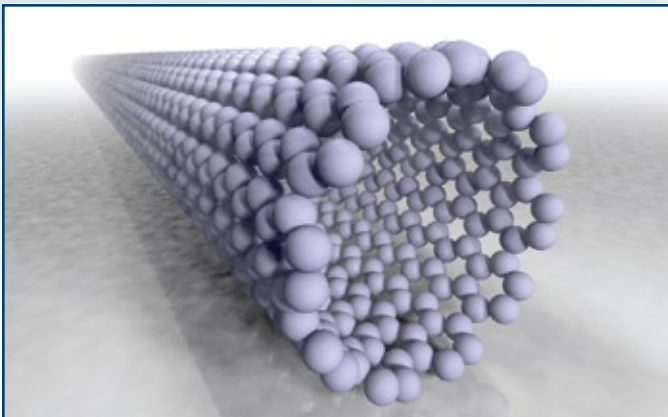


Brewer Science® CNTRENE™

Carbon Nanotube Materials



Brewer Science® CNTRENE™ family of carbon nanotube materials enables the use of carbon nanotubes and their unique properties in next-generation electronics and devices.



Emerging Technologies

- ▶ Sensors
- ▶ N/MEMS
- ▶ Electronics
- ▶ Printable Electronics
- ▶ Lighting
- ▶ Displays
- ▶ Medical Technologies
- ▶ Energy Harvesting
- ▶ RFID

Multiple Platforms for a Wide Variety of Applications

- ▶ MWNTs
- ▶ Metallic SWNTs
- ▶ Semiconducting SWNTs

Application-Specific Grades

- ▶ Electronics Grade
- ▶ Transparent Conductive

About Brewer Science

Brewer Science delivers innovative material, process, and equipment solutions for various applications including lithography, advanced packaging, MEMS, nanotechnology, optoelectronics, and compound semiconductors. The inventor of ARC® anti-reflective coating products for the microlithography world, Brewer Science continues to expand its scope with Cee® processing equipment, ProTEK® temporary etch protective coatings, WaferBOND® temporary bonding materials, OptiINDEX™ high refractive index materials, and CNTRENE™ carbon nanotube solutions. Exceptional technical expertise and extensive semiconductor industry knowledge, combined with world-class product and customer support, make Brewer Science a company that consistently enhances the value of the entire electronics industry. Further information on technologies and products from Brewer Science can be obtained via the company's web site at www.brewerscience.com.

of the People
for the Customer
by the Technology

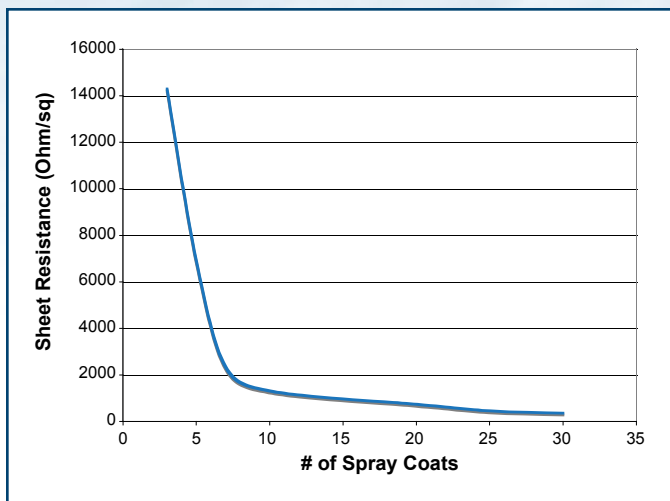
Electronics-Grade Materials

Brewer Science® CNTRENE™ electronics-grade carbon nanotube materials are designed for advanced memory devices, including nonvolatile memory (NRAM®), logic, and DRAM. The inherent robust nature of carbon nanotubes makes them suitable for use in harsh radiation environments and applications.

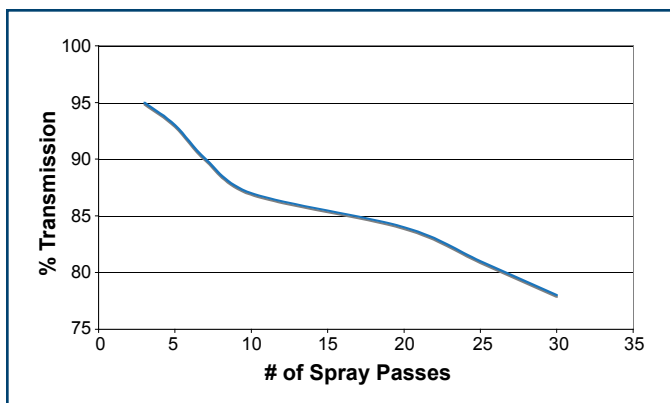
Benefits

- ▶ Electronics Grade
- ▶ Surfactant Free
- ▶ Benign Solvent System

Sheet Resistance Curve



Transmission Curve



Storage Conditions

Room Temperature (16° to 26°C)

Shelf Life

180 days

NRAM® Application

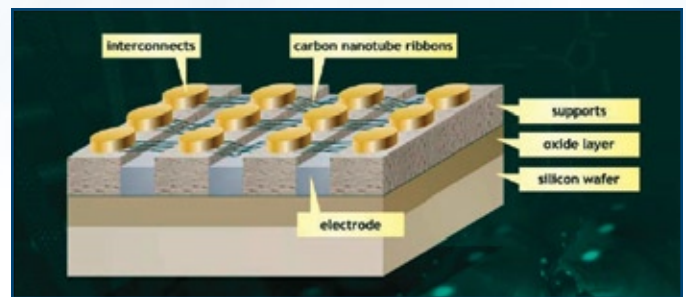


Image courtesy of Nantero

Average Ion Concentration Data (ICP-MS)

PPB		PPB	
Al:	< 15	Mo	< 1
Ca:	< 15	Ni:	< 1
Cr:	< 1	K:	< 5
Co:	< 1	Na:	< 5
Cu:	< 1	Ti:	< 1
Fe:	< 5	Zn:	< 10
Mg:	< 5		

Transparent Conductive Materials

Brewer Science® CNTRENE™ transparent conductive carbon nanotube materials are designed to replace other currently available transparent conductive materials.

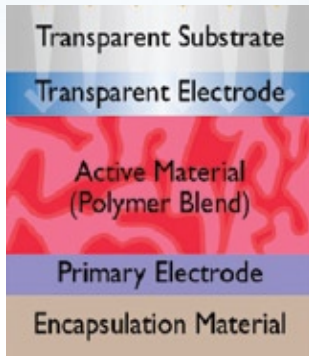
Benefits

- ▶ Good transmission over a wide range of wavelengths
- ▶ Excellent mechanical strength for flexible substrate use
- ▶ Used in high-throughput deposition techniques

Customized Materials Based On:

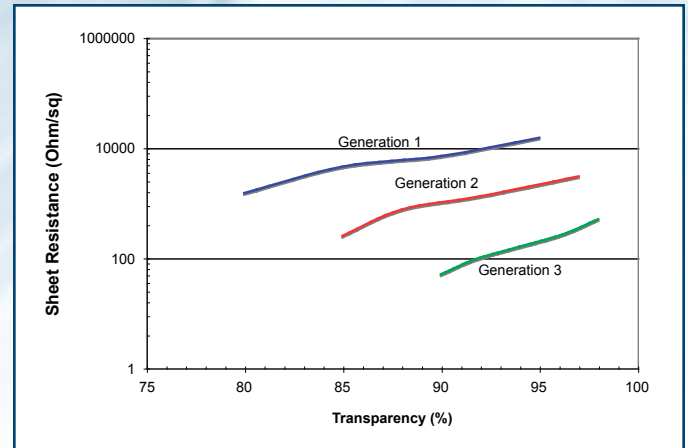
- ▶ Substrate type
- ▶ Deposition method (spray, gravure, jet process, flexo, screen)

Example Photovoltaic Cell Schematic



CNT materials can be used as the transparent electrode

Transparent Conductive Materials Roadmap



Comparison of Material Properties

	Brewer Science® CNT Materials	Alternative Technology 1	Alternative Technology 2	Alternative Technology 3
Transmission (%):	Up to 99	80-96	80-99	80-96
Sheet Resistance (Ohm/sq):	10-10 ⁶	< 1000	500-10 ⁵	< 1000
Color:	Neutral	Yellow Tint	Blue Tint	Varies
Printed Deposition:	Yes	No	Yes	Yes
Flexible Substrate Use:	Yes	Some	Yes	Yes
Environmental Stability:	Yes	Some	Some	Yes

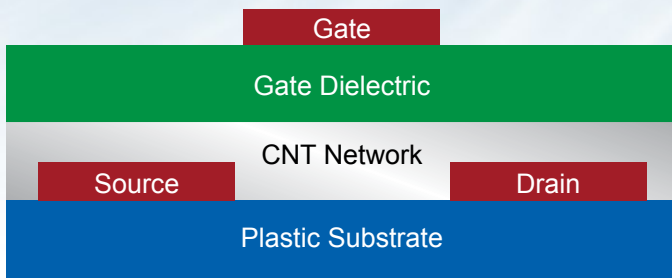
Semiconducting Materials

Brewer Science® CNTRENE™ semiconducting carbon nanotube materials are designed for advanced thin-film transistors and printed electronics.

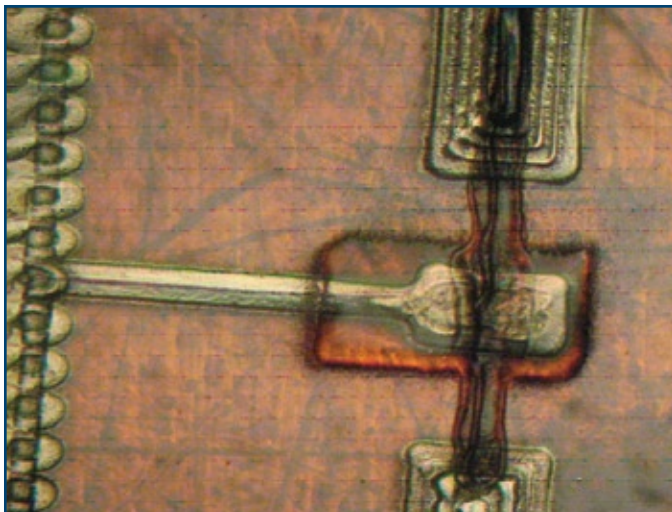
Benefits

- ▶ Scalable, high-purity semiconducting tubes
- ▶ Low ionic content
- ▶ Room temperature processing

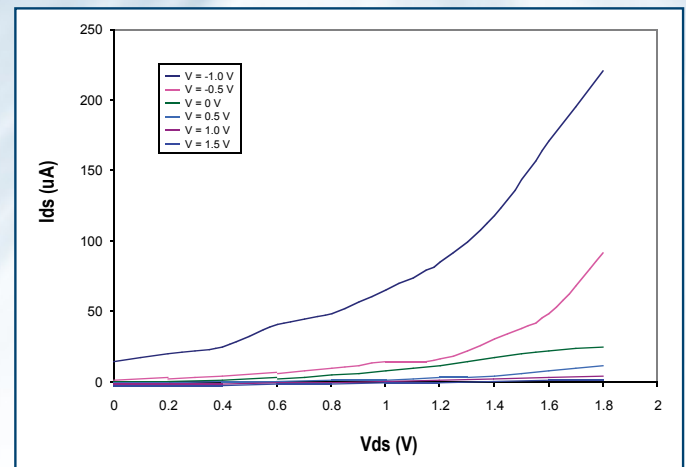
Fully Printed TFT Device Schematic



Fully Printed CNT FET-Based Switch



I/V Curve



Material Properties

	CNT FET	Organic FET
Electron Mobility (cm ² /Vs):	46,000	< 5
Hole Mobility (cm ² /Vs):	46,000	< 5
Operating Frequency:	> 5 GHz	
Thermal Conductivity:	Yes	No

All statements, technical information and recommendations contained herein are based on tests we believe to be accurate, but the accuracy or completeness thereof is not guaranteed and the following is made in lieu of warranty expressed or implied. Neither the seller nor manufacturer shall be liable for any injury, loss or damage, direct or consequential, arising from the use or inability to use the product. Before using, user shall determine the suitability of the product for his intended use, and user assumes all risk and liability whatsoever in connection therewith. No statement or recommendation not contained herein shall have any force or effect unless in an agreement signed by officers of the seller and manufacturer.

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