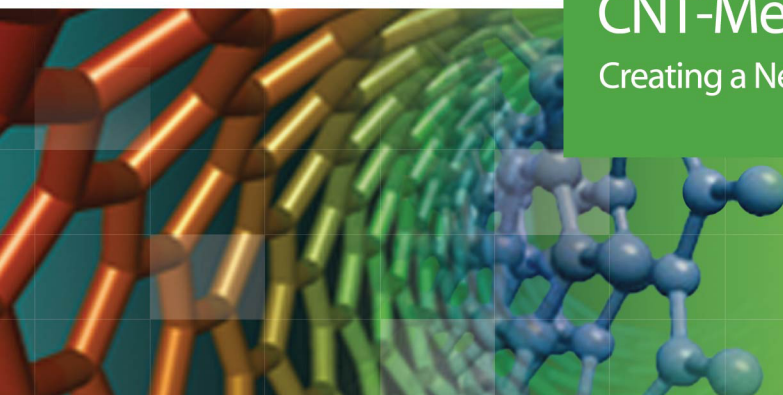


CNT-Metal Nano Composite Powders

Creating a New Era of Nano with Carbon Nanotube-Metal



- **Uniform Dispersion of Metal Nano Particles in CNT-Metal Composite**
- **Distinct and Specific Properties of Nano Size Metal in Composite**
- **Sizes of Nano Metal Particle are ranged between 10 and 500 nm**
- **Superior Thermal Conductivity and Electric Conductivity due to CNT**
- **High Tensile Strength and High Young's Modulus on mechanical properties**
- **Excellent Efficiency of Electron Emitter Characteristics**

Product Descriptions

The new CNT material, CNT-Metal Nano Composite Powders is the composite of Carbon Nanotube(CNT) threaded with nano-size metal beads. These can be mixed uniformly at the molecular level with different materials. The key feature of the products is molecular mixing with other nano-powders. The fundamental nature of agglomeration of carbon nanotube is overcome by the carbon nanotube's chemical surface treatment and subsequent formation of nano metal along the CNT. The final structure looks like a necklace made with CNT thread and nano metal beads.

Applications of CNT-Metal

- **Materials for Electric Applications:**
 - Field Emission Display
 - Field Emission Lamp
 - Back Light Unit
 - Electrode in fuel cell
 - Electromagnetic Interference (EMI) Shielding
 - Biosensor
- **Materials for Matrix Composite Applications:**
 - Oil-less bearing
 - Tool steel
 - Parts for vehicle
 - Bulletproof materials
 - Light weight weaponry and armament
 - Light weight & high strength CNT-reinforced metal matrix composite, etc.

The Features of CNT - Metal Nano Composite

CNT-Metal Nano Composite Powders have two special characteristics of carbon nanotubes and metal that can find synergy effect to use in various applications. The existing technology is sintering metal and carbon nanotubes that could not consolidate, however our innovative technology solved the problem.

- **Maximize Surface Area through CNT-Metal Nano Composite Powders**

CNT-Metal Nano Composite Powders is highly functional material that can be used as fuel cell material and secondary battery's electrode. It can also be used for the hydrogen storage materials at fuel cell and etc.

- **Uniformly dispersed CNT-Metal Nano Composite Powders**

CNT-Metal Nano Composite Powders is the product that uniformly dispersed that shows excellent property and better uniformity as a whole than the existing physical composition of CNT and metal powders.

- **Nano Metal Bonded to CNT**

The Size of the metal particles that are bonded to disperse CNT from CNT-Metal Nano Composite Powders is uniformed and the metal particles are bonded as sphere form.

Stable Electron Emitter in Display Application

Recently in the field of utilizing CNT-Metal Nano Composite Powders in application of electron emitter and field emission display is widely and actively researched throughout the world. There is a great expectation that PDP (plasma display panel), LCD (liquid crystal display) and FED (field emission display) will be mainly entering the market in the next high-tech informative generation follow by display, CRT(cathode ray tube). Especially, FED will be the next generation display since it is High Definition, High Efficiency and Low Electric Power consumption and the core technology of FED is the process technology of the Emitter tip as well as its stability.

Various Other Applications

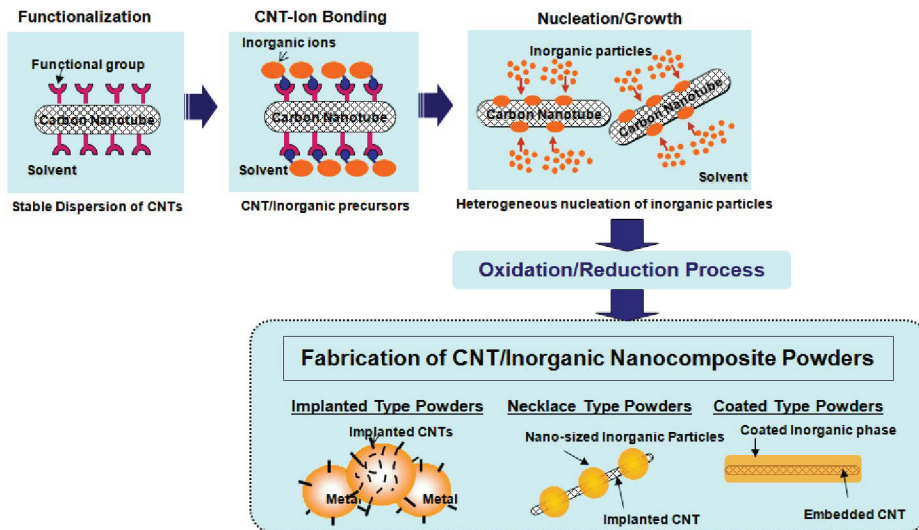
CNT-Metal Nano Composite Powders has high potential for its application in the field of high strength composite materials, magnetic storage materials, electro-magnetic interference shielding materials, parts of vehicle, bulletproof material and unlimited fields.

Various CNT/Metal ratios

CNT- Metal Nano Composite Powders consist of metal (cobalt, copper, nickel, platinum, etc.) and carbon nanotubes. The standard ratios are: 93%, 85%, 70%, 50%, and 30% metal contents. However, the ratio can be synthesized upon customers' requests.

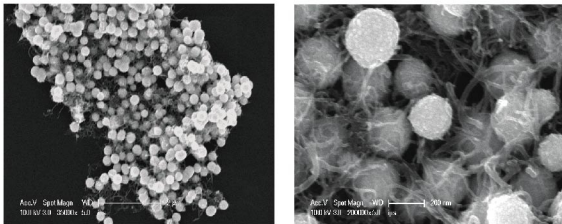
- CNT-Cobalt Nano composites
- CNT-Nickel Nano composites
- CNT-Platinum Nano composites
- CNT-Copper Nano composites
- CNT-Iron Oxide Nano composites
- CNT-Silver Nano composites

Novel Fabrication Process for CNT-Metal Composite: Molecular Level Mixing Process

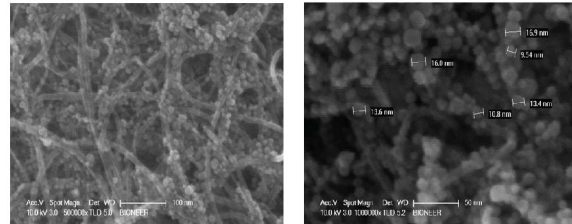


FE-SEM Image

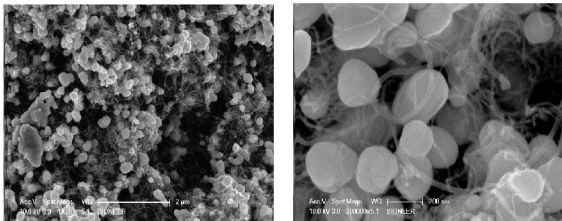
1. CNT - Cobalt: Following pictures are SEM images of Carbon Nanotube - Cobalt Composites.



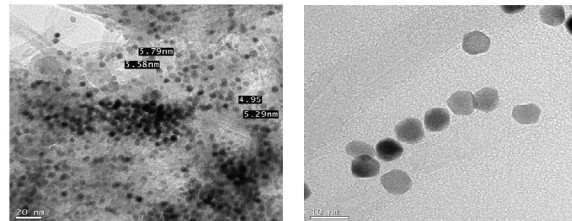
4. CNT-Iron Oxide: Following pictures are SEM images of Carbon Nanotube-Iron Oxide Composites.



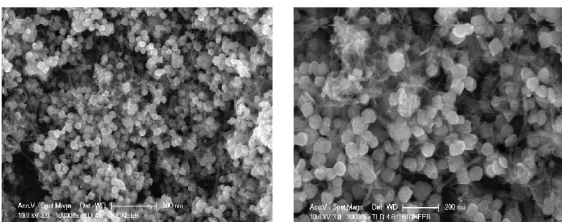
2. CNT-Copper: Following pictures are SEM images of Carbon Nanotube-Copper Composites.



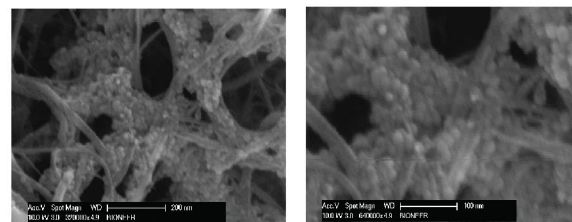
5. CNT-Platinum: Following pictures are SEM images of Carbon Nanotube-Platinum Composites.



3. CNT-Nickel: Following pictures are SEM images of Carbon Nanotube-Nickel Composites.



6. CNT-Silver: Following pictures are SEM images of Carbon Nanotube-Silver Composites.



Application Testing of CNT-Metal Composite

● Field Emission test & BLU Prototype made of CNT-Co

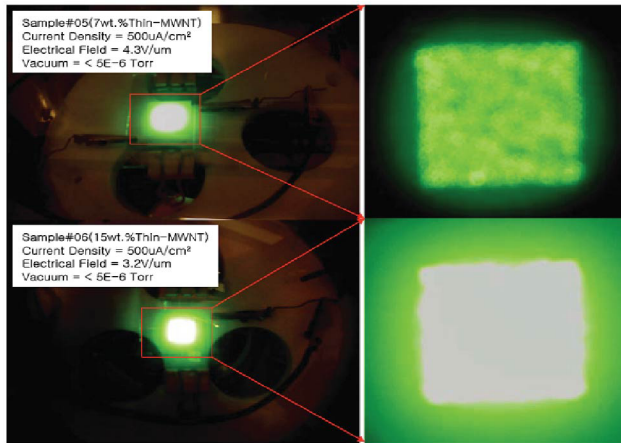


Figure 1. Emission pictures of CNT-Co composite. The CNT-Co composite was synthesized with Thin Multi wall CNT and Cobalt metal shown electron emission characteristics from CNT tip. The test conditions were 500uA/cm² of current density and 4.3V/ μm of electrical field.

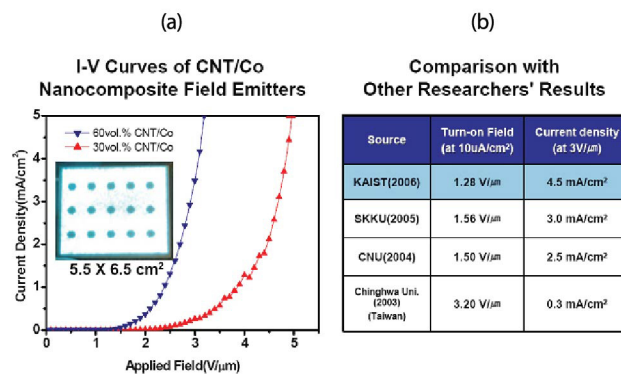


Figure 2. Field Emission properties of CNT-Co Composite: (a) I-V curves of 60 vol% CNT-Co and 30 vol% CNT-Co composite field emitters, (b) Table of turn-on field and current density for comparison with other research group's results. These images are shown by courtesy of KAIST (Korea Advanced Institute of Science & Technology)

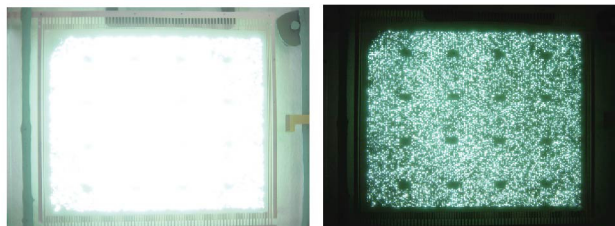


Figure 3. Prototype of BLU (Back Light Unit). Electrical fields are 8.75V/ μm and 18.75V/ μm, respectively.

● Bearing Ball sintered of CNT-Cu Composite

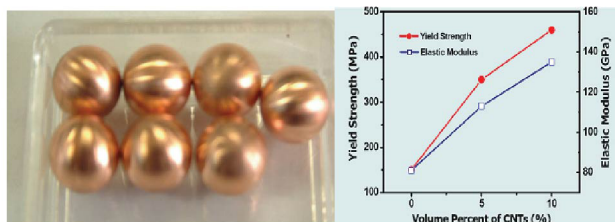


Figure 4. Bearing Ball picture made of CNT-Cu Composite and mechanical properties plot of various CNT contents in CNT-Cu composite. Bearing Ball made of CNT-Cu has shown the result of 3 times greater strength in yield strength and 2 times greater modulus in elastic modulus than properties of Copper itself. These images are shown by courtesy of KAIST

- DTA Result of CNT-Ag Composite

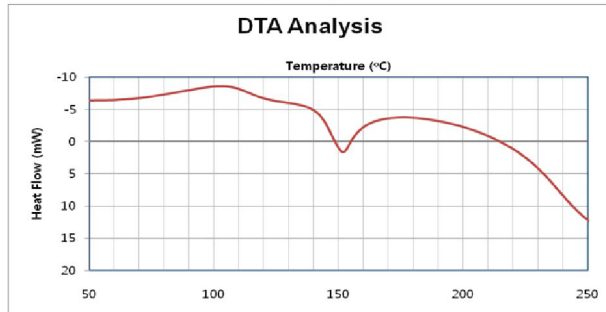


Figure 5. DTA(Differential Thermal Analysis) result of CNT-Ag composite. The silver nano particle bonded at CNT shows melting point at 150 °C due to 20nm size of silver nano particle. CNT-Ag composite can be applied to conductive inks and emitter tips.

- Polymer Composite made of CNT-Al and Epoxy Resin

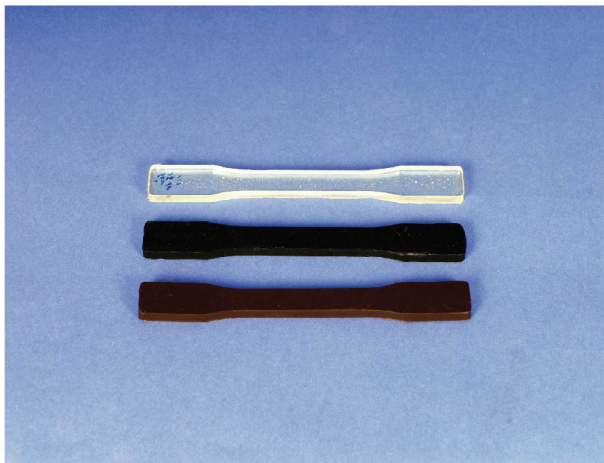


Figure 6. Tensile test specimens of epoxy resin and CNT-Al composite for measurement of mechanical properties.

This image is dog-bone shape specimens of epoxy resin and CNT-Al composite for measurement of mechanical properties as method of ASTM D638. The Table 1 Shows that epoxy composite resin made with CNT-Al results in 1.7 times greater strength in tensile strength and 3 times greater modulus in Young's modulus than properties of epoxy resin itself.

Table 1. Mechanical Properties of Pure Epoxy and CNT-Al/Epoxy Resin

Test Sample	Tensile Strength	Young's Modulus
Epoxy Resin	84 MPa	1.08 GPa
CNT-Al/Epoxy Resin	146 MPa	3.21 GPa

PET film printed with CNT-Ag



Figure 7. PET film printed with CNT-Ag paste and increased temperature to 150 °C The Temperature lasts 2 hours for melting of silver nano particles on Carbon Nanotube. Electrical conductivity of CNT-Ag printed on PET film is 2.5×10^{-2} S/cm.

Ordering Information

Please inquiry for bulk orders.

Cat. No.	Product Descriptions	Pack size	List Price (\$)
CNT-Cobalt Composite:			
T-1023-1	CNT-Co Composite 85 Cobalt 1000 nm	1 g	US\$ 200
T-1023-2	CNT-Co Composite 85 Cobalt 1000 nm	5 g	US\$ 500
T-1023-3	CNT-Co Composite 85 Cobalt 1000 nm	10 g	US\$ 750
CNT-Nickel Composite:			
T-2021-1	CNT-Ni Composite 85 Nickel 100 nm	1 g	US\$ 200
T-2021-2	CNT-Ni Composite 85 Nickel 100 nm	5 g	US\$ 500
T-2021-3	CNT-Ni Composite 85 Nickel 100 nm	10 g	US\$ 750
CNT-Copper Composite:			
T-3031-1	CNT-Cu Composite 70 Copper 100 nm	1 g	US\$ 200
T-3031-2	CNT-Cu Composite 70 Copper 100 nm	5 g	US\$ 500
T-3031-3	CNT-Cu Composite 70 Copper 100 nm	10 g	US\$ 750
CNT-Iron Oxide Composite:			
T-5041-1	CNT-Fe ₃ O ₄ Composite 50 Iron Oxide 100 nm	1 g	US\$ 200
T-5041-2	CNT- Fe ₃ O ₄ Composite 50 Iron Oxide 100 nm	5 g	US\$ 500
T-5041-3	CNT- Fe ₃ O ₄ Composite 50 Iron Oxide 100 nm	10 g	US\$ 700
CNT-Platinum Composite:			
T-1151-1	CNT-Pt Composite 30 Platinum 10 nm	1 g	US\$ 400
T-1151-2	CNT-Pt Composite 30 Platinum 10 nm	5 g	US\$ 900
T-1151-3	CNT-Pt Composite 30 Platinum 10 nm	10 g	US\$ 1,500
CNT-Silver Composite:			
T-7031-1	CNT-Ag Composite 70 Silver 100 nm	1 g	US\$ 300
T-7031-2	CNT-Ag Composite 70 Silver 100 nm	5 g	US\$ 750
T-7031-3	CNT-Ag Composite 70 Silver 100 nm	10 g	US\$ 1,125

Legal statement

' CNT-Metal Nano Composite technology ' is licensed to Bioneer from the KAIST under Korea patent 10-0558966 and US patent 7, 217,311.

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