

KH SWCNT

High Quality in Mass Quantity
for Industrial Use



KH Chemicals, Blueprint to the Future!

KH Chemicals Co., Ltd. is a company specialized in production of high quality SWCNT (Single-Walled Carbon Nanotubes) and its dispersed inks. KH Chemicals was founded in 2001 by two chemical engineer Ph.D.s, husband-and-wife, YN Kim and EH Hong. KH Chemicals' factory has an annual production capacity of 1 ton of the best quality KH SWCNT.

KH Chemicals has developed the mass production of SWCNT by its patented continuous process called "**KH Process**". The advantages of KH Process are to make uniform quality of SWCNT, in diameter and length, and to achieve the mass production of SWCNT.

Based on the advanced technology of synthesis and dispersion of SWCNT, we are working further on developing innovative and better solutions to meet the challenge of new technology. The company aims to build on a leading position as a global provider of high and best quality materials. The meaningful mass-production of SWCNT in the world will open the new era of various applications. With KH SWCNTs, we would like to contribute to bring a better life to the world!



History

2012 ~ Present	Cooperation with institutes and companies for commercialization of applications
2011	Launch of KH SWCNT dispersed ink
2010	Stabilized mass production of KH SWCNT
2009	Completion of 1 st plant
2002 ~ 2008	Pilot operation
2001	Foundation

KH Chemicals, We solved all the old problems in SWCNT manufacturing

Technology



Over 90% of KH SWCNT have uniform diameter range of 1.0 ~ 1.4 nm. KH SWCNT is different in the lowest carbon impurities. The highest content of SWCNT in our product is world top level.

Production capacity is 1ton/year. Additional enhancement of production capacity is already planned.

KH SWCNT is being manufactured in the proven and stabilized system. We strictly control the quality of daily production. Your applications with KH SWCNT will have more constant and predictable performance.

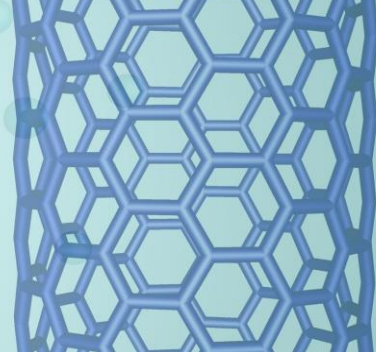
KH Chemicals' factory in Gangnung, KOREA has an annual production capacity of 1 ton of the best quality KH SWCNT.



By fully controlling catalyst and reaction conditions, our technology allows a large scale production of high purity SWCNT with uniform diameter (1.1 & 1.3 nm: dominant) while minimizing carbonaceous impurities.



KH Chemicals, Changing the world with SWCNT



KH Chemicals Co., Ltd. produces high quality SWCNTs having well-ordered structure, uniform diameters of 1.1nm and 1.3nm, and long length SWCNT. KH Chemicals' products, ED, EP, HP, and SWCNT Inks are verified and praised by world's top institutes and researchers.



Products

- KH ED is main product of KH Chemicals with purity avg. 25wt.%.
- KH EP is mildly purified version of KH ED with purity more than 60wt.%.
- KH HP is highly purified version of KH ED with purity more than 80wt.%.
- KH Ink is highly conductive and stable dispersion of KH SWCNT.

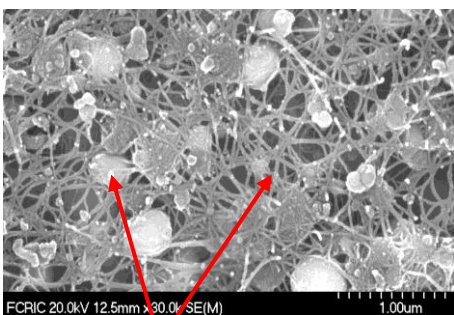
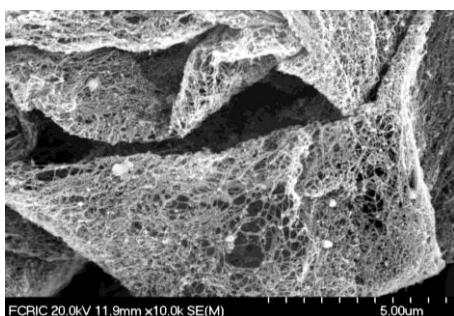


KH SWCNT ED

KH ED (Easy to Disperse) is KH Chemicals' main product, single-walled carbon nanotubes by continuous process using its patented catalytic method. It is easy to disperse by water soluble ingredients (NaCl, etc.) which are intercalated in the SWCNT bundles to prohibit tight packing of SWCNT bundles.



SEM



NaCl intercalation

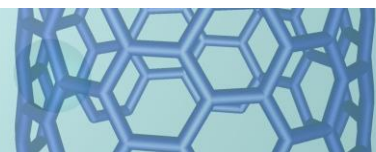
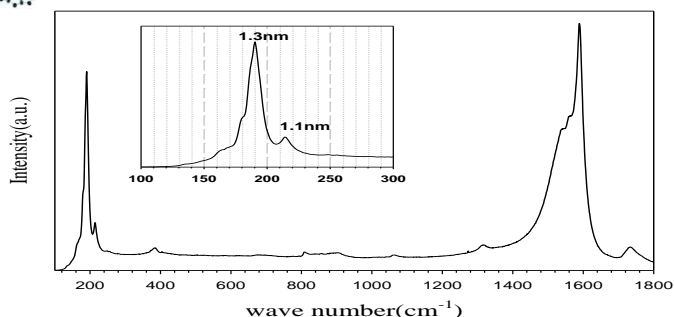


Technical Data

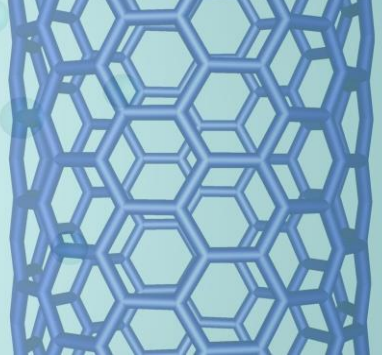
SWCNT	20 ~ 30 (avg. 25) wt.%
Transition metals	15 ~ 30 wt.%
Water soluble ingredients	40 ~ 60 wt.%
Carbonaceous materials except SWCNT	< 1 wt.%
Length	5 ~ 50 μm
Diameter	1.0 ~ 1.4 nm (Dominant: 1.1 & 1.3 nm)



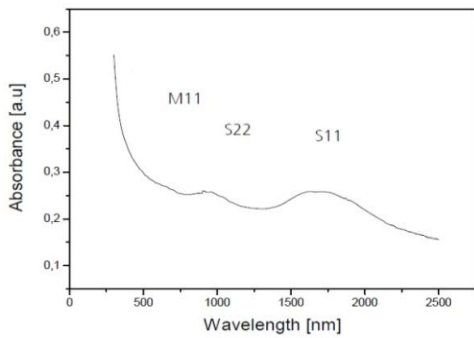
Raman



KH Chemicals, Changing the world with SWCNT



Optical Absorption

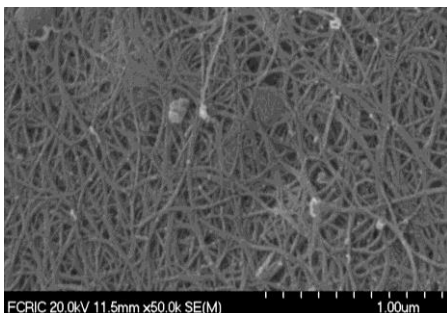


KH SWCNTs are well-ordered SWCNTs with 1.1nm and 1.3nm diameter. The fraction of semiconducting SWCNT (sc-SWCNT) is more than 80%, and metallic SWCNT (m-SWCNT) is about 20% in KH SWCNT. (M11: metallic SWCNT, S22 & S11: semiconducting SWCNT)

KH SWCNT EP

KH EP (Extra Purity) is mildly purified version. The water soluble ingredients (NaCl, etc.) and some portion of catalyst of KH SWCNT ED are removed. It has non-damaged graphitic surface, showing sharp and clear peaks in Raman spectroscopy. KH EP is suited for various applications to bring the best properties of SWCNT.

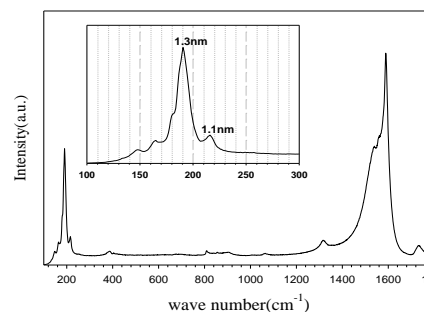
SEM



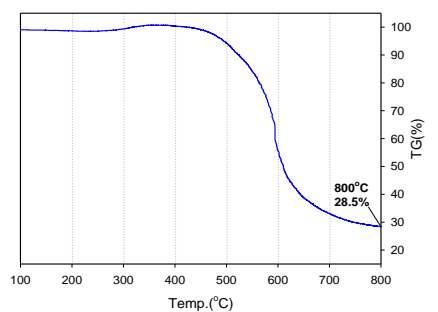
Technical Data

SWCNT	> 60 wt.%
Transition metals	< 40 wt.%
Length	5 ~ 50 μm
Diameter	1.0 ~ 1.4 nm (Dominant: 1.1 & 1.3 nm)

Raman



TGA



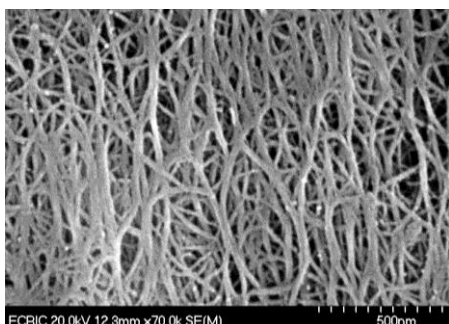
KH Chemicals, Changing the world with SWCNT



KH SWCNT HP

KH HP (High Purity) is highly purified product processed by acid treatment. It has dense SWCNT bundles. KH HP is suited for low metal content SWCNT applications to bring the best properties of SWCNT.

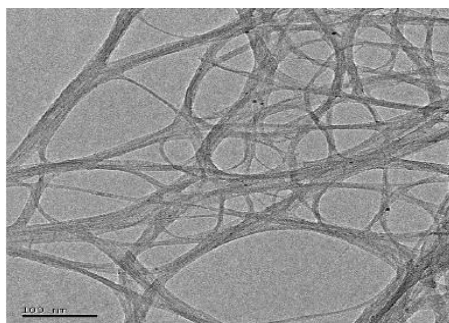
SEM



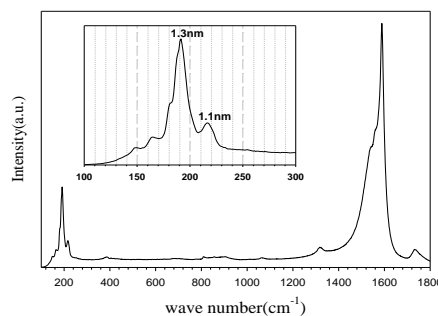
Technical Data

SWCNT	> 80 wt.%
Transition metals	< 15 wt.%
Other atomic & carbonaceous materials	< 5 wt.%
Length	5 ~ 50 μm
Diameter	1.0 ~ 1.4 nm (Dominant: 1.1 & 1.3 nm)

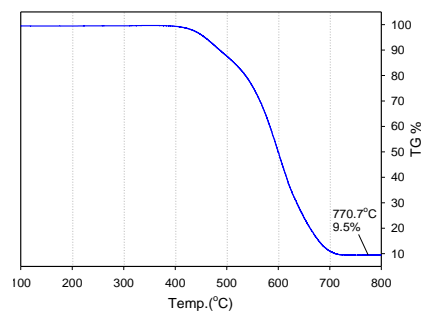
TEM



Raman



TGA



Recommendations

■ KH SWCNT ED

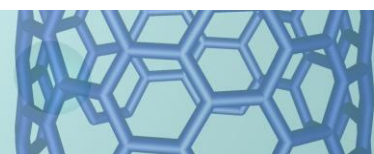
If you disperse SWCNT for your application, we recommend KH SWCNT ED as starting material. NaCl can be removed by washing.

■ KH SWCNT EP

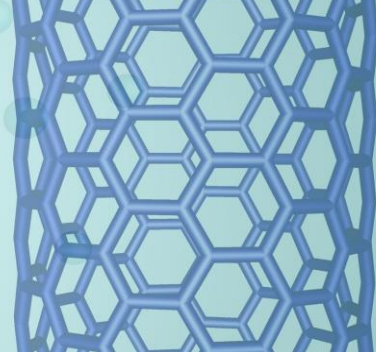
If you prefer purified SWCNT with non-damaged graphitic surface, we recommend KH SWCNT EP.

■ KH SWCNT HP

If you prefer extremely purified SWCNT with low metal content, we recommend KH SWCNT HP.



KH Chemicals, Changing the world with SWCNT



KH SWCNT Inks

KH WS (Water Solution) & KH OS (Organic Solution) are very stable and highly conductive dispersions. KH Chemicals has its own dispersion technology and provides KH SWCNT dispersed inks in various solvents, water, Ethanol, MEK, etc. KH SWCNT inks are developed primarily of use in the future-oriented markets and KH WS is applicable to various fields requiring high electrical conductivity, such as TCF, electrode materials, ESD/EMI shielding, etc.

Technical Data

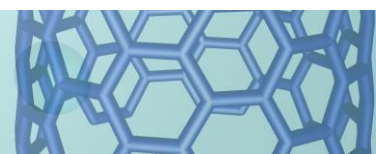
	KH WS	KH OS
Solvent	Water	Ethanol, MEK, etc.
SWCNT Content	0.1 wt.% (≤ 0.2 wt.%)	0.1 wt.% (≤ 0.2 wt.%)
Surface resistance	$10^{2\sim 3} \Omega/\square$ on PET film	-
Transmittance	80 ~ 90%	-
Remarks	Available for customized development in various organic solvent	

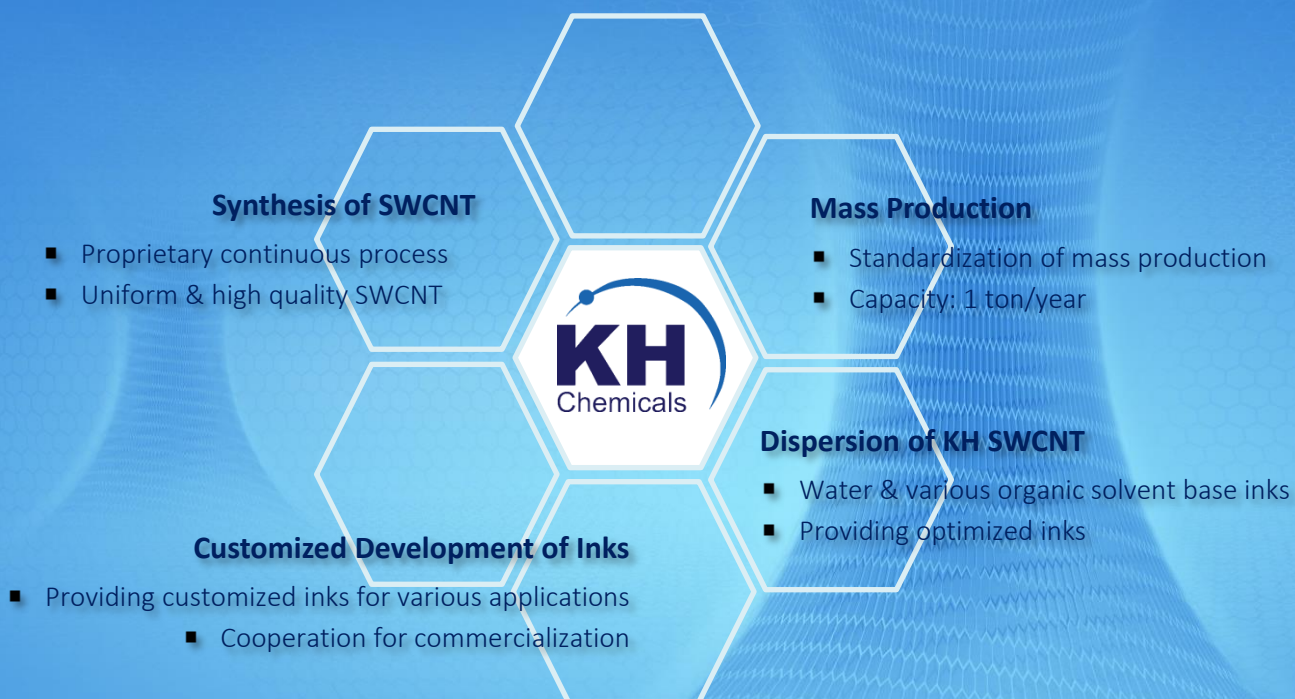
- Conductive SWCNT coating
- Stabilized dispersion
- Excellent adhesion
- Various dispersion solvents
- Customized R&D



Applications

- Transparent Conductive Film (TCF)
- EDLC or secondary battery electrode material
- ESD/EMI shielding
- Conductive Textile
- Dye-sensitized solar cell, etc.





KH Chemicals Co., Ltd.

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

TEL +82-33-642-4116
FAX +82-33-642-4126
Website www.khchem.com
E-mail info@khchem.com