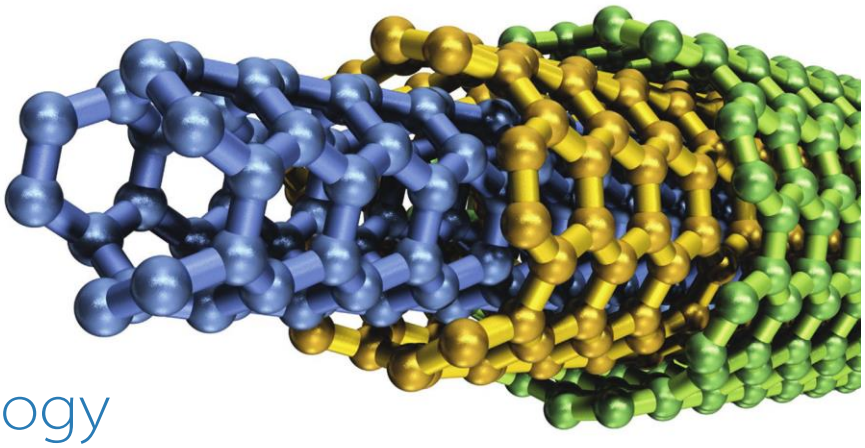
RAYMOR NanoIntegris

PRODUCT CATALOG 2018



Enabling the Future through Nanotechnology

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Brief History

In October 2006, Professor Mark Hersam's research group at Northwestern University published a ground breaking paper in Nature Nanotechnology describing a process to sort CNTs by electronic structure. Flooded with sample requests from around the world, NanoIntegris was founded in January 2007 and established in Skokie, Illinois. Raymor, a high-value added materials supplier, acquired NanoIntegris in 2012 to expand its client base and its expertise in nanotube processing.

Over the past 10 years, Raymor Industries has developed its plasma processing capability which led to the marketing of two outstanding products: plasma-grown single-wall carbon nanotubes (SWCNT) and plasma-grown crumpled graphene nanoplatelets.

Raymor and NanoIntegris offer a wide variety of premium nanomaterials to companies and academic institutions developing next-generation electronics, energy, and biomedical technologies. We pride ourselves on our thorough, accurate, and honest material characterization.

Our nanotube powders, inks for printed electronics, and dispersions are among the purest in the industry. What is more, our strict quality control standards and procedures enable us to guarantee the reliability and consistency of our products. If you have further questions, please don't hesitate to contact us.

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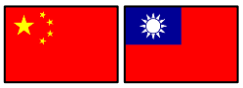

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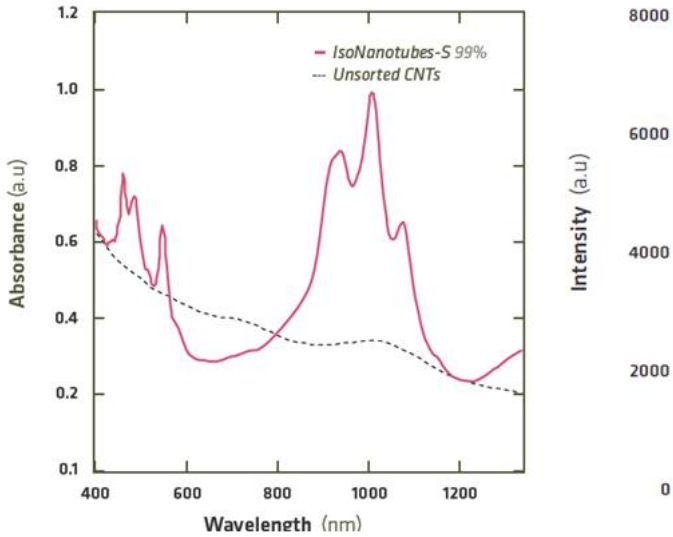
IsoNanotubes-S: Semiconducting SWCNT

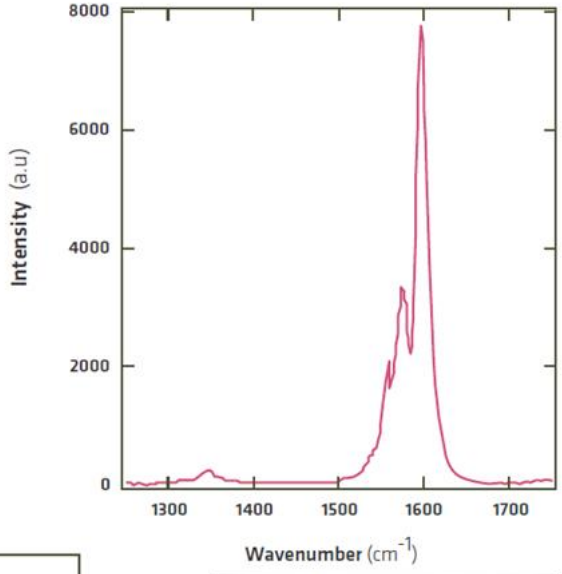
Description: Semiconducting single-wall carbon nanotubes are a NanoIntegris exclusivity. They are sorted using a scalable production process. Offered in an aqueous solution or a powder.

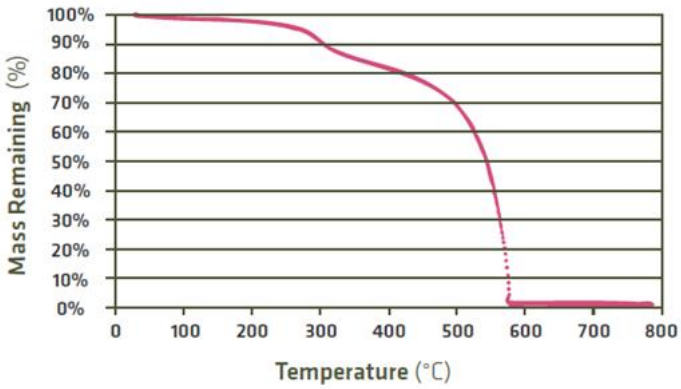
Semiconducting carbon nanotubes may replace or complement traditional semiconductors in both high-performance and low-cost thin film transistor (TFT) devices. Today, TFTs are most commonly used in the backplanes of LCD and OLED displays. As the flexible electronics industry matures, TFTs will likely be incorporated into a much wider range of commercial electronics.

Please note that SKU# 1117 and 1118 use SWCNT from the CoMoCAT process.

Specifications:







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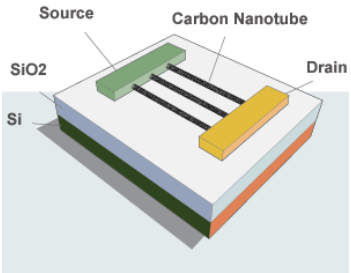
Parameter	IsoNanotubes-S
Available Purities	90%, 95%, 98%, 99% and 99.9%
Metal content from TGA	< 1%
Length from AFM	0.3-4 µm
Solvant	Water or Toluene
Diameter range	1-1.7 nm

Prices:

SKU#	Product	Price (USD)	Quantity (mg)
1101	IsoNanotubes-S 99% Aqueous	800	1.0
1102	IsoNanotubes-S 99% Powder	850	1.0
1103	IsoNanotubes-S 98% Aqueous	450	1.0
1104	IsoNanotubes-S 98% Powder	500	1.0
1105	IsoNanotubes-S 95% Aqueous	300	1.0
1106	IsoNanotubes-S 95% Powder	350	1.0
1107	IsoNanotubes-S 90% Aqueous	200	1.0
1108	IsoNanotubes-S 90% Powder	250	1.0
1115	IsoNanotubes-S 99.9% Aqueous	1200	1.0
1116	IsoNanotubes-S 99.9% Powder	1250	1.0
1117	(6,5) Chirally Enriched 95% Aqueous	1150	200.0
1118	(6,5) Chirally Enriched 95% Powder	1150	1.0g

Significant discounts are available for large size orders. Please contact our sales team for special quote.

Did you know?



Semiconducting carbon nanotubes may replace or complement traditional semiconductors in both high-performance and low-cost thin film transistor (TFT) devices. Today, TFTs are most commonly used in the backplanes of LCD and OLED displays. As the flexible electronics industry matures, TFTs will likely be incorporated into a much wider range of commercial electronics.

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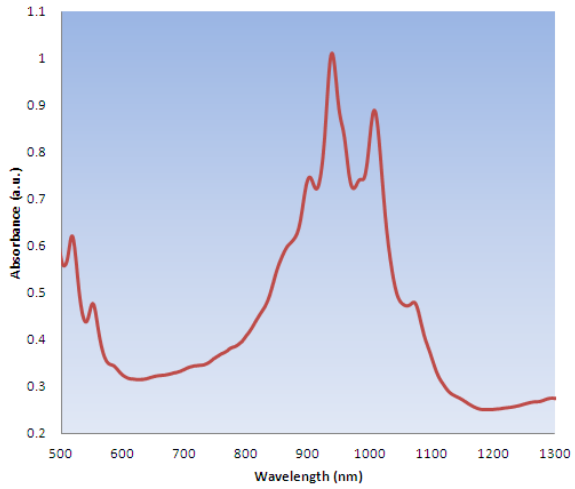
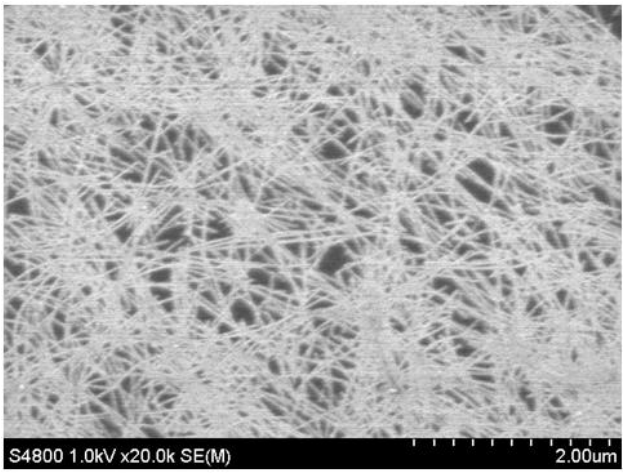
IsoSol-S: Semiconducting SWCNT

Description: IsoSol-S100 is the award-winning semiconducting carbon nanotube ink with the highest purity ever measured coupled to a fully scalable manufacturing route that does not rely on ultracentrifugation. When processed optimally, our solution lead to carbon nanotube thin-film transistors (SWCNT-TFT) that deliver average mobilities of 10-20 $cm^2/V/s$ and current ON/OFF ratios of 10^3-10^6 (on Si/SiO_2) as well as average current densities of 1-10 µA/µm, sufficient in principle to drive organic light-emitting diodes (OLEDs). The semiconducting single-wall carbon nanotubes are sourced from the highly-scalable RF-plasma process, and separated using conjugated polymer extraction.

Specifications:





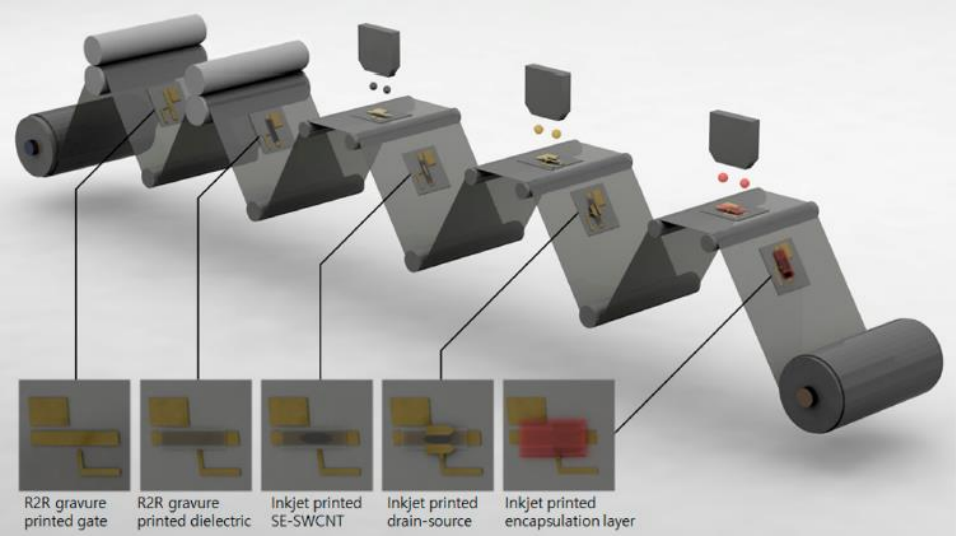
Property	Value
Optical Purity	>99.9%
Itkis Ratio (Ï)	>0.5
Phi Value (Φ)	>0.39
Nanotube Concentration	> 0.01mg/mL
Surfactant : Nanotube Concentration	<4
Standard Solvent Media	Toluene
Shelf Life	3 months

Prices:

SKU#	Product	Price (USD)	Quantity (mg)
1111	100% IsoSol-S100 Polymer Wrapped Powder	795	1.0
1112	100% IsoSol-S100 Aromatic Solution	695	1.0

Significant discounts are available for large size orders. Please contact our sales team for special quote.

Did you know?

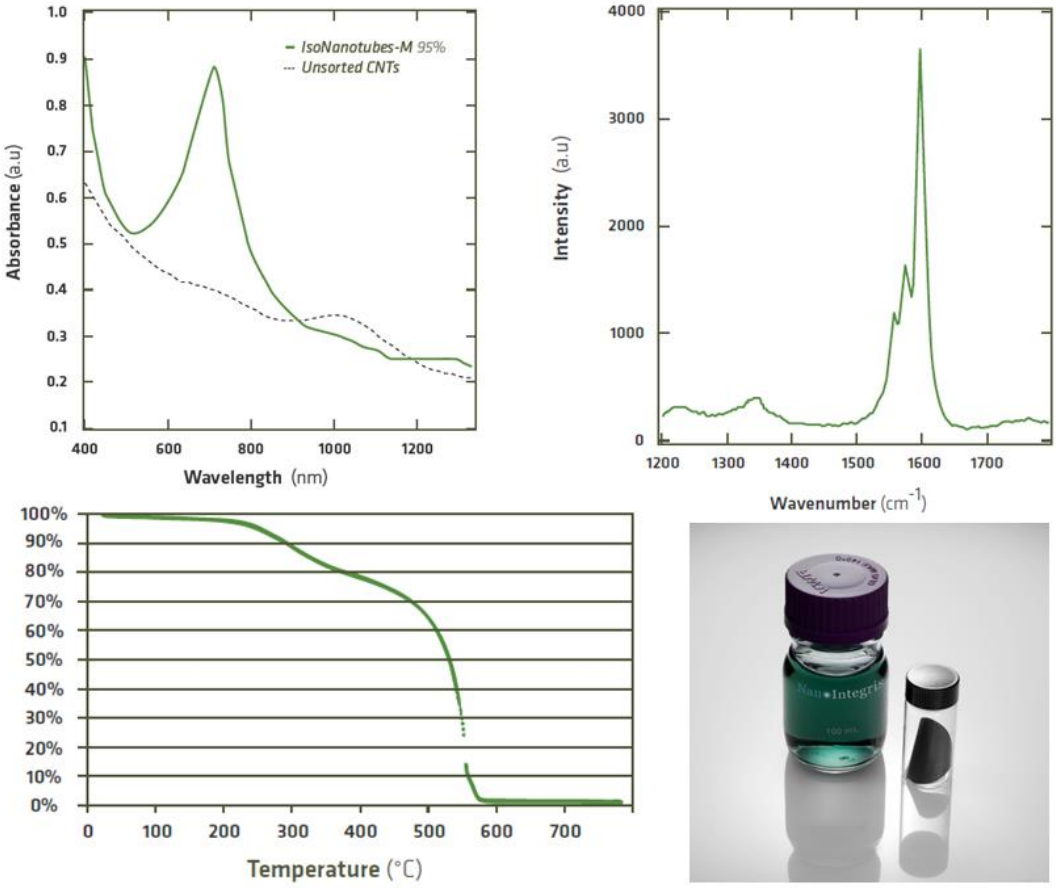


Transistors can be printed using roll-to-roll (R2R) gravure on flexible polyethylene terephthalate (PET) substrate with silver gate electrodes and a high-k BaTiO3 dielectric layer. The IsoSol-S100 was inkjet-printed at 50 mg/L along with silver source/ drain contacts, defining a channel of 1000 µm x 150 µm. The on/off ratios were determined to be 7×10^4 with a subthreshold swing of 1.8V/decade, a threshold voltage of -2.5V, and a mobility of $6cm^2/Vs$. **Reference**: ACS Appl. Mater. Interfaces 2016, 8, 27900-27910.

IsoNanotubes-M: Metallic SWCNT

Description: Metallic single-wall carbon nanotubes are a NanoIntegris exclusivity. They are sorted using our patented density gradient ultracentrifugation (DGU) process and offered in an aqueous solution or a powder.

Specifications:



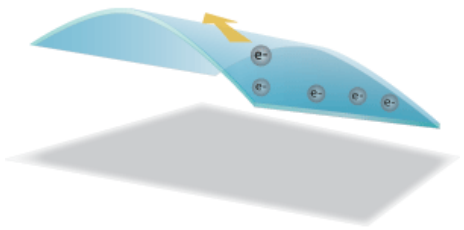
Parameter	IsoNanotubes-M
Available Purities	70%, 90%, 95%, 98% and 99%
Metal content from TGA	< 1%
Length range from AFM	0.3-4 µm
Solvant	Water
Diameter range	1-1.7 nm

Prices:

SKU#	Product	Price (USD)	Quantity (mg)
1201	IsoNanotubes-M 99% Aqueous	900	1.0
1202	IsoNanotubes-M 99% Powder	950	1.0
1203	IsoNanotubes-M 98% Aqueous	700	1.0
1204	IsoNanotubes-M 98% Powder	750	1.0
1205	IsoNanotubes-M 95% Aqueous	400	1.0
1206	IsoNanotubes-M 95% Powder	450	1.0
1207	IsoNanotubes-M 90% Aqueous	300	1.0
1208	IsoNanotubes-M 90% Powder	350	1.0
1209	IsoNanotubes-M 70% Aqueous	200	1.0
1210	IsoNanotubes-M 70% Powder	250	1.0

Significant discounts are available for large size orders. Please contact our sales team for special quote.

Did you know?

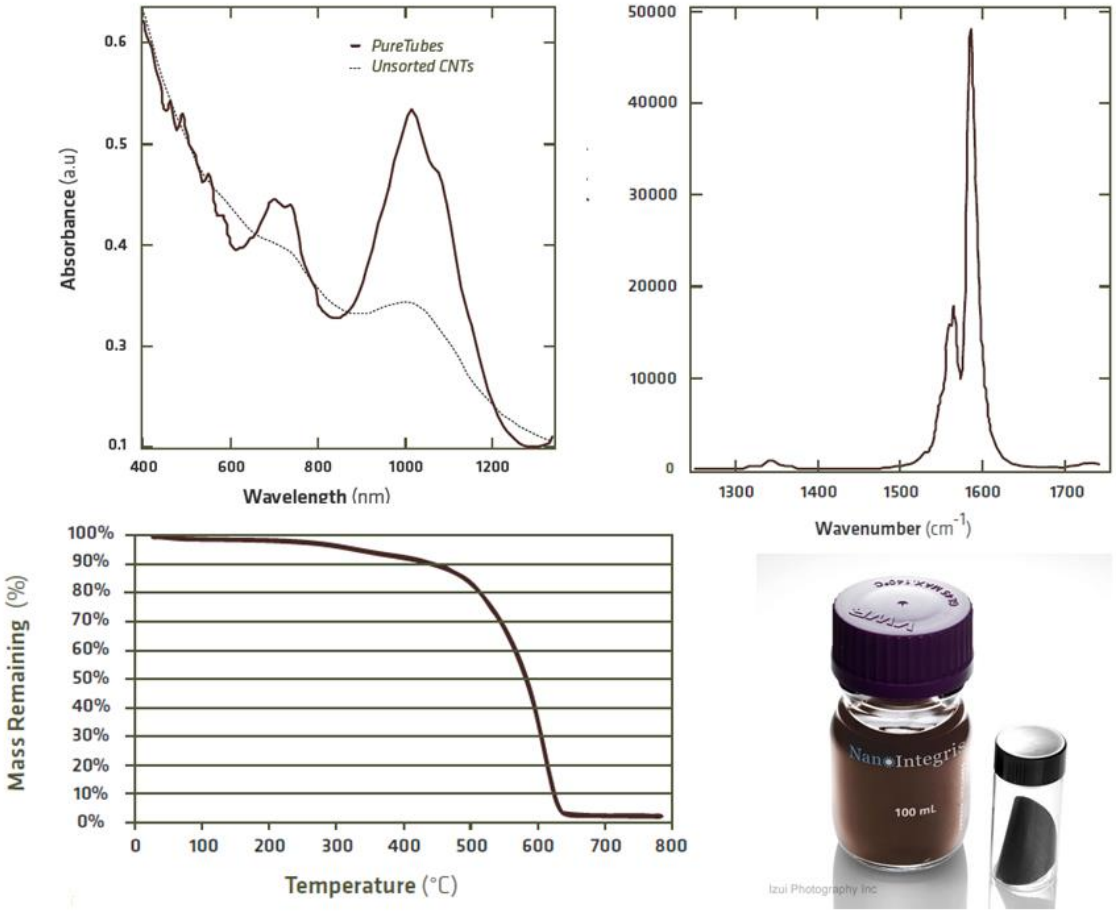


Owing to their processability, stability, and high conductivity, carbon nanotubes have received significant attention from electronics-industry researchers over the past several years as an alternative to ITO. However, development work with nanotubes has been largely precluded by the unavoidable electronic polydispersity of as-grown CNTs. NanoIntegris has effectively solved this polydispersity problem—by separating as-grown nanotubes via DGU, we can produce large quantities of uniform metallic CNTs with up to 99% purity

Unseparated Arc-Discharge SWCNT

Description: These single-wall carbon nanotubes are purified to values of 95-98% (nanotube content measured via the Itkis ratio). PureTubes offer metal content lower than 5% and SuperPureTubes offer less than 2% metal content (as per TGA). These are our highest purity un-sorted nanotubes. Sourced from the arc-discharge processes and offered in solution or dry powder.

Specifications:



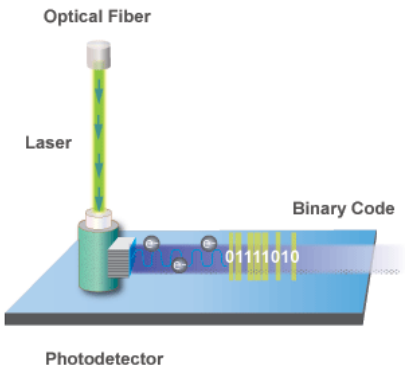
Parameter	PureTubes	SuperPureTubes
G/D ratio from Raman	> 30	> 30
Metal content from TGA	< 4%	1%
Length range from AFM	0.1-4 µm	0.1-4 µm
Carbon impurities	<5%	<5%
Diameter range	1-1.7 nm	1-1.7 nm
Itkis index from Optical Absorbance	> 0.2	> 0.2

Prices:

SKU#	Product	Price (USD)	Quantity (mg)
1301	Super PureTubes Aqueous	2500	1.0
1302	Super PureTubes Powder	2600	1.0
1303	PureTubes Aqueous	960	1.0
1304	PureTubes Powder	1060	1.0
1305	P2 Powder	350	1.0g
1306	AP Powder	135	3.0g
1307	COOH-Functionalized P2	1000	1.0g
1308	COOH-Functionalized AP	750	1.0g

Significant discounts are available for large size orders. Please contact our sales team for special quote.

Did you know?



Photonic devices are widely used for optical communications, spectroscopy, and precision surgery (e.g. medical lasing). Materials which exhibit strong nonlinear electro-optical behaviors are required for most photonic applications. Ideally, these materials should exhibit fast response times, absorb over a broad wavelength range, and exhibit low optical loss. Nanotubes are one of a handful of materials in existence which satisfy these property requirements.

Product Kits

Description: Dozens of researchers publish groundbreaking research using our tubes every year (over 500 publications as of January 2016). Make sure the next major paper published in Nature, JACS, ACS Nano or Nano Letters is yours! If you are starting a new project and you are not sure which nanotube product will perform best, try a starter kit, sample or premium kit and make sure to save over 60% of the retail price if items were sold separately.

Starter kits include:	**2 mg** of IsoNanotubes **90%-M** **2 mg** of IsoNanotubes **90% - S** **50 mg of PureTubes**
Sample kits include:	**2 mg** of IsoNanotubes **70%-M, 2 mg** of IsoNanotubes **90%-M** **2 mg** of IsoNanotubes 90% - S, **2 mg** of IsoNanotubes **95%-S** **100 mg of PureTubes**
Premier kits include	**1 mg** of IsoNanotubes **99%-M, 1 mg** of IsoNanotubes **98%-M** **1 mg** of IsoNanotubes 99% - S, **1 mg** of IsoNanotubes **98%-S** **50 mg of PureTubes**.

Specifications: see section above for specifications of IsoNanotubes – M, IsoNanotubes – S and PureTubes.

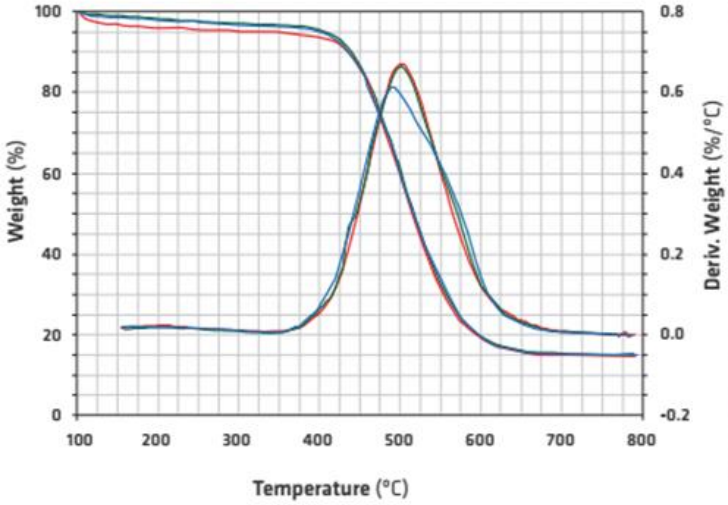
Prices:

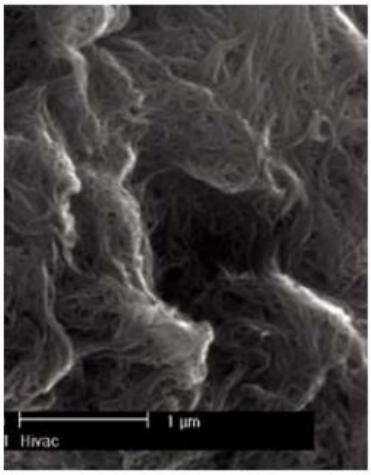
SKU#	Product	Price (USD)	Quantity (mg)
1401	Starter Aqueous Solution	900	See above
1402	Starter Powder	950	See above
1403	Sample Aqueous Solution	700	See above
1404	Sample Powder	750	See above
1405	Premier Aqueous Solution	400	See above
1406	Premier Powder	450	See above

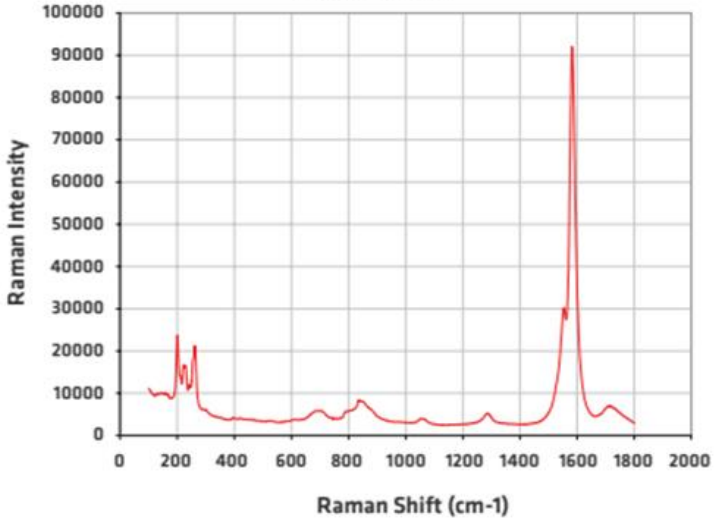
HiPco Small Diameter SWCNT

Description: HiPco SWCNT represent a benchmark for small diameter nanotubes both in the academic community and for industrial and commercial applications. They are synthesized in the original fluidized bed process developed by Nobel laureate Professor Richard Smalley and located at Rice University. We offer three grades of purity for this unique material. Raw HiPco SWCNT contain up to 15% of iron, whereas Purified HiPco SWCNT and Superpurified HiPco SWCNT contain less than 10 and 5% iron respectively.

Specifications:







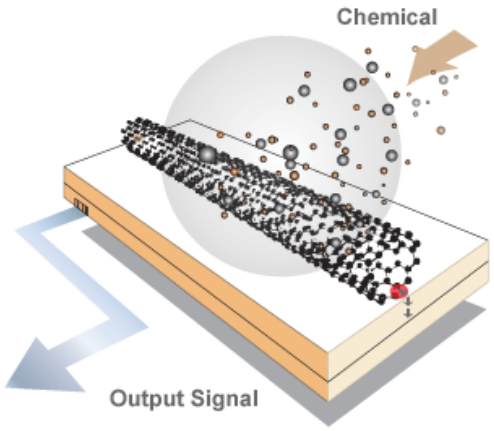
Parameter	Raw	Purified	SuperPurified
Residual Iron Content	<35%	<15%	<5%
Length	0.1-1 µm	0.1-1 µm	0.1-1 µm
Diameter	0.8-1.2 nm	0.8-1.2 nm	0.8-1.2 nm

Prices:

SKU#	Product	Price (USD)	Quantity (g)
1601	Raw Fluffy Powder	550	1.0
1602	Raw Wet Cake	550	1.0
1603	Purified	800	1.0
1604	Super Purified	2200	1.0

Discounts are available for large size orders. Please contact our sales team for special quote.

Did you know?



Chemical sensors are used for many purposes, such as environmental hazard screening, explosives detection, product characterization, and medical testing. The electronic properties of SWNTs can change significantly when gases and bio-molecules are adsorbed to their surface. These changes can be detected in resistor, transistor, or capacitor devices. A principle advantage of TFT SWNT sensors in particular is that they respond to analyte surface coverage, as opposed to conventional sensors, which respond to analyte concentration.

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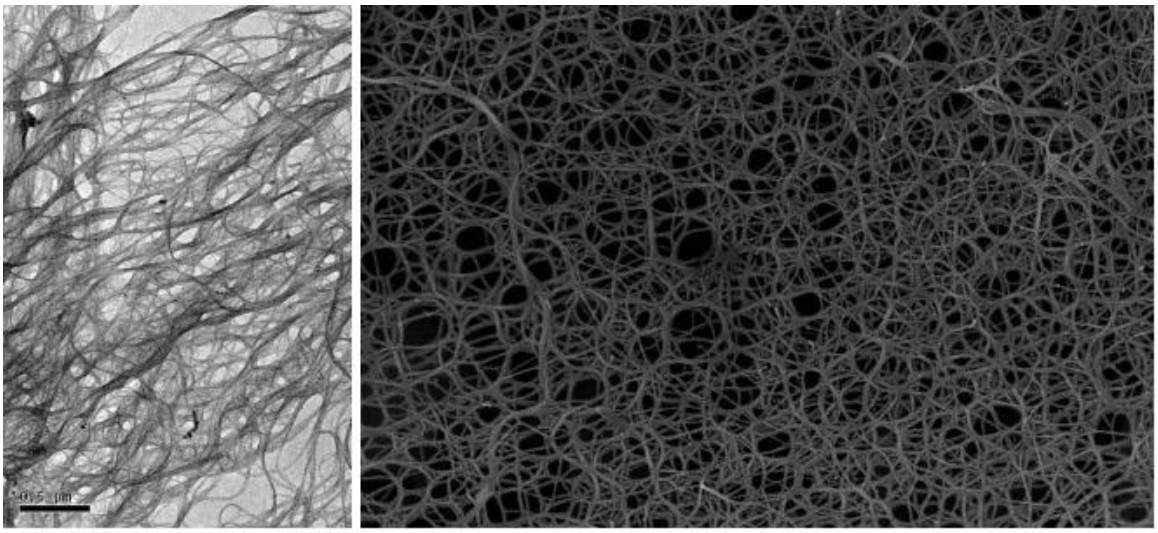
HiPco(ß): Small Diameter SWCNT

Description: NanoIntegris is very proud to offer a new grade of HiPco SWCNT. These small diameter single-wall carbon nanotubes are synthesized using the high-pressure carbon monoxide process developed at Rice University. A new reactor, recently launched, produces the same material, but at a different location and at larger scale.

Specifications:



Metric	Value	Method of Analysis
Diameter	0.6 – 1.1 nm	Raman, TEM
Length	400 – 700 nm	TEM
Color	Black	-
Ash content of Raw SWCNT	< 10 wt%	TGA
Ash content of Purified SWCNT	< 1 wt%	TGA
Carbon Purity	> 90%	TGA
Average G/D Ratio	~ 35	Raman (514 nm)

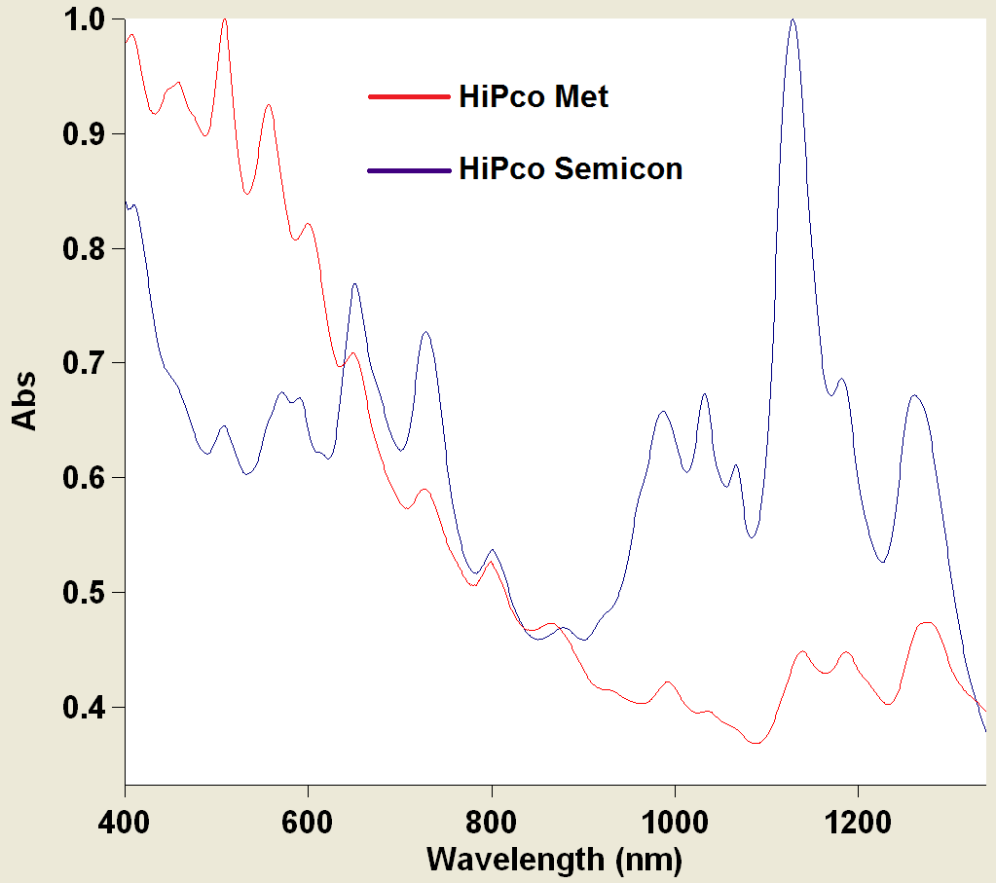
Prices:

SKU#	Product	Price (USD)	Quantity (g)
1613	HiPco(β) SWCNT - Raw	299	1.0
1614	HiPco(β) SWCNT - Purified	549	1.0

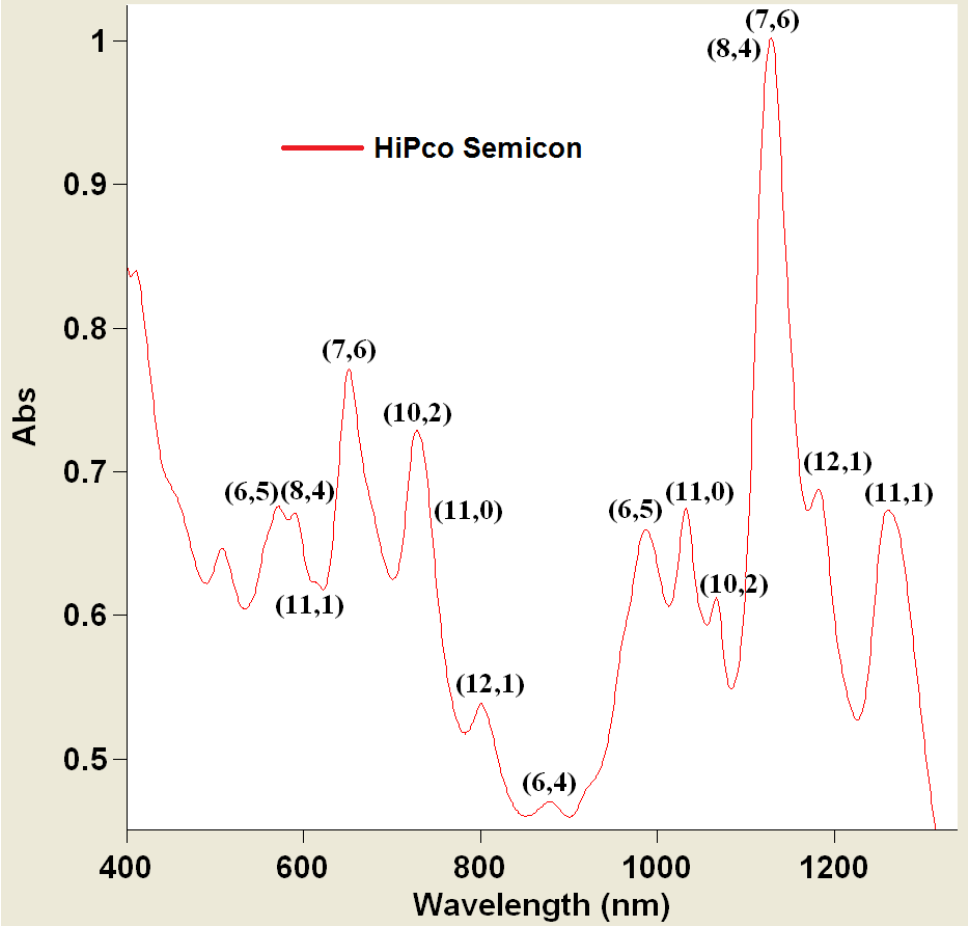
HiPco Semiconducting/Metallic Sorted SWCNT

Description: HiPco SWCNT represent a benchmark for small diameter nanotubes both in the academic community and for industrial and commercial applications. They are synthesized using the fluidized bed process developed by Nobel laureate Richard Smalley. We offer three grades of purity for this unique material. Raw HiPco SWCNT contain up to 15% of iron, whereas Purified HiPco SWCNT and Superpurified HiPco SWCNT contain less than 10 and 5% iron respectively.

Specifications:



Product	Semiconducting Enrichment	Metallic Nanotube Content	Diameter	Residual Fe Catalyst
HiPco Semiconducing SWCNT	>98%	<2%	0.8-1.2nm	<5% by weight
HiPco Metallic SWCNT	<5%	>95%	0.8-1.2nm	<5% by weight



Prices:

SKU#	Product	Price (USD)	Quantity (g)
1605	Metallic Enriched Aqueous Solution	600	1.0
1606	Metallic Enriched Powder	650	1.0
1607	Semiconducting Enriched Aqueous Solution	500	1.0
1608	Semiconducting Enriched Powder	550	1.0

PureWave Graphene

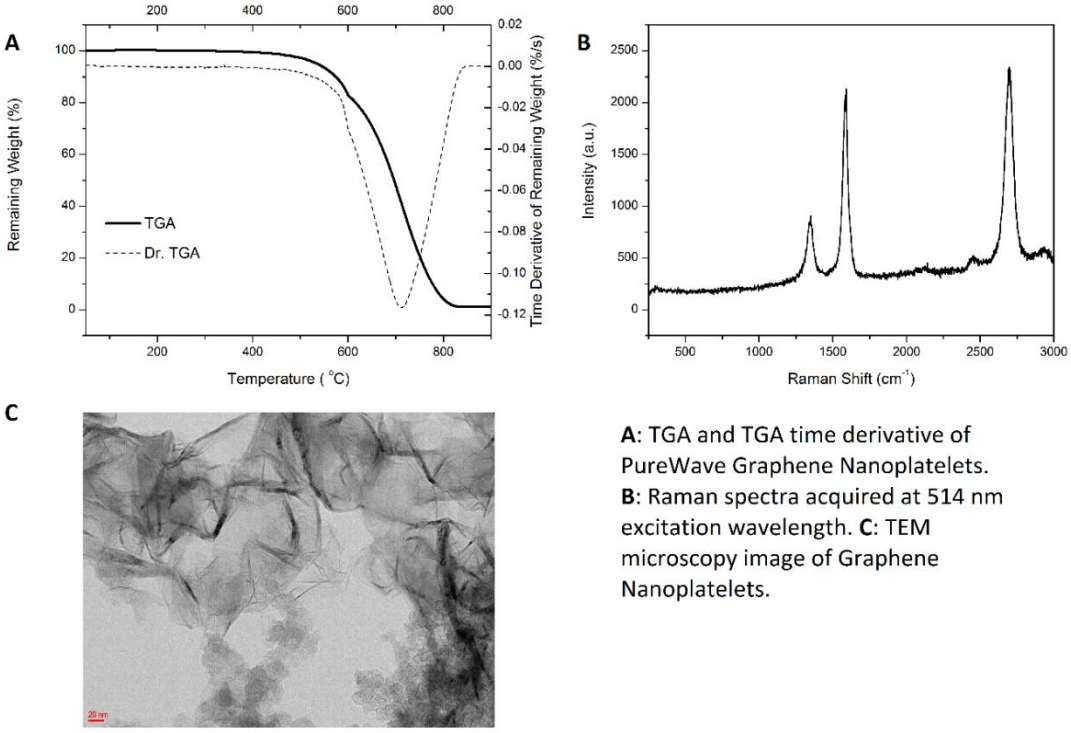
Description: Our PureWave Graphene Nanoplatelets (GNP) material is composed of thin, highly dispersible graphene nanoplatelets with very low oxygen content. The turbostratic and wavy morphology of the material leads to an unequalled ability to be dispersed in a variety of solvents and resins. Furthermore, the unique plasma process used to grow our PureWave Graphene Nanoplatelets is easy to scale and thus produces a low cost product. Our unique and protected growth process based on plasma enables us to produce this material at over 200 g/hour, enabling commercial graphene applications such as energy storage and conductive inks as well as elastomers and resins.

Their non-planar morphology imparts these GNPs with a comparatively weak tendency to aggregate relative to planar exfoliated GNPs. This and their small size results in excellent dispersiblity in solvents and polymer matrices even though they are pristine. This characteristic coupled with their excellent electrical conductivity makes PureWave graphene especially effective in conductive composites, coatings, inks and energy storage devices such as lithium ion battery anodes, cathodes and in supercapacitors. In several important polymeric matrices and even in solvent, PureWave graphene has been found to give conductive formulations (percolate) at lower concentrations than exfoliated GNPs. Addition of PureWave plasma GNPs to formulations containing larger planar exfoliated GNPs gives a substantial synergistic boost to conductivity, indicating that the small PureWave GNPs are very effective at electrically connecting the larger particles. Likewise, plasma GNPs are especially effective as the conductive component in cathode and anode coatings.

Further reading: Types and Applications of Graphene: Introducing PureWave Plasma GNPs. N. Vanier et al. (2014) https://www.printedelectronicsworld.com/articles/10940/types-and-applications-of-graphene-introducing-purewave-plasma-gnps

Specifications:

Physical Characterization	
Parameter	**Value**
G/D ratio from Raman (514 nm)	3
2D/G ratio from Raman	0.8-1
BET Specific Surface Area	> 400 m^2/g
Average Number of Layers	6
Flake Size	150-200 nm
Oxygen Content	1%
Average Flake Thickness	2.4 nm
Carbon Content (TGA)	> 98%
Metal Impurities (ICP-MS)	< 300 ppm
Performance in Formulation (screen printed)	
Parameter	**Value**
Resistivity (Ω/□/mil)	1.0 - 5.0



A: TGA and TGA time derivative of PureWave Graphene Nanoplatelets. **B**: Raman spectra acquired at 514 nm excitation wavelength. **C**: TEM microscopy image of Graphene Nanoplatelets.

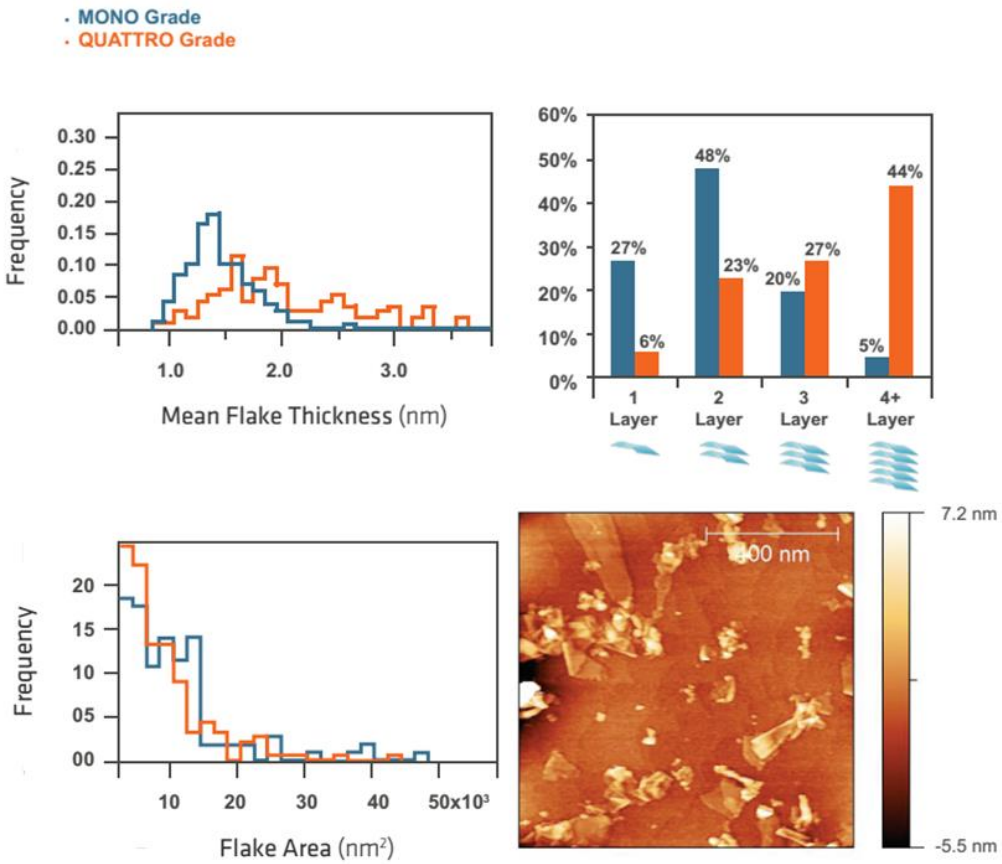
Prices:

SKU#	Product	Price (USD)	Quantity (g)
1708	PureWave Graphene Nanoplatelets (GNP)	100	2.0
1708	PureWave Graphene Nanoplatelets (GNP)	500	20.0
1708	PureWave Graphene Nanoplatelets (GNP)	1,500	100.0

PureSheets: 1-4 Layer Graphene Nanoplatelets

Description: PureSheets graphene nanoplatelets (GNP) were mechanically exfoliated from graphite. Our graphene solutions are post-processed to remove thicker platelets that were not properly exfoliated. This step ensures the optimal dispersion and stability of our products. PureSheets-MONO GNP contain, on average, 1-3 graphene layers according to AFM while PureSheets-QUATTRO contain, on average, 4-6 layers of graphene.

Specifications:



RAYMOR NanoIntegris

2018 Product Catalog

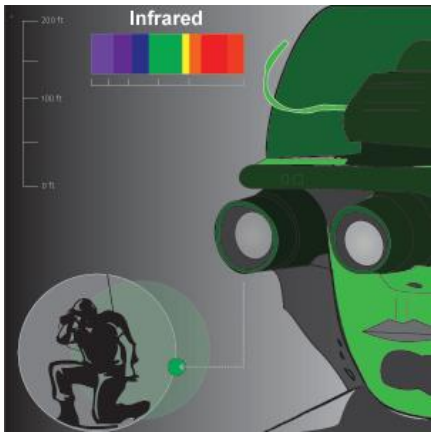
Parameter	MONO	QUATTRO	Measurement
Single Layer Content	27%	6%	AFM
Double Layer Content	48%	23%	AFM
Triple Layer Content	20%	27%	AFM
4+ Layer Content	5%	44%	AFM
Average Flake Area	10000 nm²	10000 nm²	AFM
Solution Type	Acqueous	Acqueous	n/a
Graphene Concentration	0.05 mg/ml	0.05 mg/ml	n/a
Surfactant Concentration	2% w/v	2% w/v	n/a

Prices:

SKU#	Product	Price (USD)	Quantity (mg)
1701	MONO Aqueous	625	400.0
1702	MONO Powder	675	400.0
1703	QUATTRO Aqueous	400	400.0
1704	QUATTRO Powder	450	400.0
1708	PureWave graphene nanoplatelets	100	5.0g

Significant discounts are available for large size orders. Please contact our sales team for special quote.

Did you know?



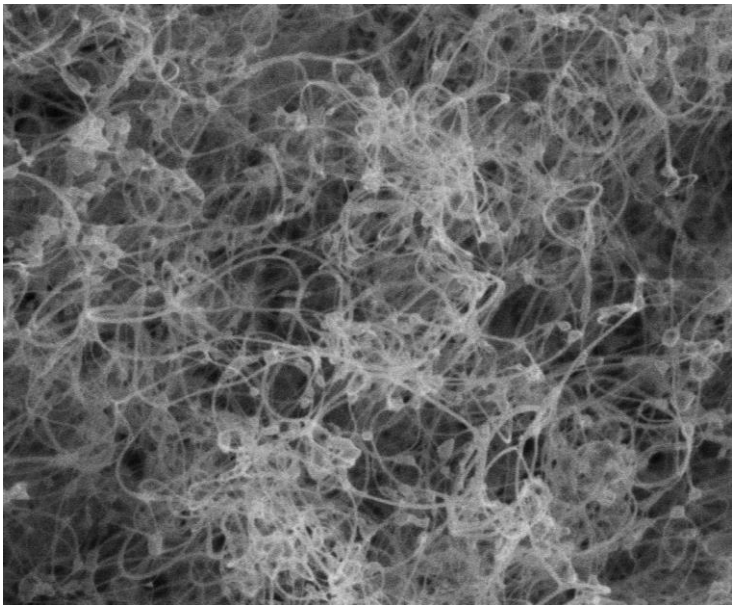
Large-diameter semiconducting SWNTs are good absorbers and emitters of light in the infrared. Moreover, high-purity SWNT thin films have been demonstrated to be photoconductive and photo-luminescent under NIR illumination.

IR sensors/emitters are useful for a number of military and civilian applications.

PlasmaTubes SWCNT

Description: Using a patented plasma torch process, Raymor Nanotech produces raw single-wall carbon nanotubes (SWCNT) at high rates, enabling the lowest prices on the market. As shown by the detailed analysis below, plasma-grown SWCNT display a high graphitization level, diameters (0.9-1.5 nm) and lengths (0.3-4 µm) close to those of laser- and arc-grown SWCNT. The purity of the raw SWCNT (RN-020) is comparable to the purity of the best arc-discharge SWCNT on the market. The following sections will display the information gathered by thermogravimetric analysis, Raman spectroscopy and optical absorption on the raw (RN-020), purified (RN-220) and SuperPurified (SPT-220) SWCNT. The Super Purified SWCNT (SPT-220) product has a nanotube purity of 95-99%. This material is provided in an aqueous surfactant solution with a nanotube concentration of 0.50 mg/ml or a surfactant-removed thick film. Regarding the difference between RN-020, and RN-000 raw SWCNT, the first are grown using a Co-Fe-Ni catalyst mixture whereas the latter are grown using a Ni-Y catalyst mixture. Unless requested, RN-020 is used for all purified and separated grades.

Specifications:



Parameter	Measurement for RN-020 & RN-000	Typical range
G/D ratio with BWF subtraction	Raman spectroscopy at 514 nm	> 35
G/D ratio without BWF subtraction	Raman spectroscopy at 514 nm	> 30
Ash content	Thermogravimetric analysis	27%
1st oxidation peak	Thermogravimetric analysis	400 ºC
2nd oxidation peak	Thermogravimetric analysis	690 ºC
Itkis index	Optical absorption	0.06-0.08
Carbon Purity	Thermogravimetric analysis	80-85%

Parameter	Measurement for RN-220	Typical range
G/D ratio with BWF subtraction	Raman spectroscopy at 514 nm	> 80
G/D ratio without BWF subtraction	Raman spectroscopy at 514 nm	> 70
Ash content	Thermogravimetric analysis	21%
1st oxidation peak	Thermogravimetric analysis	580 ºC
2nd oxidation peak	Thermogravimetric analysis	650 ºC
Itkis index	Optical absorption	0.08-0.1

Parameter	Measurement for SPT-220	Typical range
G/D ratio with BWF subtraction	Raman spectroscopy at 514 nm	> 40
G/D ratio without BWF subtraction	Raman spectroscopy at 514 nm	> 35
Ash content	Thermogravimetric analysis	1-3%
1st oxidation peak	Thermogravimetric analysis	580 ºC
2nd oxidation peak	Thermogravimetric analysis	650 ºC
Itkis index	Optical absorption	> 0.2

Prices:

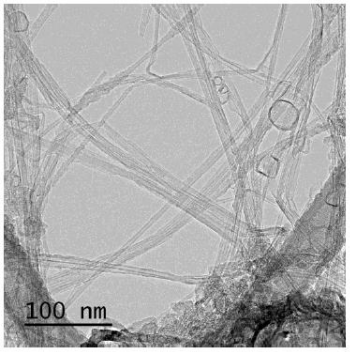
SKU#	Product	Price (USD)	Quantity (g)
1801	Super Purified (SPT-220) Aqueous	1000	1.0
1802	Super Purified (SPT-220 Powder	1100	1.0
1803	Semi-Purified (RN-220) Aqueous	155	1.0
1804	Semi-Purified (RN-220) Powder	85	1.0
1805	Air-Oxidized (RN-120) Aqueous	100	1.0
1806	Air-Oxidized (RN-120) Powder	42	1.0
1807	Raw (RN-020) Aqueous	35	1.0
1808	Raw (RN-020) Powder	20	1.0
1809	Raw (RN-000) Aqueous	35	1.0
1810	Raw (RN-000) Powder	20	1.0

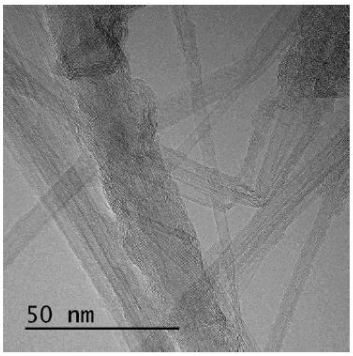
Significant discounts are available for large size orders. Please contact our sales team for special quote.

Purified Few-Walled Boron Nitride Nanotubes (BNNT)

Description: Boron Nitride Nanotubes (BNNT) are a brand new addition to our catalog. Their extreme resistance to high temperatures (up to 900°C in air) and optical transparency make them an ideal filler for the structural reinforcement of glass, ceramics and metal matrices. Furthermore, their high thermal conductivity may enable BNNT to solve one of the main challenges in electronic engineering: thermal management of ever smaller circuit components. Our BNNT are synthesized using a patented plasma torch process, leading to scalable production.

Specifications:





Attribute	Measurement
BNNT Purity	> 69 % by weight
Number of Walls and Diameter	1 - 5 walls typical / ~ 5 nm diameter
Tube Length	≤ 200 µm
Surface Area	100-1800 m^2/g
Bundles	≤ 5 tubes across
Electrical Conductivity / Band Gap	Large band gap insulator ~5.5 eV
Total h-BN & BNH content	≤ 20 %
Tap Density	~0.25mg/cm^3
Thermal Stability	Stable in highly oxidizing environments, e.g. ~900 °C in air.

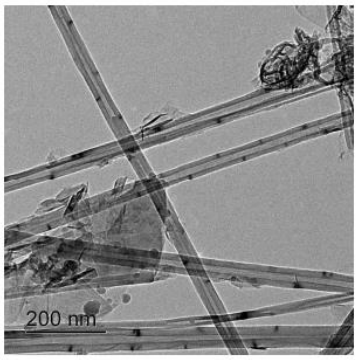
Prices:

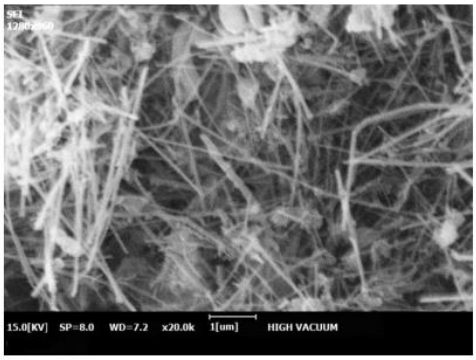
SKU#	Product	Price (USD/g)	Quantity (g)
1907	Purified BNNT Powder	1650	0.5-49
1907	Purified BNNT Powder	1350	49-99
1907	Purified BNNT Powder	1065	100+
1905	Hexagonal Boron Nitride Flakes	1	100.0

Multi-Walled Boron Nitride Nanotubes (MW-BNNT)

Description: Multi-Walled Boron Nitride Nanotubes (MW-BNNT) may provide the answer to your microelectronic circuit overheating problems! Their extreme resistance to high temperatures (up to 900°C in air) and optical transparency make them ideal for the structural reinforcement of glass, ceramics and metal matrices. In a thermal conductivity epoxy composite comprising 0.5wt% MW-BNNT, thermal conductivity was enhanced twofold (from 1.3 to 3.4 W/mK) compared to an epoxy contained h-BN only. It is projected that this material could provide a thermal conductivity up 10 W/mK in such epoxy composites. Finally, the electric breakdown voltage of these composites was measured at 26.3 kV/mm. Our MW-BNNT are synthesized by a CVD process.

Specifications:





Metric	Value
BET Surface Area	> 30 m^2/g
Diameter	50-100 nm
Length	10 - 20 micron

Prices:

SKU#	Product	Price (USD/g)	Quantity (g)
1910	BNNT-MW Powder	625	1 - 99
1910	BNNT-MW Powder	500	100 - 199
1910	BNNT-MW Powder	300	200 -299

Silver Nanowire Ink for Transparent Conductive Film

Description: We offer a new high performance silver nanowire ink for transparent conductive film applications. Our highly conductive transparent ink works can be coated with slot die coating and micro-gravure coating, along with other application techniques.

Specifications:

Performance Index	Testing method	Testing Result
AgNW diameter / length	TEM / SEM	30nm / 20μm
Appearance	Visual	Gray suspension
AgNW content (wt%)	Wet Combustion Method	0.2 - 0.3
Density (g/ml)	Densimeter	1.05
Viscosity (cps) @ 25℃	Rotor rotational viscometer	5 -30 cps
Curing temperature	130℃ for 3-5 min	
Sheet resistance (Ω/口)	Four Probe Method	50 - 100
Transmittance (%)	WGW	90 - 91
Haze (%)	WGW	1 - 1.5
Surface hardness (H)	Pencil hardness testing device	2 - 3H
Adhesion	3M 600 tape, pull vertically	Not shed

Prices:

SKU#	Product	Price (USD)	Quantity
2004	Silver Nanowire Ink	350	1 g / 100 ml

Significant discounts are available for large size orders. Please contact our sales team for special quote.

Double and Multi-Walled Carbon Nanotubes (MWCNT)

Description: Multi-walled carbon nanotubes (MWCNT) are the ideal filler for the structural reinforcement or improvement in electrical conductivity of polymers, elastomers and epoxy. These CVD-grown nanotubes display high purity and low metal content, a controlled diameter range, good length and aspect ratio but most importantly are priced to suit both research and industrial needs.

Specifications:

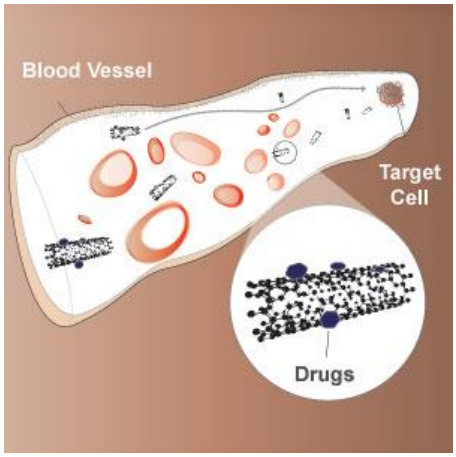
Parameter	99% Purity MWNT	<8 nm MWNT	10-20 nm MWNT
MWNTs Outer Diameter	<20nm	<8 nm	10-20 nm
MWNTs Inside Diameter	4nm	2-5 nm	3-5 nm
MWNTs Ash	0 wt%	<1.5 wt%	<1.5 wt%
MWNTs Purity	>99 wt%	>95 wt%	>95 wt%
WNTs Length	1-12µm	10-30 µm	10-30 µm
Source Material	CVD	CVD	CVD
MWNTs Specific Surface Area	n/a	500 m^2/g	233 m^2/g
MWNTs Electrical Conductivity	n/a	>100 S/cm	>100 S/cm
MWNTs Bulk density	n/a	0.27 g/cm^3	0.22 g/cm^3
MWNTs True density	n/a	~2.1 g/cm^3	~2.1 g/cm^3

Prices:

SKU#	Product	Price (USD)	Quantity (g)
2117	99%, Powder	125	5
2118	99%, Solution	175	1
2103	95%, <8nm OD Powder	65	5
2103	95%, <8nm OD Solution	360	100
2105	95%, 10-20nm OD Powder	50	5
2115	95%, 10-20nm OD Solution	100	1

Significant discounts are available for large size orders. Please contact our sales team for special quote.

Did you know?



CNTs have proven useful for targeted drug delivery. Anti-cancer drugs may be delivered more efficaciously and with fewer systemic side-effects using a "smart" nanotechnology platform than by conventional methods. Carbon nanotubes represent one such promising platform, due to their strong absorbance in the so-called therapeutic infrared window (between 700-1100 nm, depending on body tissue type).

Services

Description: Take advantage of our 10 years of expertise in the nanotechnology and specifically in the nanotubes industry. Raymor and NanoIntegris constitute one of the world's largest and most trusted provider of single-walled carbon nanotubes. We have produced, purified, separated, functionalized and dispersed nanotubes using the best methods in a variety of media and solvents. Please contact us for any special projects or inquiries. It will be our pleasure to provide you with the simplest and most cost effective solution. The following list is subset of available services so please do not hesitate to contact us for your special requirements.

Prices:

SKU#	Product	Price (USD)
2201	Powder/ Thick Film Creation	50
2202	Dispersion: Aqueous	Ask for quote
2203	Dispersion: Non-Aqueous Solution	Ask for quote
2204	Small-scale Testing	Ask for quote
2205	Production Scale-up	Ask for quote
2206	Product Development/ R&D	Ask for quote
2207	Scientific Consultation	Ask for quote
2209	Solution Processing Fee	Ask for quote

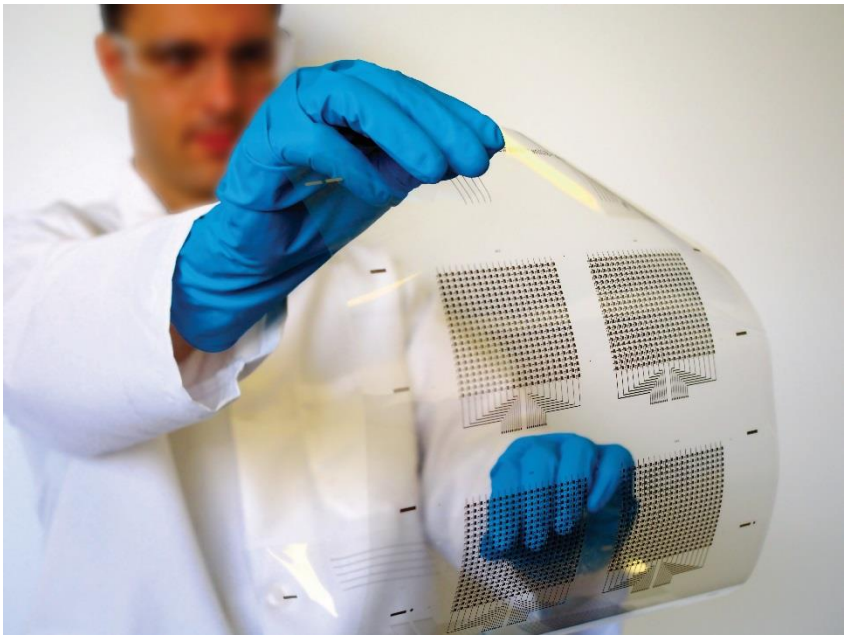
Inks for Printed Electronics

Description: NanoIntegris has begun selling a complementary thin film transistor package. The materials package combines a new **dielectric ink (xdi-dcs)** developed at the XRCC with NanoIntegris' high purity, single-walled carbon nanotube ink (IsoSol-S100), to improve the overall performance of printed high-mobility p-type transistors. Compatibility between semiconducting and dielectric materials is critical for reliable processing and device performance.

One of the challenges that have limited the implementation of single-walled carbon nanotube based thin film transistors is that they exhibit considerable hysteresis with a non-zero threshold voltage when exposed/operated in air ambient. This new materials package addresses performance issues when the **Xdi-dcs ink** is used as a **dielectric**, and when further used as an encapsulant. Key to addressing issues such as hysteresis is the hydrophobic surface of the dielectric layer, which can eliminate water and mitigate charge trapping. Both materials have low viscosity, enabling spin coating, inkjet printing or aerosol deposition, and can be cured at or below 150 °C, making them compatible with the most popular low temperature substrate polyethylene terephthalate (PET).

Further details: J. Lefebvre et al. Hysteresis free carbon nanotube thin film transistors comprising hydrophobic dielectrics. Appl. Phys. Lett. 107, 243301 (2015).

Specifications:



Solution Characteristics		
Metric	**IsoSol Semiconductor**	**Xdi-dcs Dielectric**
Viscosity at 25 ^{o}C	18-22 cps	8-9 cps
Surface Tension	25-30 mN/m	24-25 mN/m
Solvent System	organic	organic
Cure (thermal, air)	150 ^{o}C / 10 min	140 ^{o}C / 30 min
Shelf Life	up to 3 months	up to 2 months
Preferred Deposition Method	Aerosol	Spin-coating
Thin Film Transistor Characteristics		
Metric	**Value (in air)**	**Value (encapsulated)**
Mobility	40 $cm^2/V/s$	> 6 $cm^2/V/s$
On/Off Ratio	1 x 10^4	1 x 10^2
Threshold Voltage	4 $\pm$ 1 V	0 $\pm$ 1 V
Hysteresis	0.004 ± 0.03 V	0.004 ± 0.03 V
Dielectric Constant	4	4
Dielectric Layer Thickness	~ 500 nm	530 nm

Prices:

SKU#	Product	Price (USD)	Quantity (g)
1121	Xdi-dcs Dielectric Ink	16 $/g	< 2000
1121	Xdi-dcs Dielectric Ink	12 $/g	> 2000
1122	10g XDI-DCS Ink & 1mg IsoSol-S100	775	10 g Xdi-dcs+ 1 mg IsoSol

Please view page 8 for the details of IsoSol-S100 semiconducting ink.