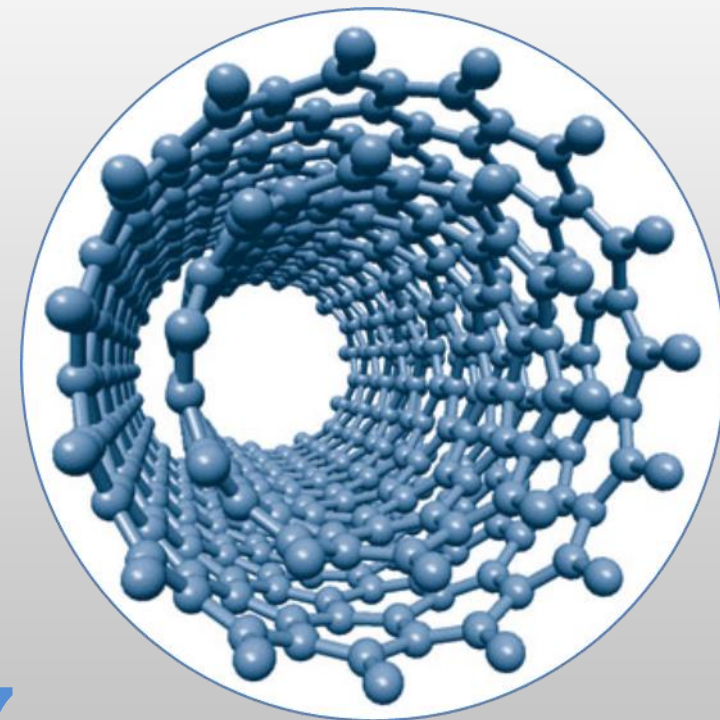


# NANOSTRUCTURED CARBON PRODUCTION AND IMPLEMENTATION IN CERAMIC MATERIALS

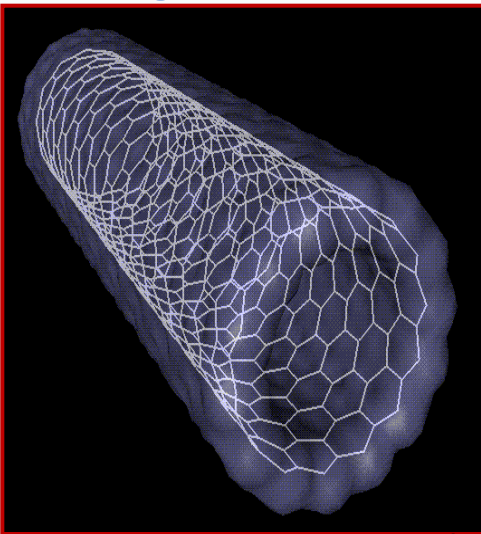
**S.A. ZHDANOK**

**MINSK, 2017**

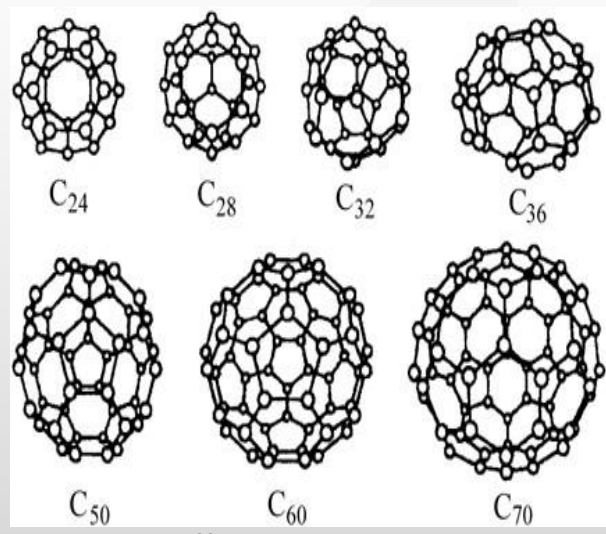


# Carbon is inexhaustible.

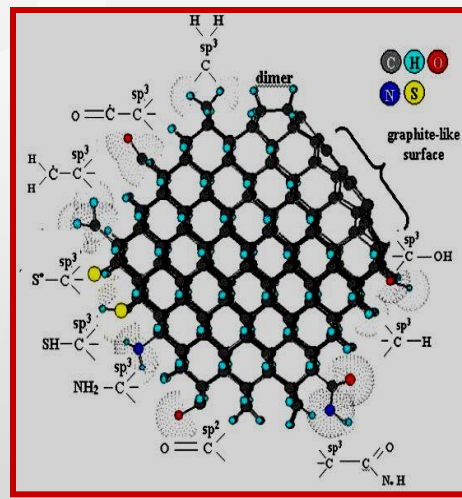
## There can be a great number of its allotropic forms



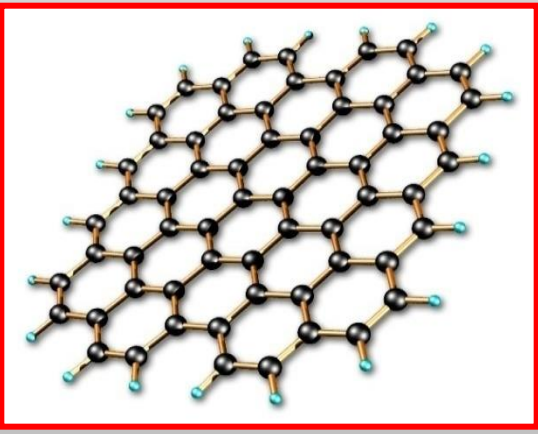
Nanotube



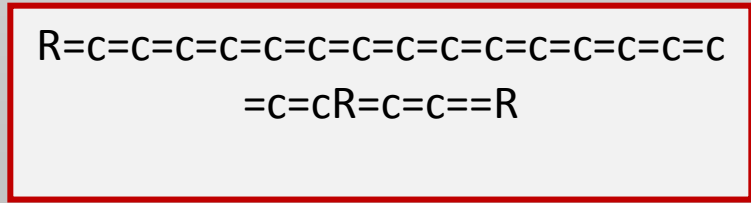
Fullerenes



Nanodiamond



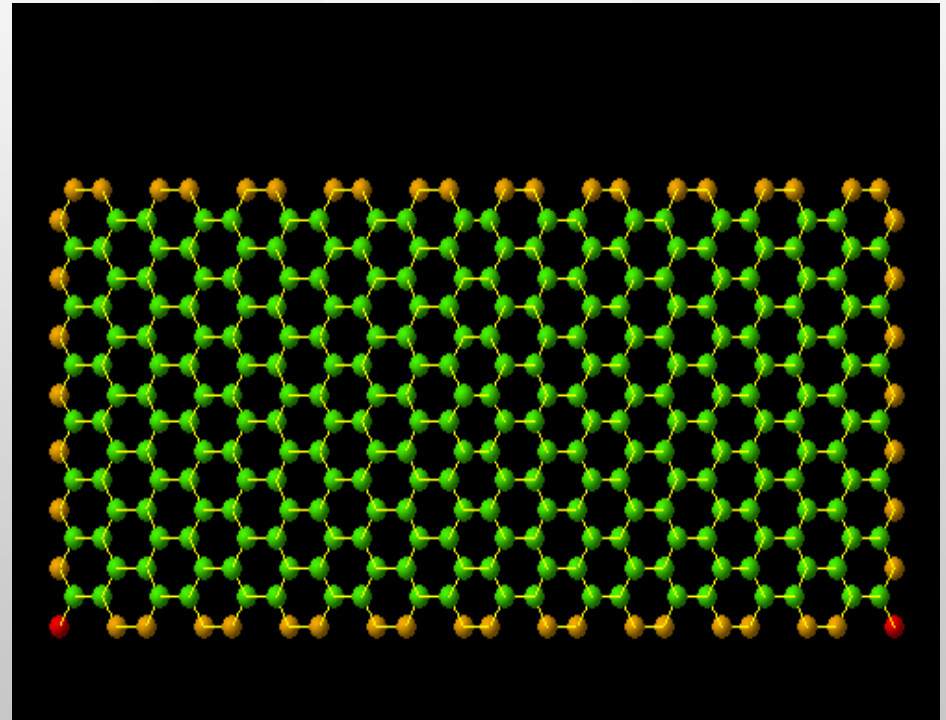
Graphene



Carbyne

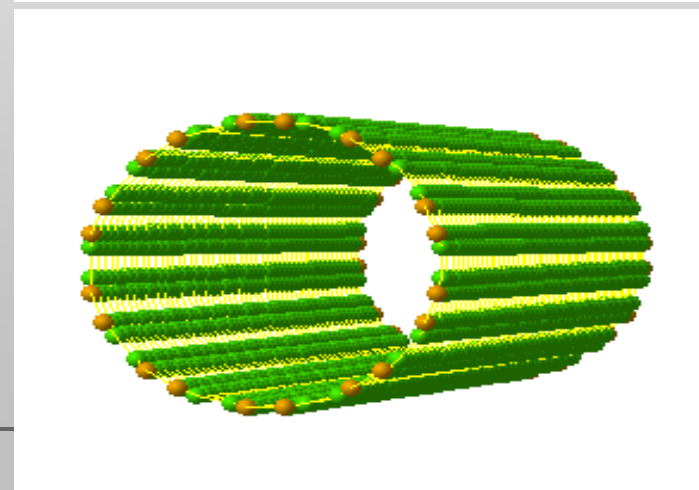
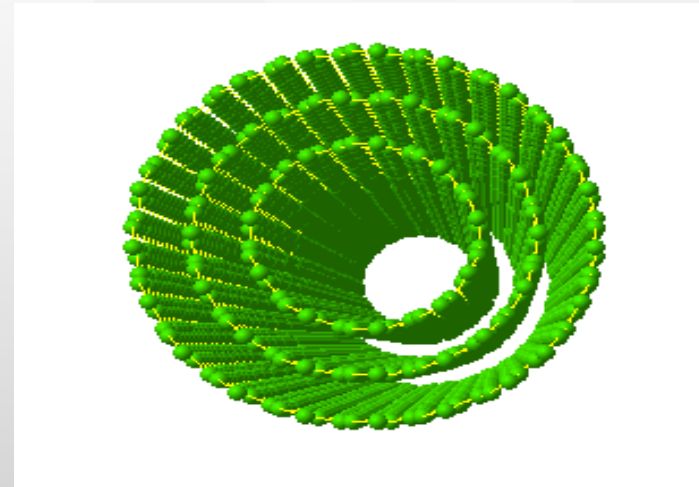
# Carbon Nanotubes

- CNT can be described as a sheet of graphite rolled into a cylinder
- Constructed from hexagonal rings of carbon
- Can have one layer or multiple layers
- Can have caps at the ends making them look like pills



# Nanotubes Classification

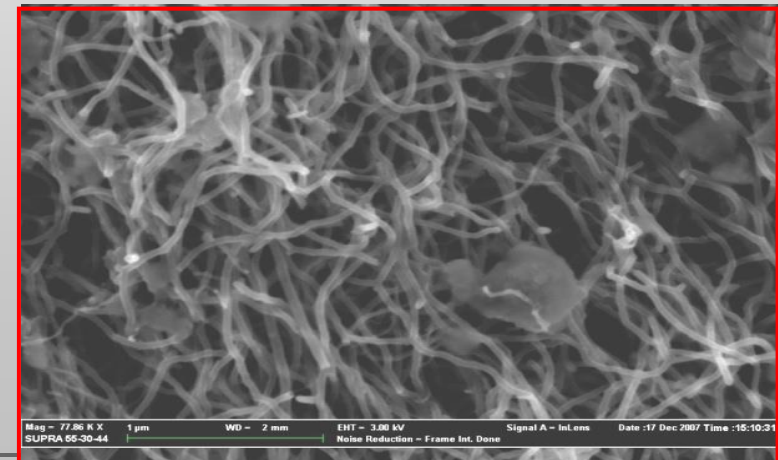
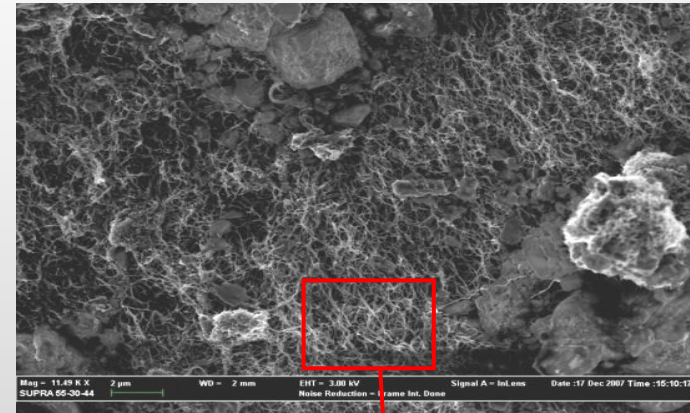
- **MWNT**
  - Consist of 2 or more layers of carbon
  - Tend to form unordered clumps
- **SWNT**
  - Consist of just one layer of carbon
  - Greater tendency to align into ordered bundles
  - Used to test theory of nanotube properties



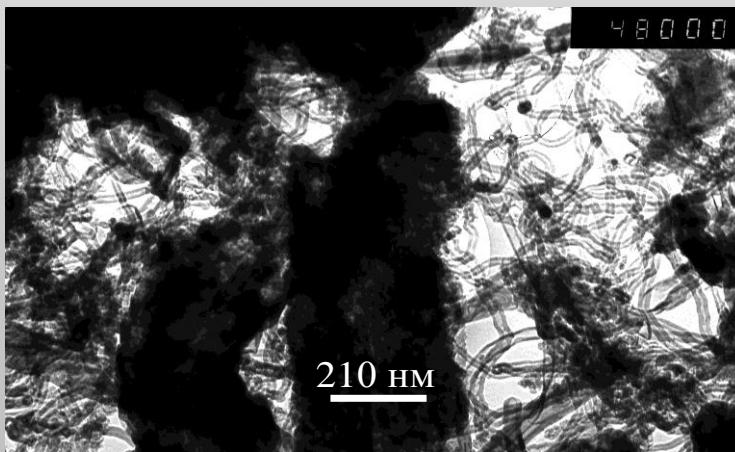
# Manufacture of Carbon Nanotubes



**Installation for obtaining carbon nanomaterial capacity of 10 g / h**



**SEM-picture of CNM**

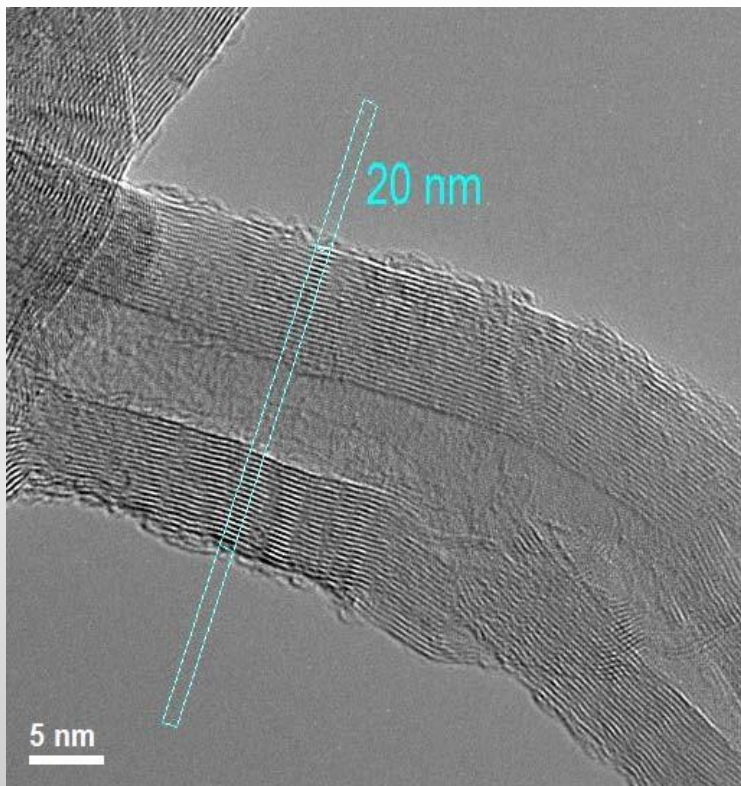


**TEM-picture of CNM**

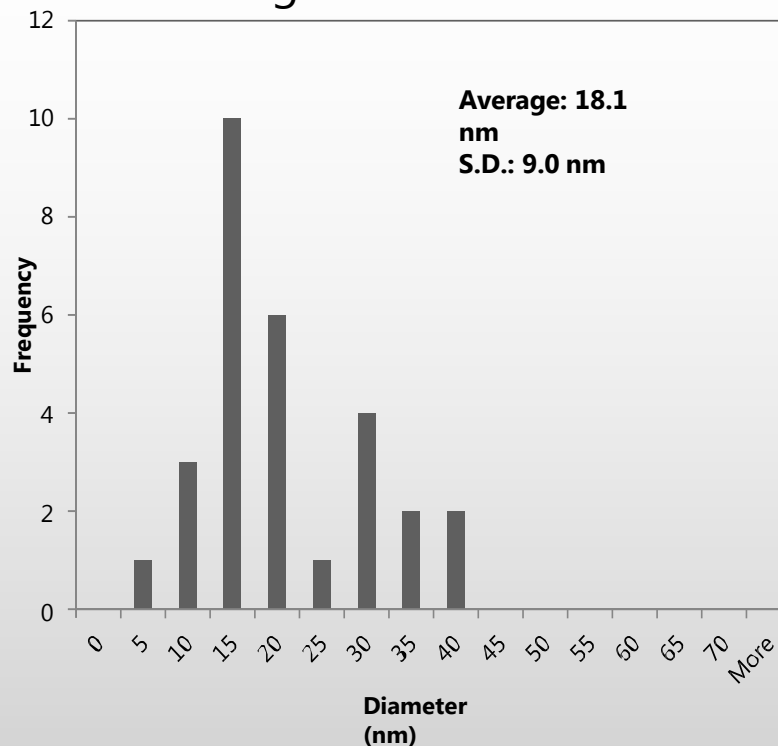


# ADVANCED RESEARCH & TECHNOLOGIES

Minsk, Belarus



Histogram of tube diameter



## ➤ Characteristics of the CNTs

- 10~40 nm in diameter
- 10~20 walls
- >2  $\mu\text{m}$  in length (limited by the field of view)
- Percentage of single-walled and double-walled tubes: <1% (none observed so far)



# ADVANCED RESEARCH & TECHNOLOGIES

## Minsk, Belarus



### ART CARBON

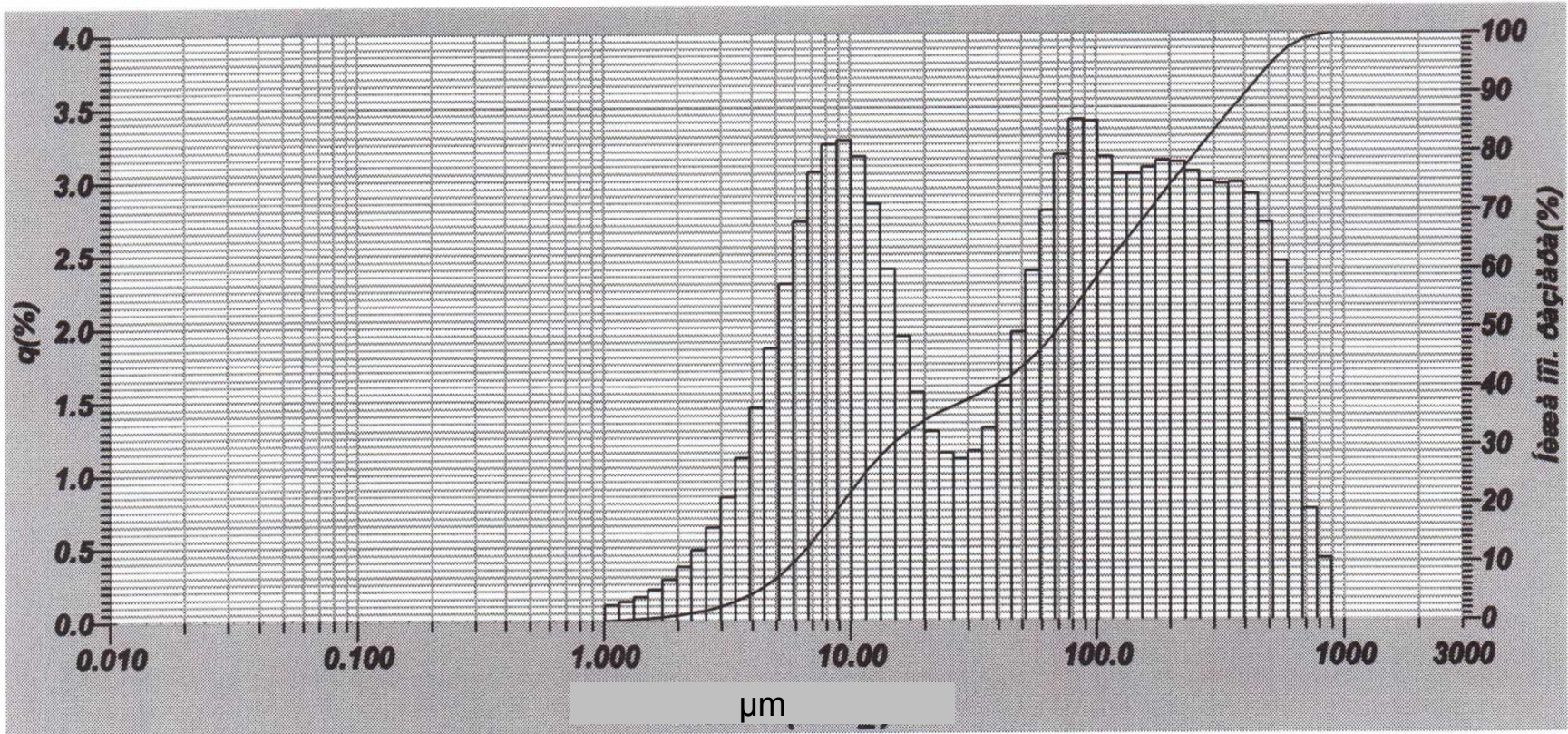
Advanced Research & Technologies

## Production of "ART NANO" CARBON NANOTUBES



**1kg/hour CNT production facility**

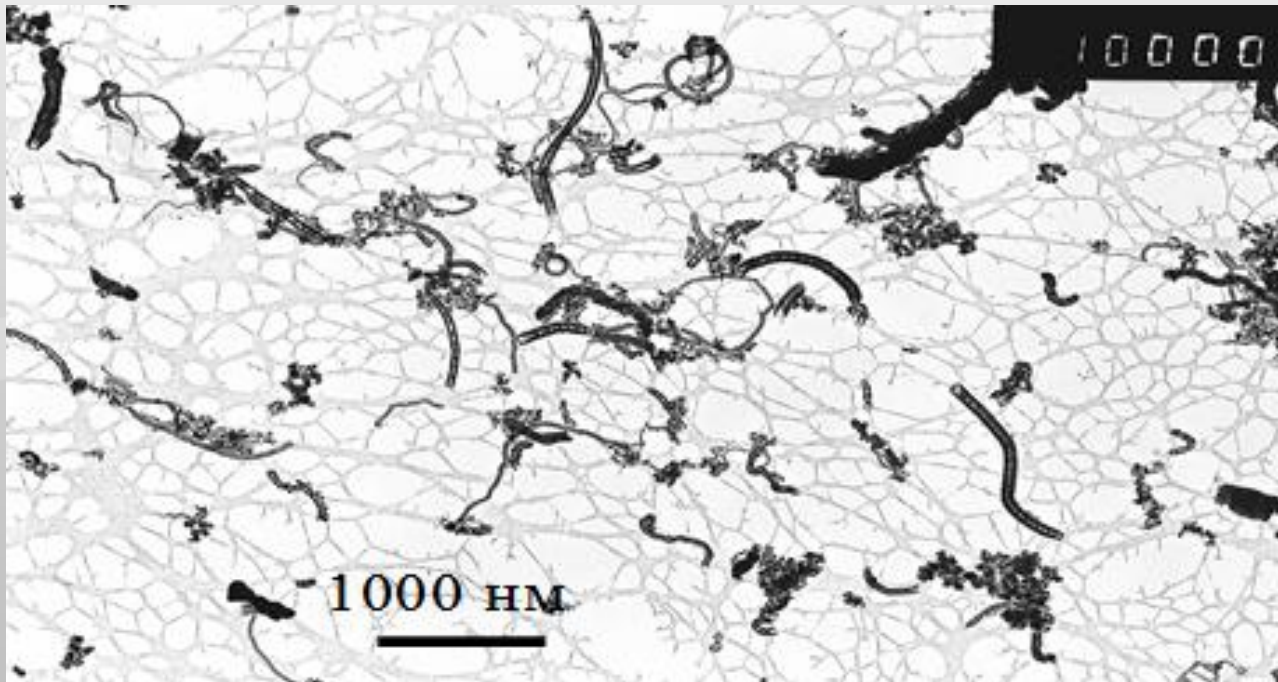
# Manufacture of "ART NANO" Carbon Nanotubes



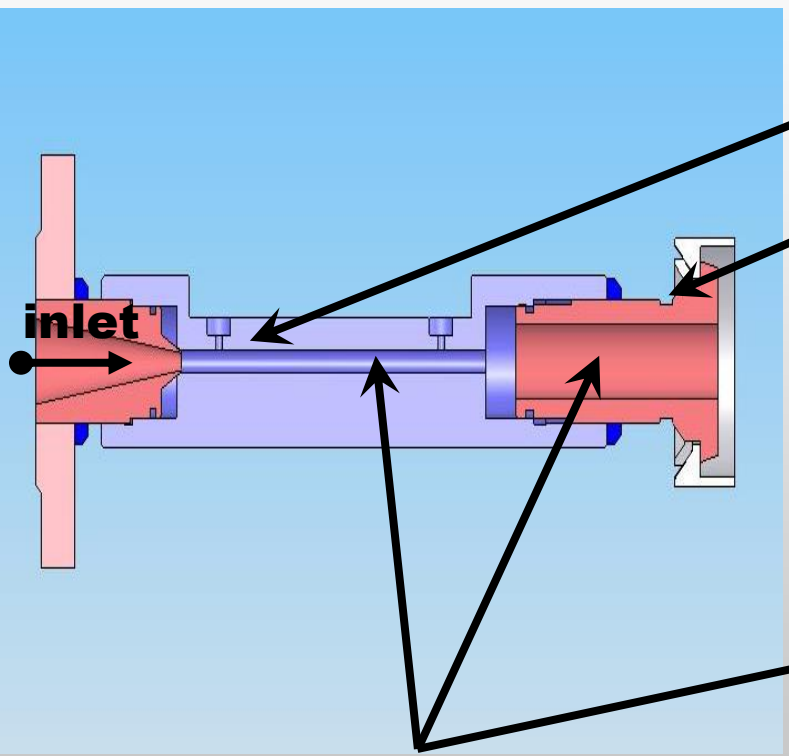
**Measurement of dispersed composition of the carbon nanomaterial as produced (Horiba particle Size distribution analyzer LA-950).**



# NANOSTRUCTURED CARBON DISPERSION



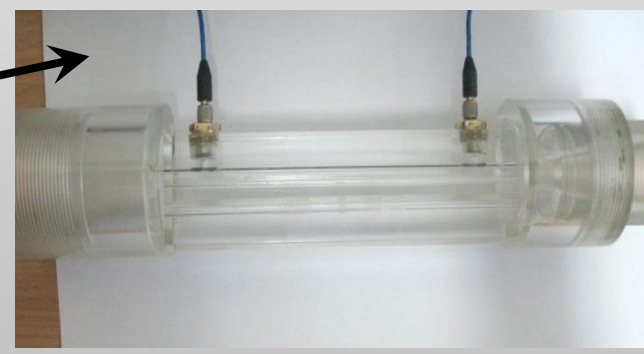
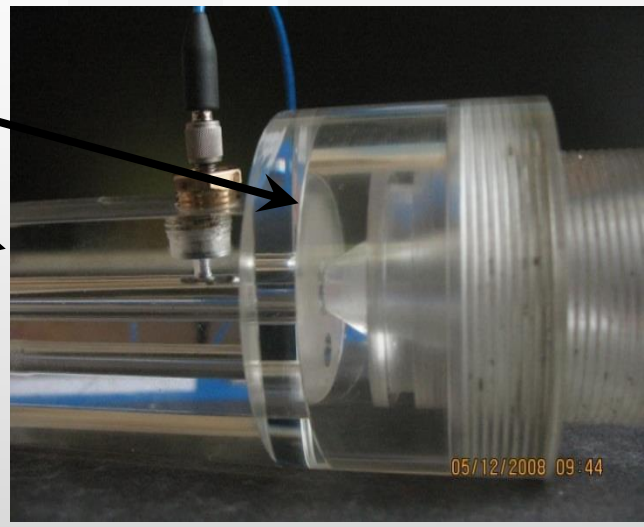
# CAVITATION BASED ART NANO CARBON DISPERSION UNIT



**Cone**

**The case**

**The pressure gauge**

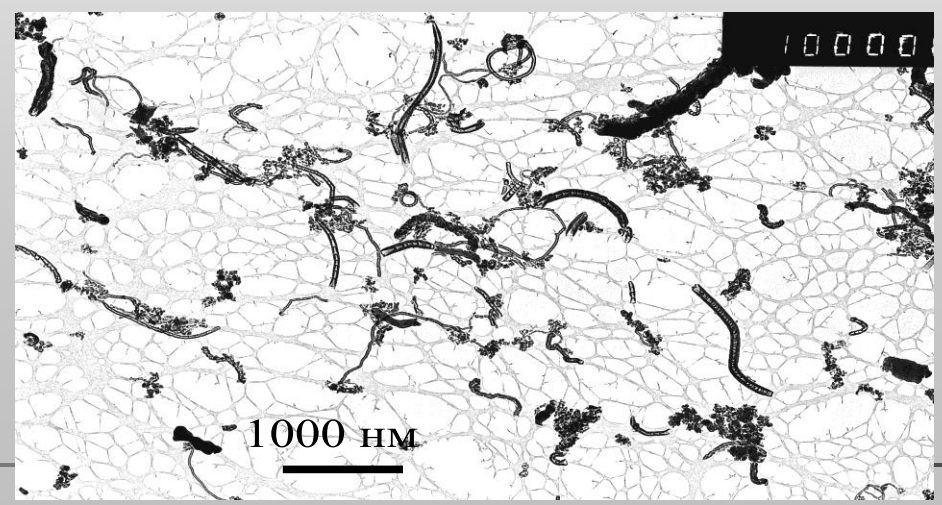
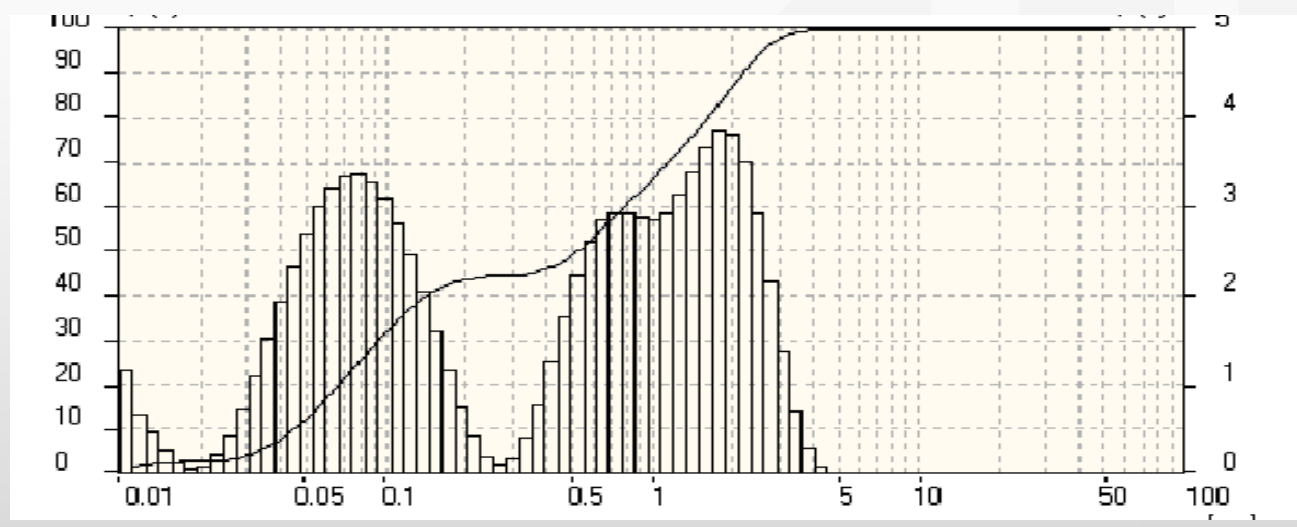




**ART CARBON**

Advanced Research & Technologies

# Dispersion and Morphological Structure of "ART NANO" CARBON

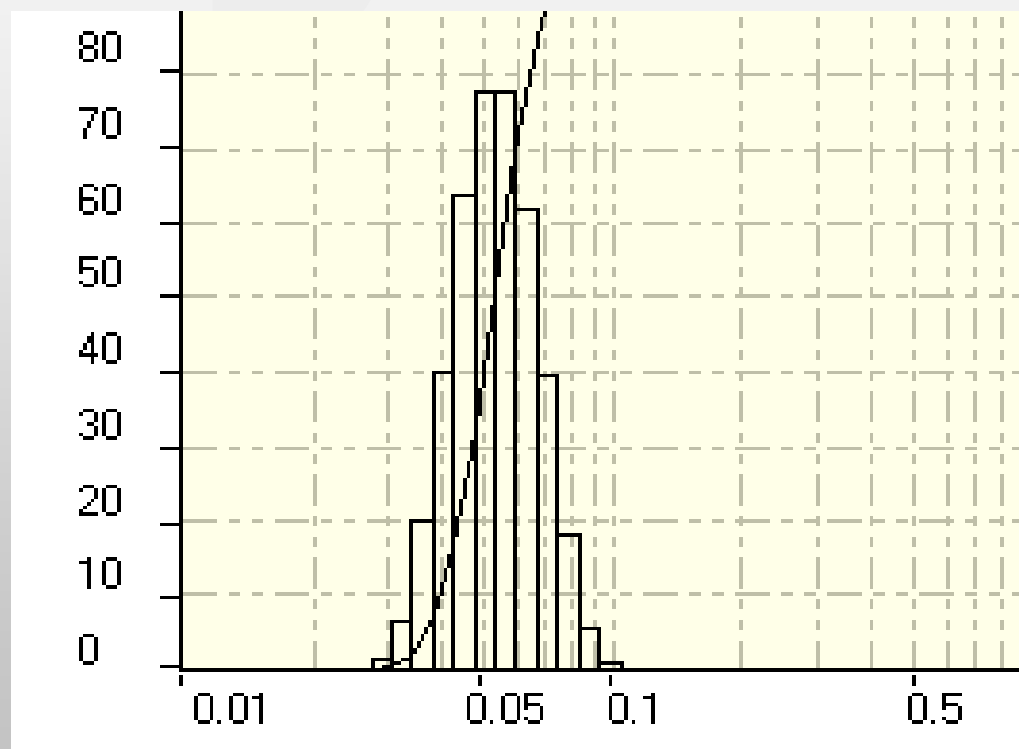
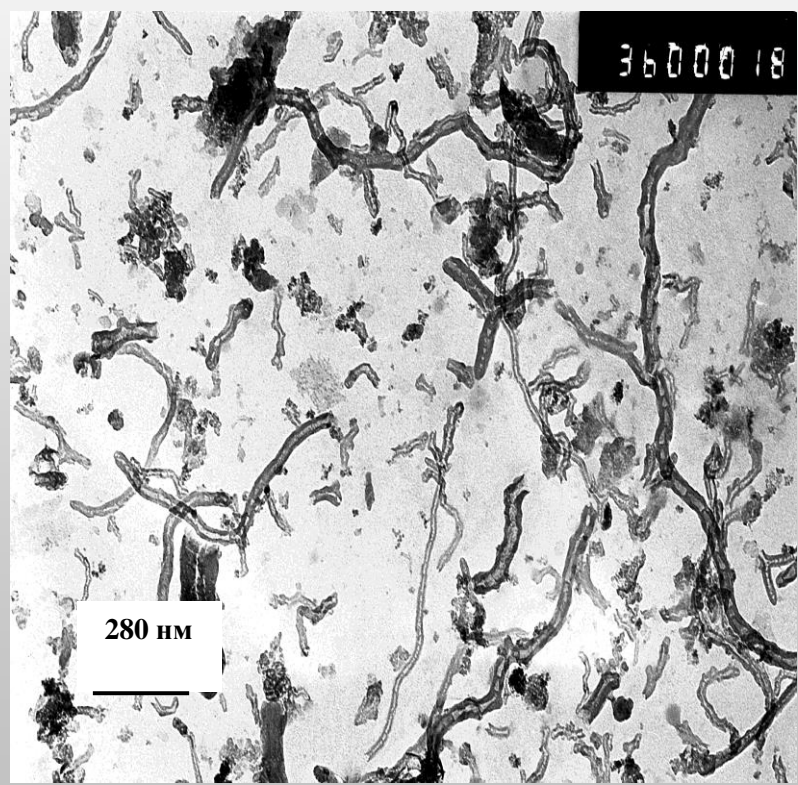


ПЭМ – фотография «суспензии»

# HYDRODYNAMIC CAVITATION BASED NANOSTRUCTURED CARBON DISPERSION FACILITY



# Particles Size Distribution and Morphological Structure of ART NANO CARBON After Dispersion and Refining

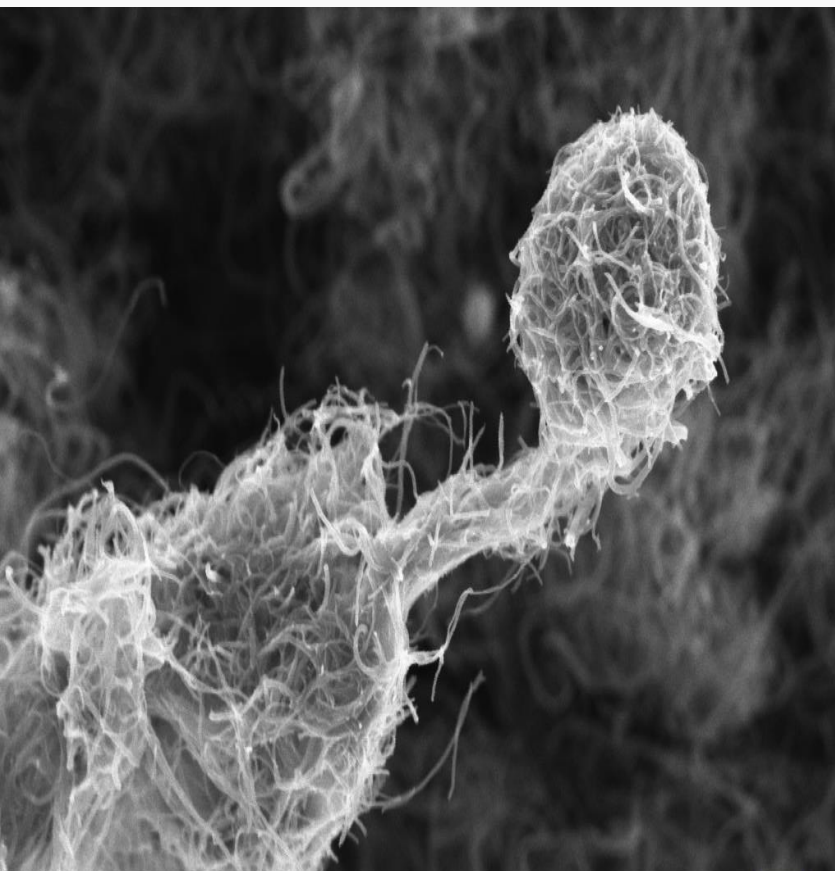




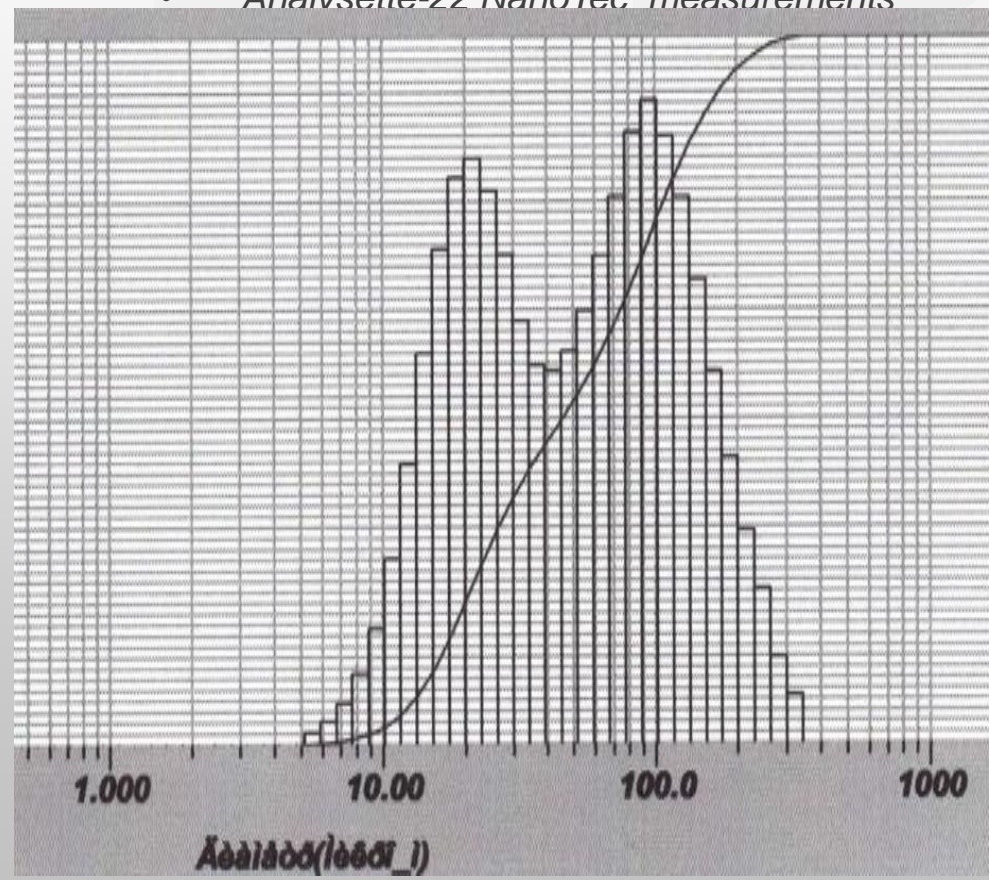
**ART CARBON**  
Advanced Research & Technologies

# Particles Size Distribution and Morphological Structure of C150P “BAYER” Carbon Nanotubes After Dispersion in Hydrodynamic Cavitation Facility

- Particles size distribution
- *Analvsette-22 NanoTec measurements*



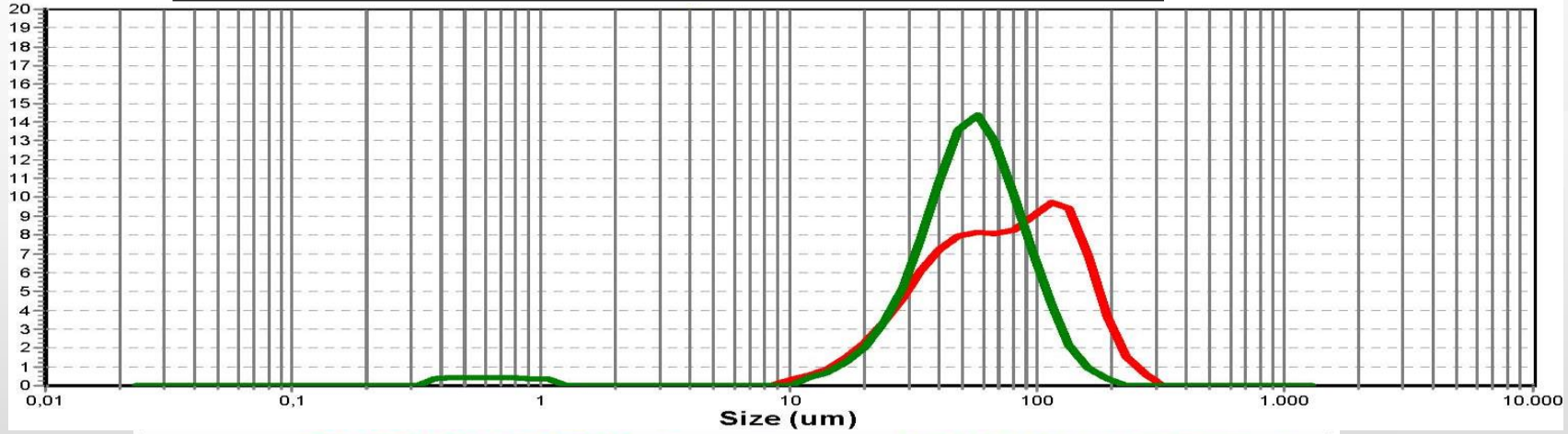
200 nm<sup>+</sup> EHT = 3.00 kV Signal A = InLens Date :13 May 2010  
WD = 2.9 mm Photo No. = 9705 Time :19:49:14



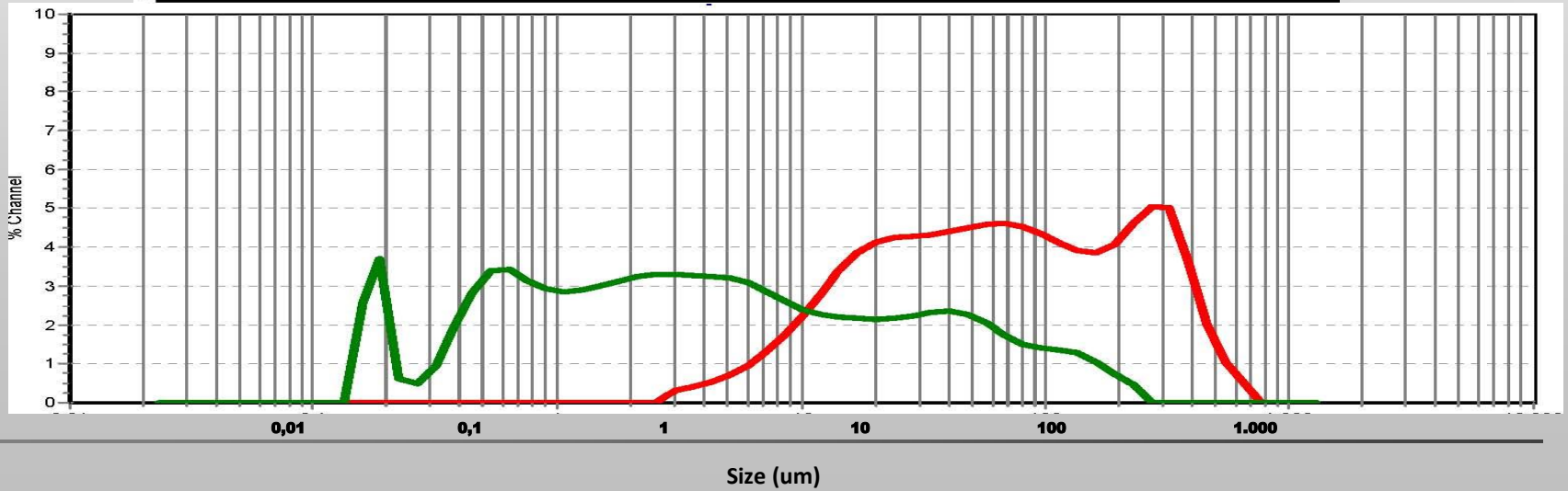
# Comparison of Particles Size Distribution of “ART Nano” Carbon Nanotubes and South Korean ( «Nano-Vision Tech» ) Carbon Nanotubes



DB: 22:0 Ws/ml, CNT Korea:-  DB: 23:500 Ws/ml, CNT Korea:-



DB: 24:0 Ws/ml, CNT Minsk:-  DB: 25:500 Ws/ml, CNT Minsk:-



# Nanostructured Carbon Materials Dispersion

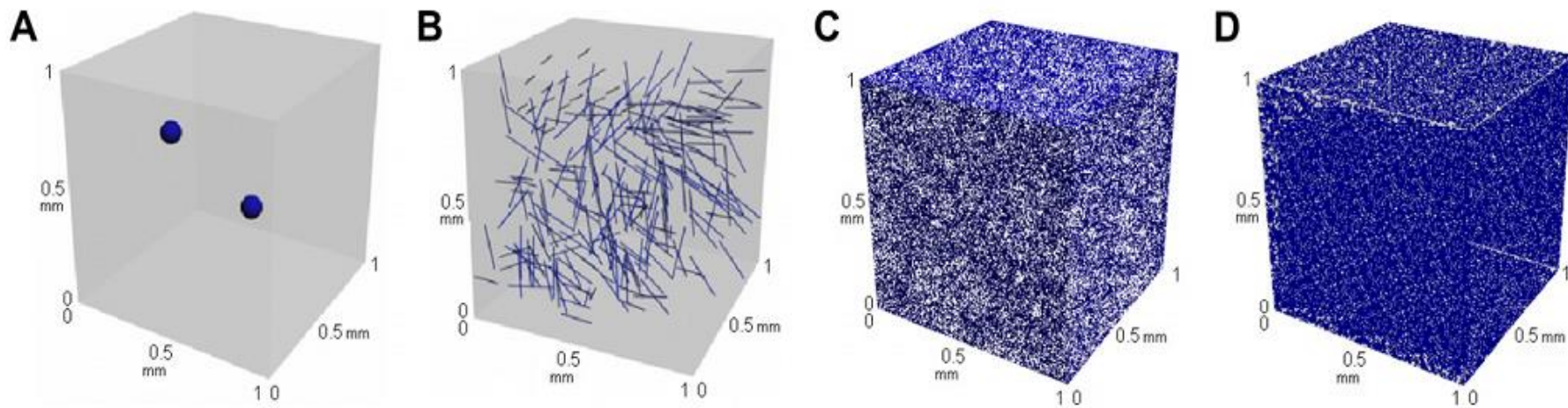


Illustration of Different Size Nanostructured Carbon Particles Distribution

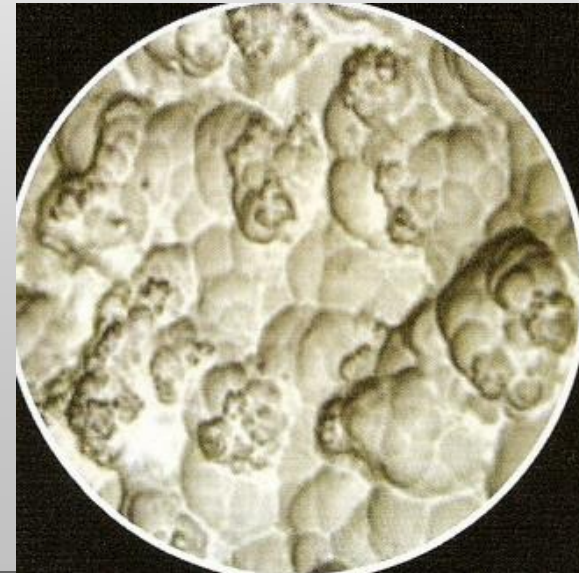
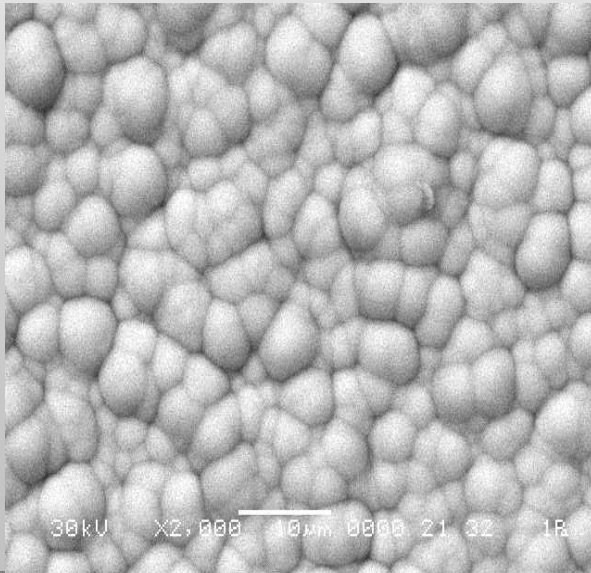
Concentration 0.1% volume in 1 mm<sup>3</sup>.

- |  |                  |
|--|------------------|
| A – Agglomerated particles (Bayer, Nano-Vision Tech), $d = 100 \mu\text{m}$ , $N = 2$ ;      | Surface=S        |
| B – carbon fibers, $l = 5 \mu\text{m}$ , $N = 255$ ;   | Surface=36S      |
| C – graphene plates, $l = 45 \mu\text{m}$ , $\delta = 10 \text{ nm}$ , $N = 6.6 \times 10^4$ | Surface=1600S    |
| D – ART-Nano CNT, $l = 2 \mu\text{m}$ , $d = 20 \text{ nm}$ , $N = 4.4 \times 10^9$          | Surface=1000000S |



# NANOSTRUCTURED CARBON IMPLEMENTATION

**Main Idea: Effect of Nanostructured Carbon on Properties of Different Composite Materials is Not The Direct Reinforcement Due To Their Strength, But The Changing Of The Composite Structure For More Regular One**





## Ceramics Production Technology

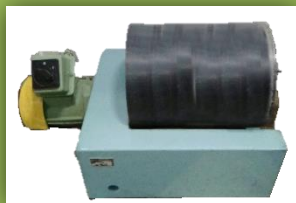
Mixture  
composition

Mixing

Drying

Pressing

Sintering



**The analyses of the samples:**

- dielectric and electromagnetic properties
- Tensile strength



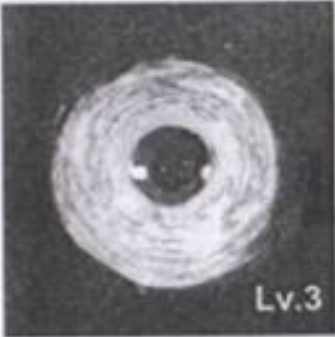
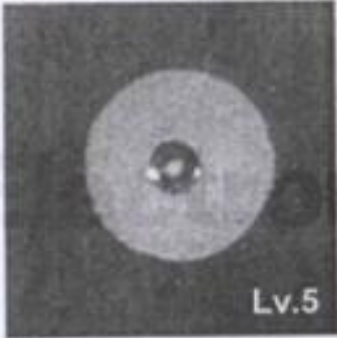
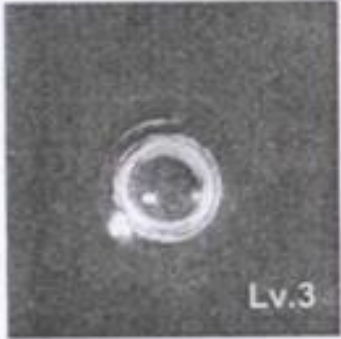
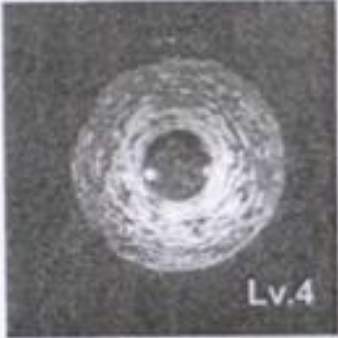
**The element of antenna system –  
ceramic insulator AC - 4500 – 300  
with voltage up to 1000V and tensile  
strength 4.5 tones**

**Introduction of the nanostructured carbon  
material ART NANO in an amount 0.05 wt%  
allowed:**

- Increase the plasticity of molding powder,  
which is important in the technological  
process of manufacturing;**
- Increase sample tensile strength at 40%**

# ART NANO CARBON Applications in Porcelain Ceramics at LG

- Effect of CNT to adhesion of PE: Increment of adhesion level (1~2 class)
- Varieties of CNT: CNT #01 > CNT #02

	No CNT (0.0000%)	CNT #01 (Normal 0.0001%)	CNT #02 (w/ Functional group 0.0001%)
A frit			
B frit			

# ART NANO CARBON Applications in Bricks Production





# Relative Bricks with ART NANO CARBON Additives Compression Strength Gain

