KH Chemicals

Technical Data Sheet

KH ED

SWCNT 20~30wt.%

KH EP

SWCNT ca. 60wt.%

KH HP

SWCNT >80wt.%

KH WS

Water Based Dispersion

KH OS

Organic (Ethanol/MEK) Based Dispersion

106-71, Gwahakdanji-ro, Gangnung-city, Gangwon-do, KOREA 210-340

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Better Quality

"We deliver what we really have.

No lab production, No gram limit order, No gimmick. "

KH Chemicals is a Korean chemical manufacturer specialized in production of **Single-walled Carbon Nanotubes (SWCNTs)** using its patented catalyst method. By fully controlling metal catalysts prior to the reaction with carbon source, KH Chemicals' technology allows a **large scale production** of high purity SWCNTs with uniform diameters (1.1 & 1.3 nm) in a continuous process.

If you have further questions, please do not hesitate to contact us.

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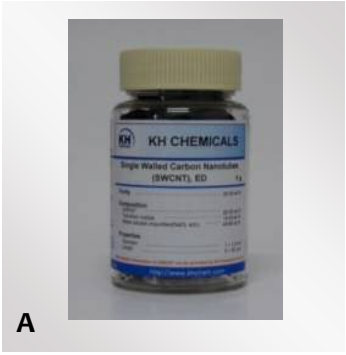
Products List

We currently offer our high quality and uniform SWCNTs and stabilized dispersions in various solvents: KH ED is our main product and it is easy to disperse by water soluble ingredients to loosen SWCNT bundle. KH EP is a mildly purified version of KH ED and easier than KH HP to disperse. KH HP is highly purified version of KH ED. KH EP and HP are suited for electronic devices, FED/FET, electrode materials, etc. to bring the best property of SWCNT. KH WS & OS are very stable and highly conductive dispersions.

KH ED



A

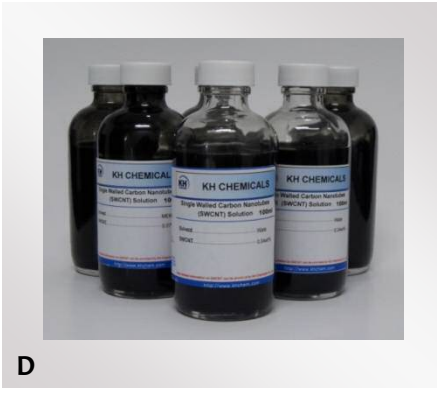
KH EP

B

KH HP

C

KH WS & OS



D

Figure 1. A. SWCNT 20~30wt.% (Capa: 1ton/year)
B. SWCNT ca. 60wt.% (Capa: 200kg/year)
C. SWCNT more than 80wt.% (Capa: 200kg/year)
D. SWCNT 0.1~0.2wt.% in solvent, water, Ethanol, and MEK. Applicable for various applications to enhance thermal and electrical conductivity and mechanical property, etc. KH WS is best fit to TCF application.

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Analysis Data

Optical Absorption Spectroscopy

KH SWCNT

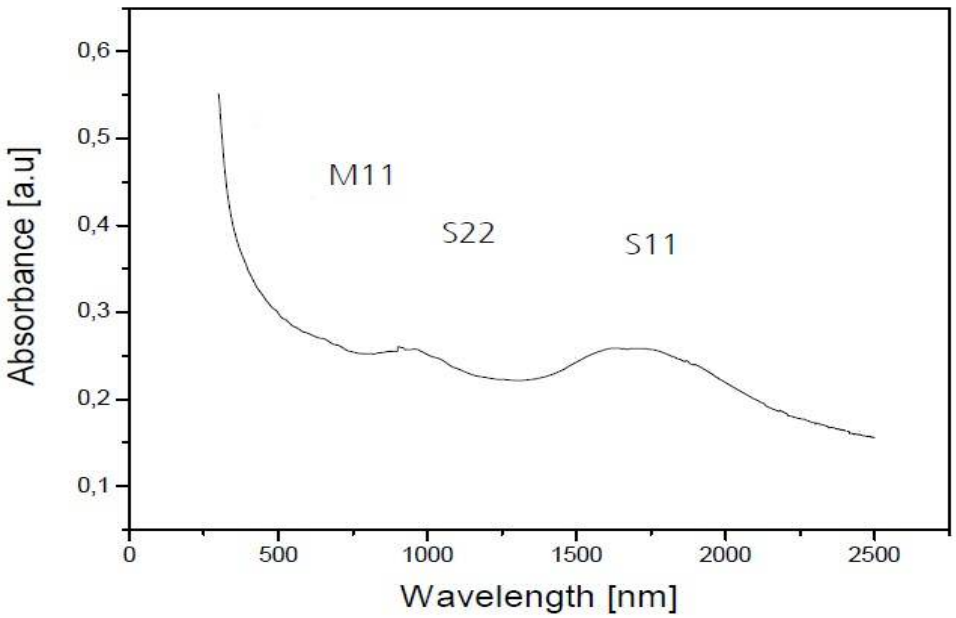

Figure 2. Optical absorption spectroscopy for KH SWCNT. The fraction of metallic SWCNT (m-SWCNT) is about 20% in the KH SWCNT. And more than 80% is semiconducting SWCNT, best fit to FET application. (M11: metallic SWCNT, S22&S11: semiconducting SWCNT)

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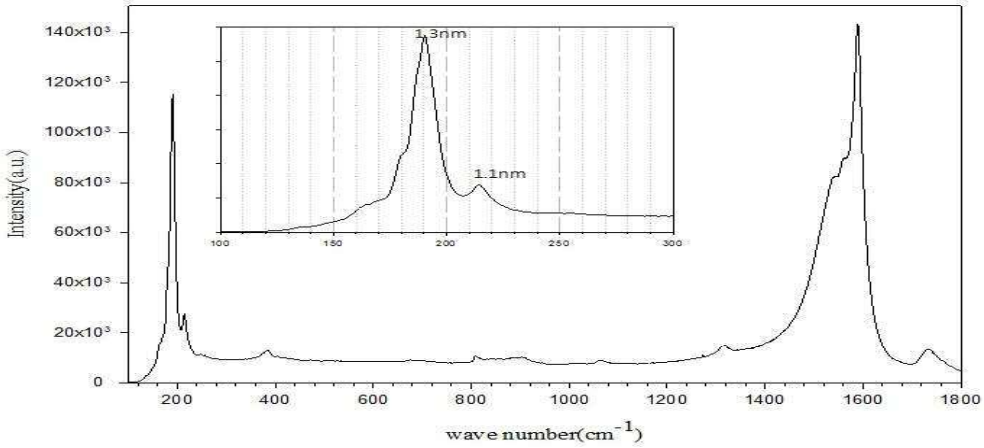
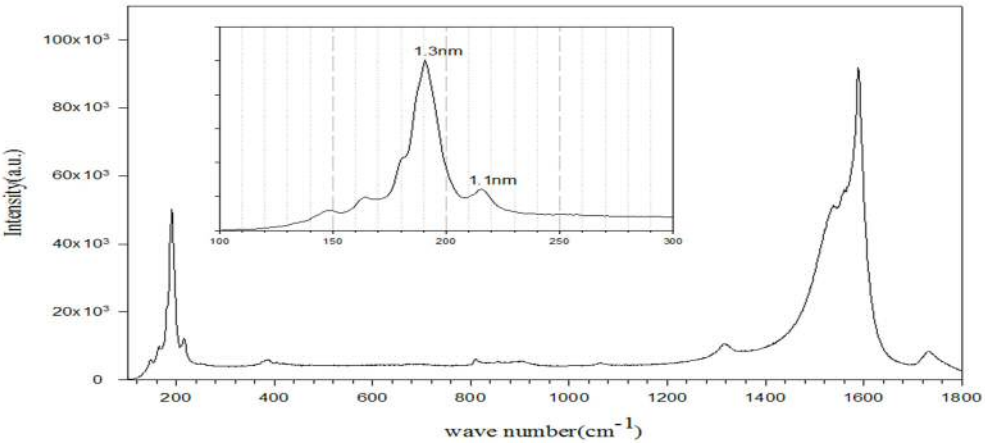
Analysis Data

Raman Spectrum

KH ED



KH EP



KH HP

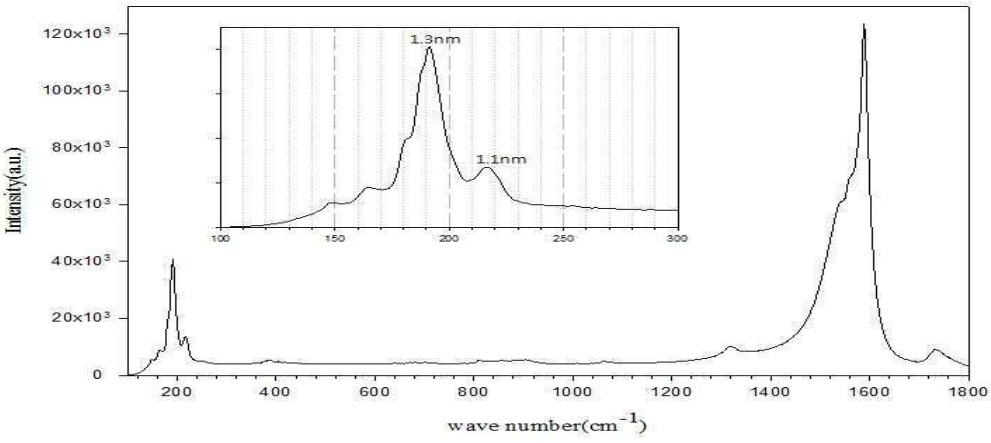


Figure 3. Raman spectrum for KH ED, KH EP and KH HP. All Raman measurement was taken using a 633nm laser. The G/D ratio (I_G/I_D) of KH SWCNT range from approximately 40 to 60, indicating extremely low level of amorphous carbon and/or damaged nanotubes.

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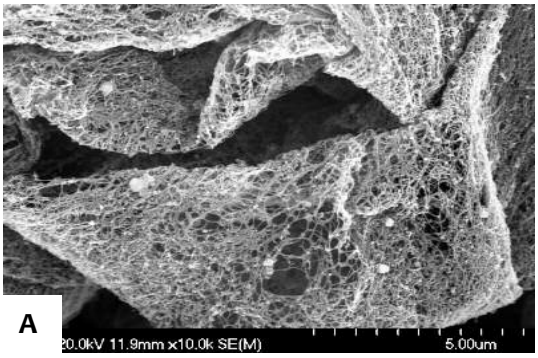
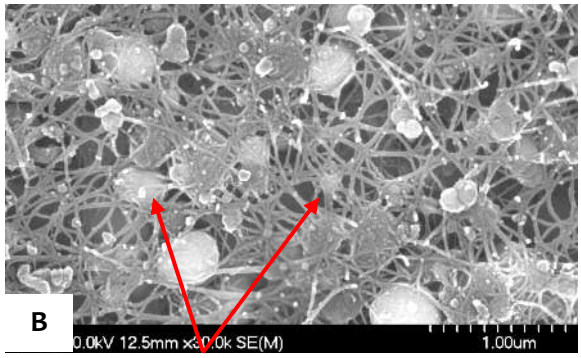
Analysis Data

SEM & TEM

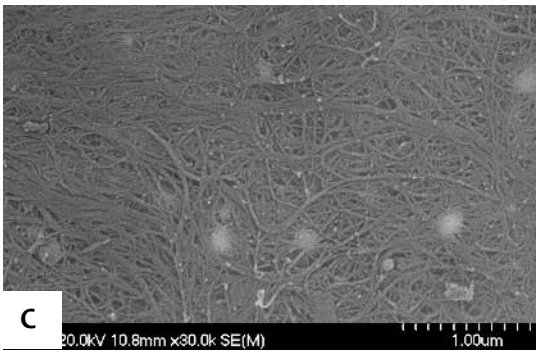
KH ED

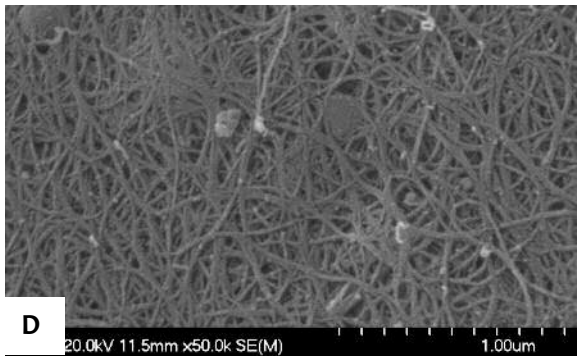




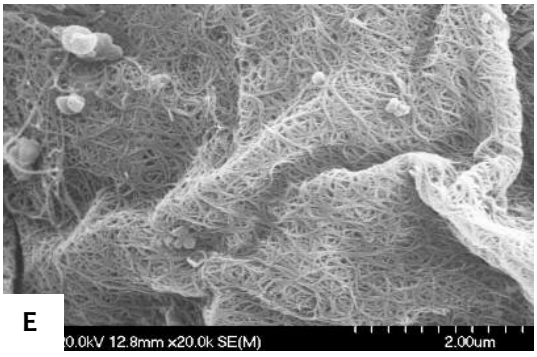
NaCl intercalation

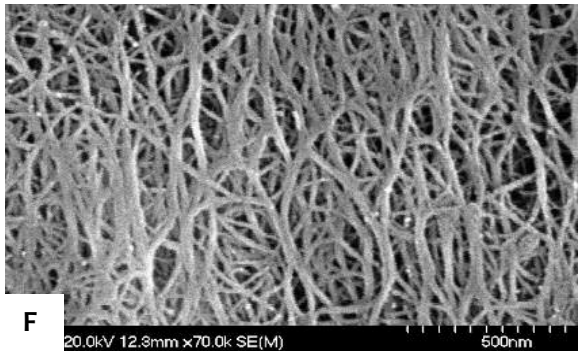
KH EP





KH HP





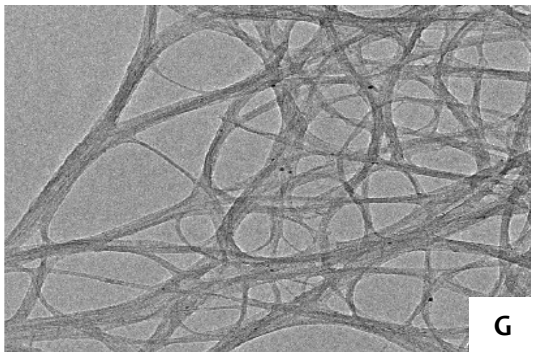


Figure 4. A.B. SEM image for KH ED. NaCl is intercalated to prohibit tight packing of CNT bundles. **C.D.** SEM image for KH EP. **E.F.** SEM image for KH HP. **G.** TEM image for KH SWCNT.

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Analysis Data

Energy Dispersive X-ray microanalysis

KH ED

Element	App Conc.	Intensity Corrn.	Weight%	Weight% Sigma	Atomic%
C K	3.07	0.1959	22.51	2.21	41.52
O K	4.65	0.5327	12.54	0.91	17.35
Na K	8.23	0.6510	18.14	0.71	17.48
Cl K	13.21	0.8158	23.22	0.78	14.51
Fe K	8.00	0.8613	13.33	0.58	5.29
Co K	6.05	0.8460	10.26	0.55	3.85
Totals			100.00		

A

KH EP

Element	App Conc.	Intensity Corrn.	Weight%	Weight% Sigma	Atomic%
C K	72.86	0.7184	64.05	0.60	86.15
O K	3.30	0.4166	5.01	0.50	5.05
Fe K	28.33	0.8349	21.43	0.39	6.20
Co K	12.27	0.8150	9.51	0.31	2.60
Totals			100.00		

B

KH HP

Element	App Conc.	Intensity Corrn.	Weight%	Weight% Sigma	Atomic%
C K	80.96	1.2396	81.74	0.82	92.42
O K	1.36	0.3172	5.35	0.79	4.54
Fe K	3.46	0.7965	5.43	0.29	1.32
Co K	4.64	0.7760	7.48	0.37	1.72
Totals			100.00		

C

Figure 5. A.B.C. Energy Dispersive X-ray microanalysis for KH ED, KH EP and KH HP. The catalyst comprises Fe and Co, and KH SWCNT ED contains water soluble ingredient, NaCl, to loosen SWCNT bundle for its easy dispersion. KH EP & HP don't include water soluble ingredients by purification process.

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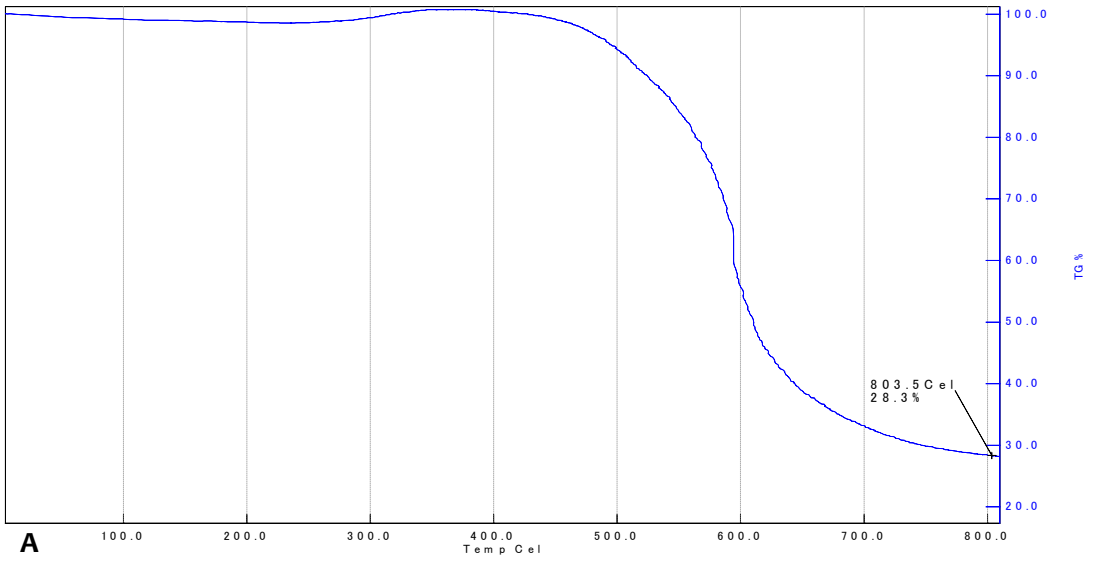
Analysis Data

Thermogravimetric Analysis

KH SWCNT- EP



KH SWCNT- HP

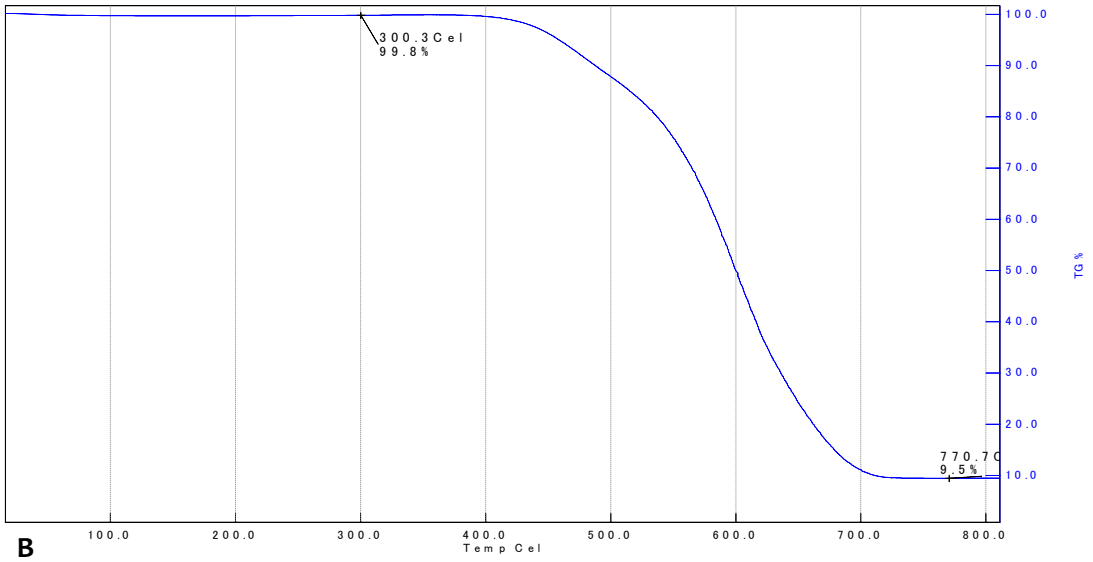


Figure 6. A.B. Thermogravimetric analysis of KH SWCNT EP and HP. KH EP and HP start to burn above 400°C and the residual is ca.30% for KH EP and less than 10% for KH HP.

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Properties at a Glance

High electrical conductivity, High aspect ratio, Mechanical property, Thermal property, Optical transparency

Property	ED	EP	HP	WS	OS
SWCNT Synthesis	CCVD	CCVD	CCVD	CCVD	CCVD
Purity (wt.%)	20~30	ca. 60	>80	0.04~0.2	0.07~0.15
Diameter (nm)	1.0~1.4	1.0~1.4	1.0~1.4	1.0~1.4	1.0~1.4
	(1.1 & 1.3: dominant)				
Length range (㎛)	5~50	5~50	5~50	-	-
Catalyst (wt.%)	15~30	ca. 30	<15	-	-
Water soluble ingredients (wt.%)	45-60	-	-	-	O
Other atomic & carbonaceous Materials (wt.%)	<1	<10	<5	-	-
Semiconducting Content in SWCNT (%)	>80	>80	>80	-	-
Solvent	-	-	-	Water	Ethanol, MEK, etc.
Surfactant	-	-	-	O	O

Figure 7. Properties of KH Products. 1.0 ~ 1.4 nm in diameter, up to 1,000 times as long as it is wide. This structure has remarkable optical and electrical properties, tremendous strength and flexibility, and high thermal and chemical stability.

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