	0.44	10
Tm:Ho	150	41	1.0	15

High Caliber International Team



Ari Ahola
Investor, Chairman of the Board
International Serial Entrepreneur



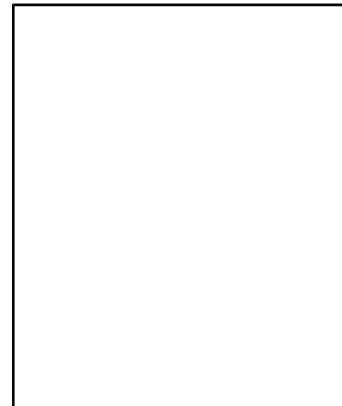
David Brown
Founder, CEO, Ph.D.
High Tech Entrepreneur & Scientist



Yrjö Neuvo
Board Member, Ph.D.
Ex-CTO of Nokia



Esko Kauppinen
Founder, Board Member, Professor
World Leading Nanotechnologist



TBT
Sales and Marketing
International Experience



Brad Aitchison
Production Manager, M.S.
Driving force of R&D

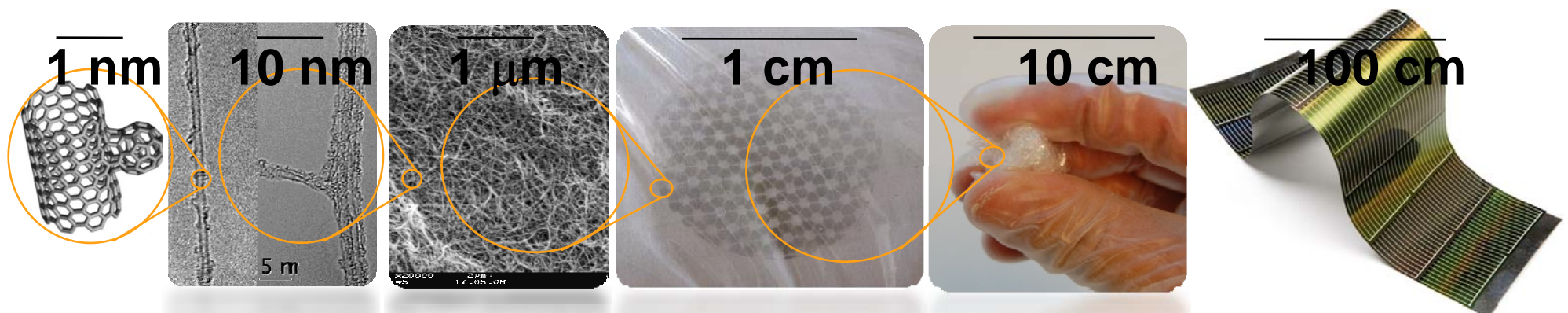
Canatu in four simple steps

Superior Technology

Industrial Scale Process

World Class Team

Strong Intellectual Property



Low Cost, High Performance, Environmentally Friendly Components for Next Gen Devices

e.g. Nokia's Morph Phone

