Title:

Electromagnetic Field Detection in front of Vibrating Carbon Nanotubes

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URSI GASS 2020

29 August – 5 September, 2020

Rome, Italy

Vibrating Carbon Nanotubes (CNT) Synthesis

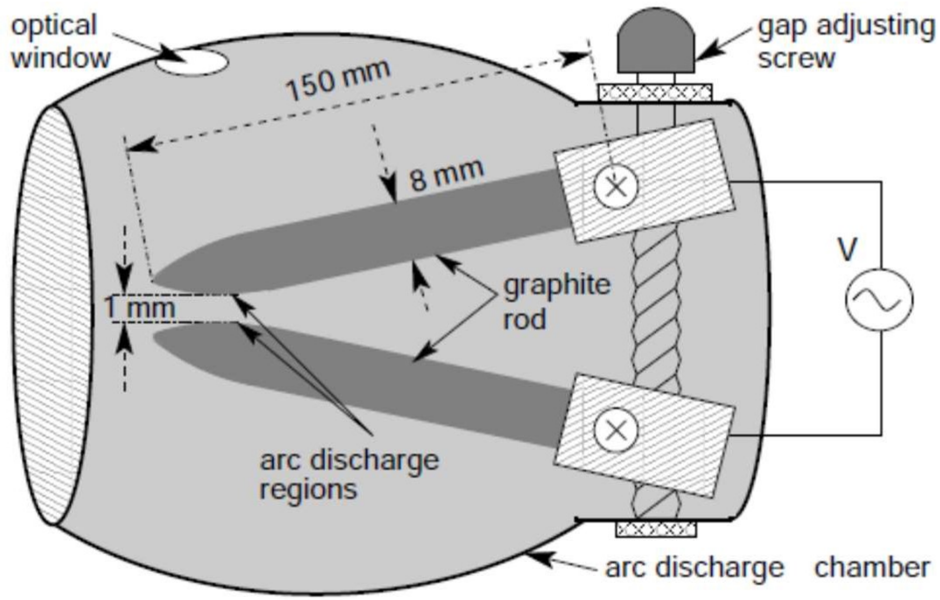
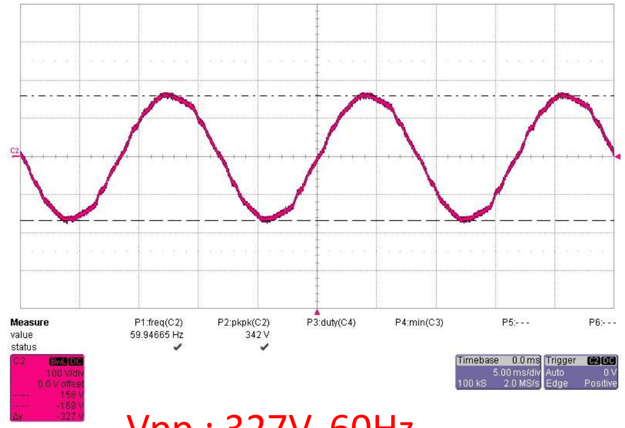


Fig.-1: Schematic diagram of arc-discharge setup



Vpp : 327V, 60Hz

Ipp : 24.0A, 60Hz

Fig.-2: Voltage and current used for arc-discharge

CNTs are synthesized through AC arc-discharge between two high purity identical graphite rods placed end to end as electrodes in normal air pressure inside an open-front arc discharge chamber.

SEM micrograph of the arc discharge region of the graphite electrode used in arc discharge

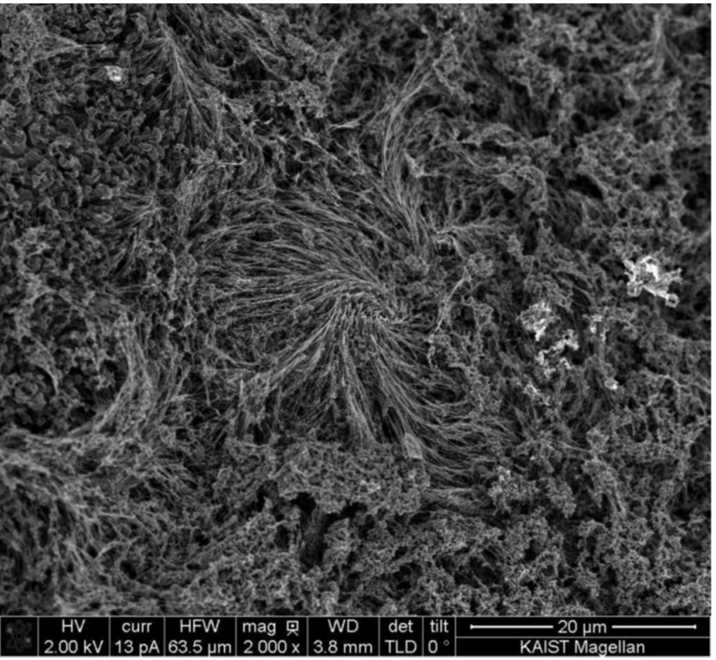


Fig.-1: SEM images of the fabricated CNTs in 20 µm scale

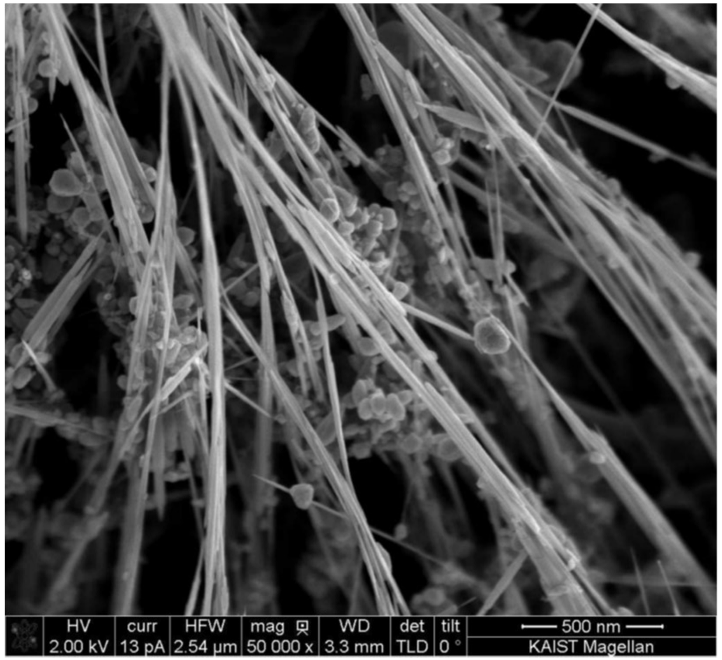


Fig.-2: SEM images of the fabricated CNTs in 500 nm scale

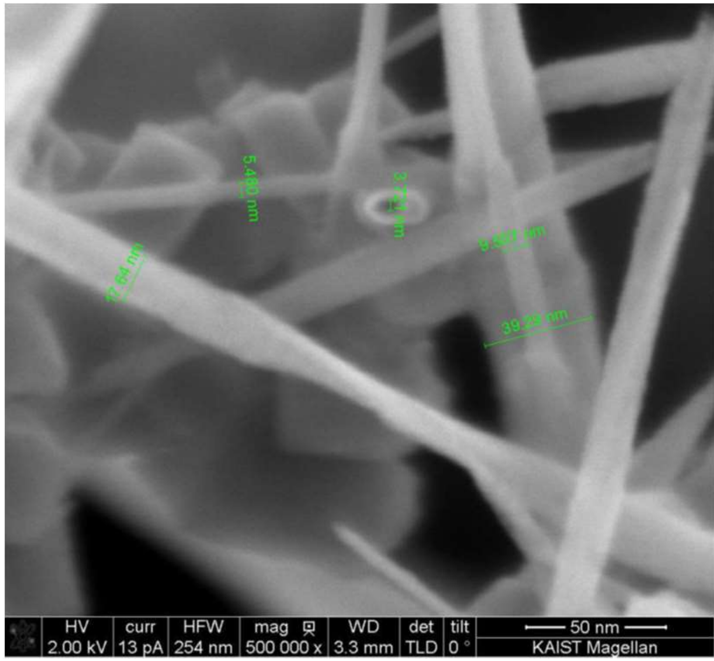


Fig.-3: SEM images of the fabricated CNTs in 50 nm scale

SEM images of the deposited materials at and near the arc discharge region of the graphite roads show the presence of a large variety of multilayer nanostructures like MWCNT, deformed MWCNT, graphitic nanoparticles.

TEM micrographs of the deposited carbon on the electrodes end

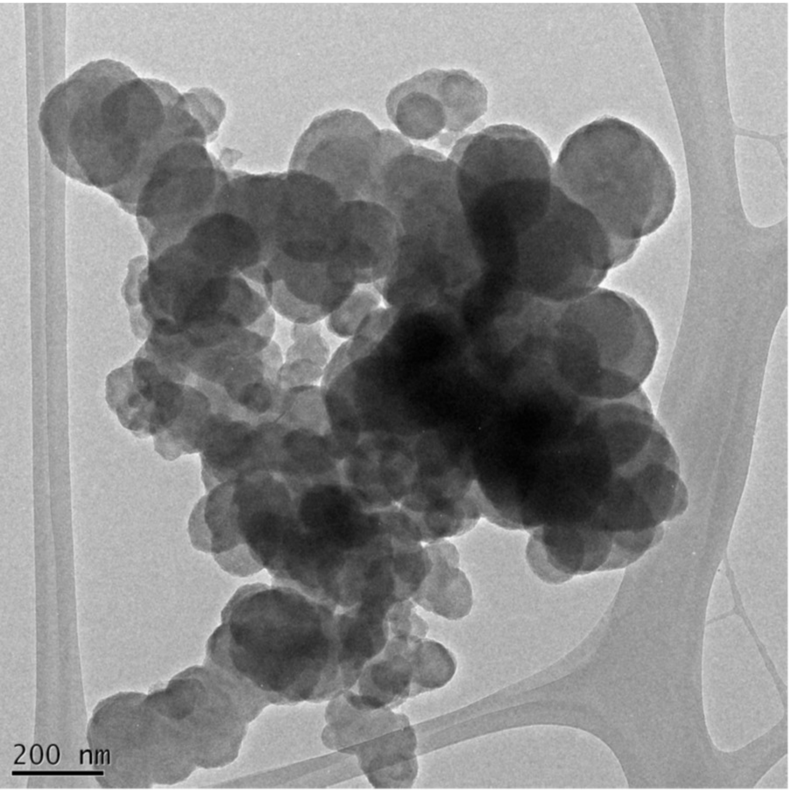


Fig.-1: In 200 nm scale

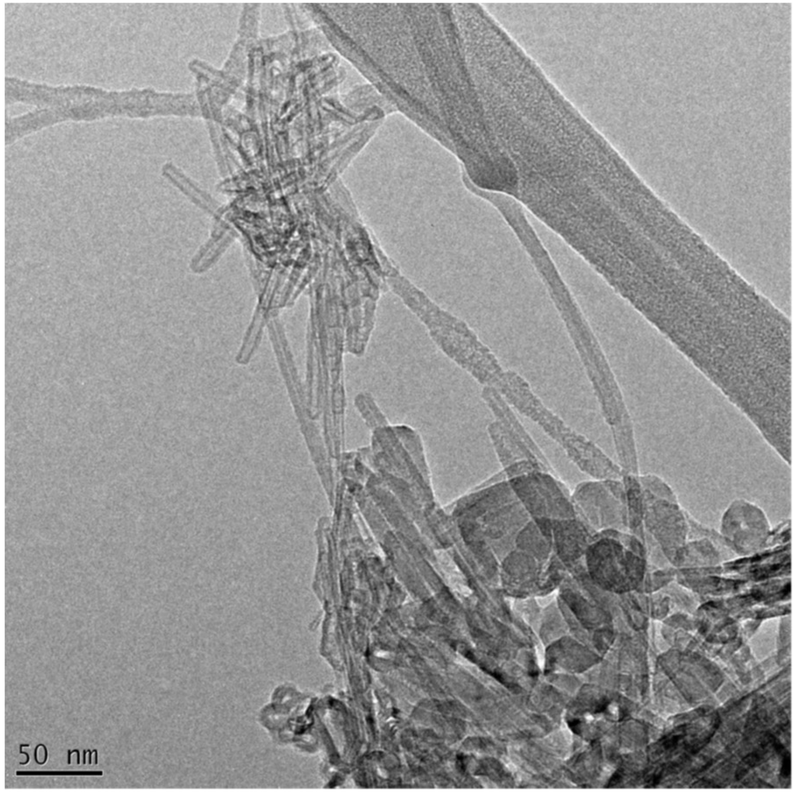
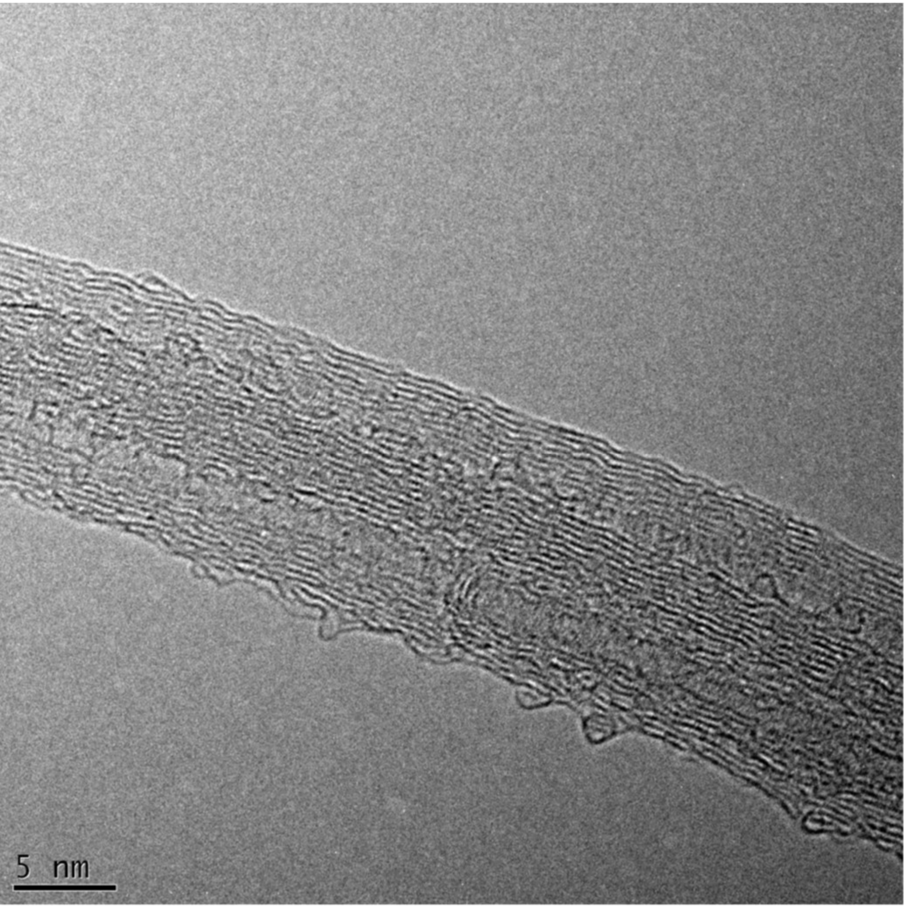
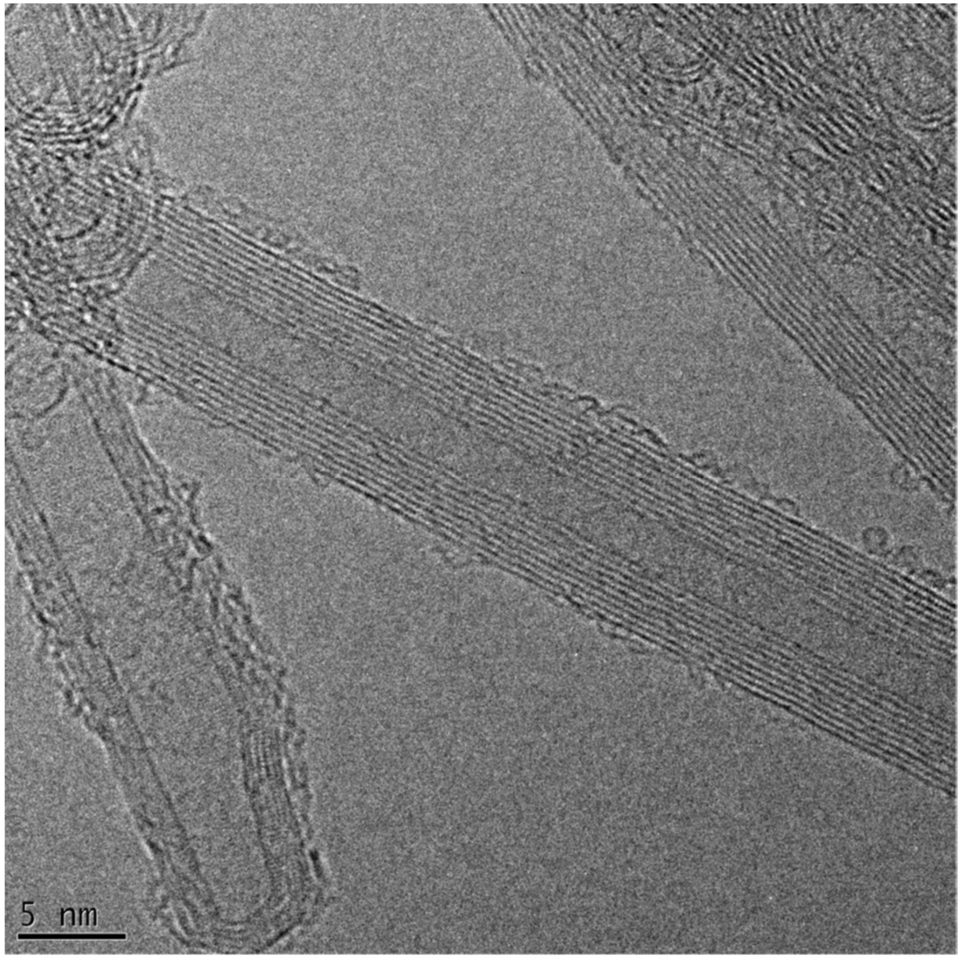


Fig.-2: In 50 nm scale

TEM images of the deposited materials at and near the arc discharge region of the graphite roads show the presence of a large variety of multilayer nanostructures like MWCNT, deformed MWCNT, graphitic nanoparticles.

TEM micrographs of the deposited CNTs on the electrodes end





Diameter of the CNT varies from 5.721 nm to 39.29 nm

The Q-factors for arc-produced nanotubes are varied in the range of 300 - 2000 with a center of 1000 [1]

$$Q = \frac{f_0}{\Delta f} \qquad (2)$$

The resonant frequency of a CNT is related to the Young's modulus (Y) and length (L) given by

$$f_0 = \frac{1.875^2}{2\sqrt{3}\pi}\sqrt{\frac{3YI}{m_0 L^3}} \qquad (3)$$

where I is the moment of inertia given by $\pi(r_0^4 - r_1^4)$ r0 & ri the outer and inner radii of the nanotube respectively.

[1] S. Akita, S. Sawaya, and Y. Nakayama, "Energy Loss of Carbon Nanotube Cantilevers for Mechanical Vibration," *The Japan Society of Applied Physics*, vol. 46, no. 9B, pp. 6295–6298, 2007.

Field measurement inside the anechoic chamber

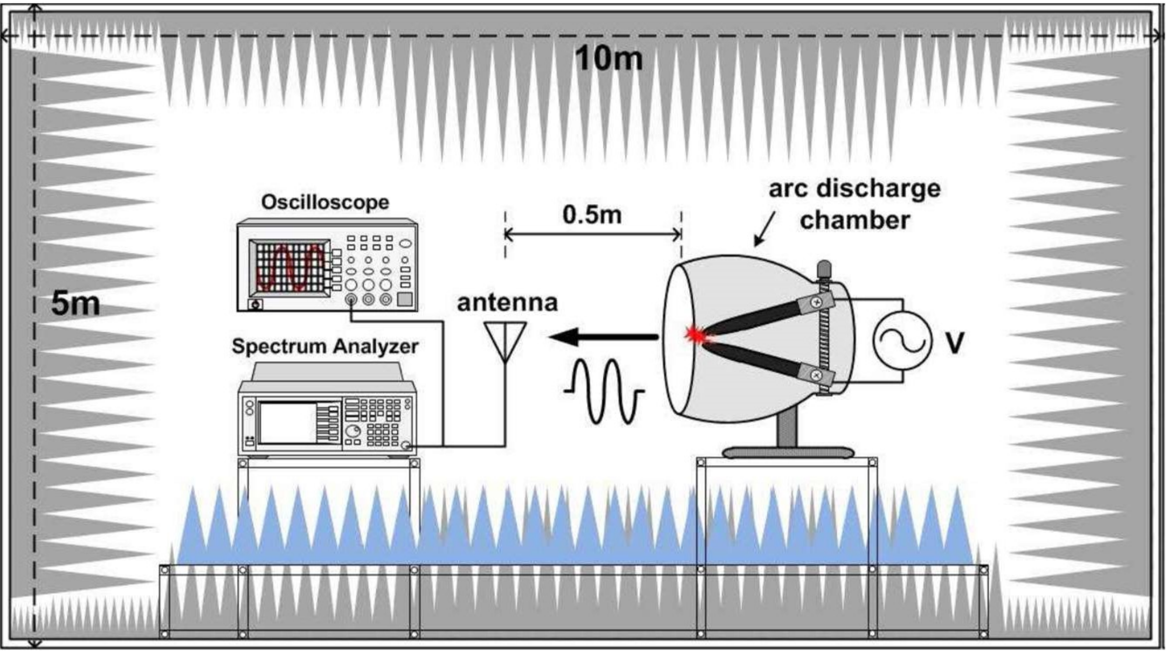


Fig.-1: Schematic diagram of measurement arrangement inside an anechoic chamber

Fig.-2: Measurement arrangement inside an anechoic chamber

- Broadband (0.65 CHz- 11 GHz) double ridged horn antenna
- WavePro760Zi oscilloscope
- Agilent-E4440A spectrum analyzer

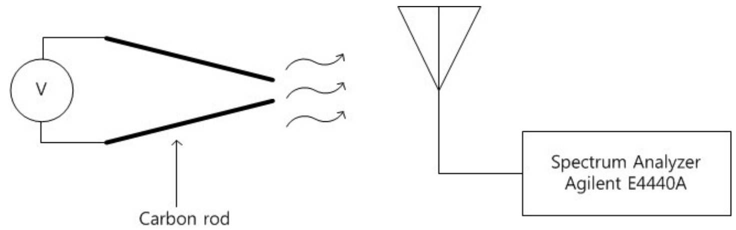
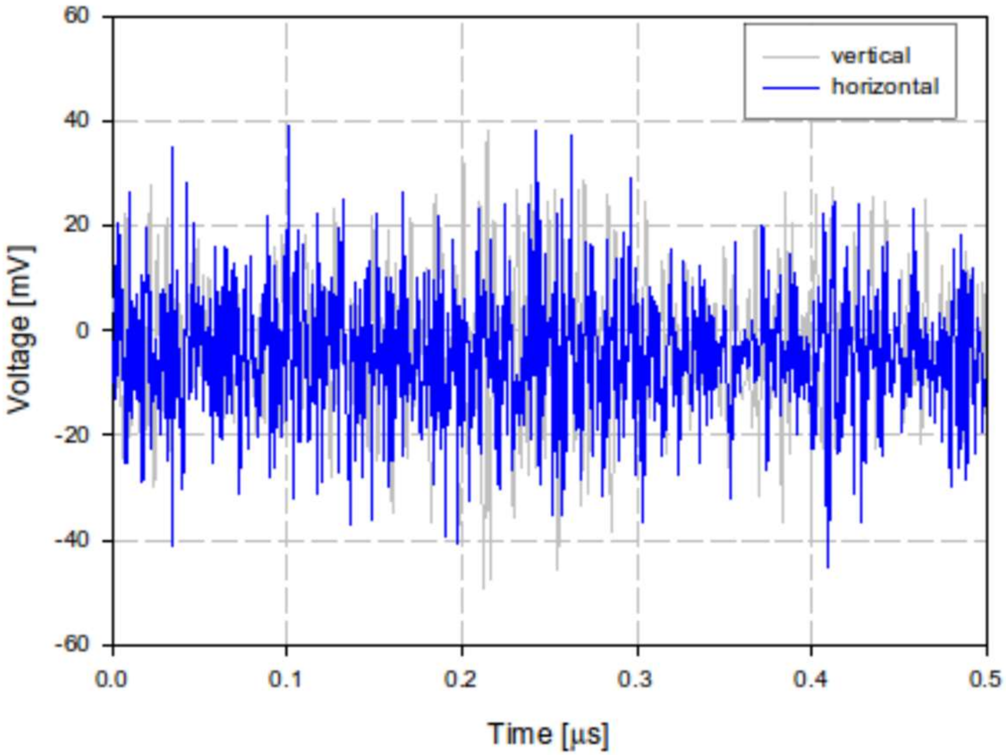
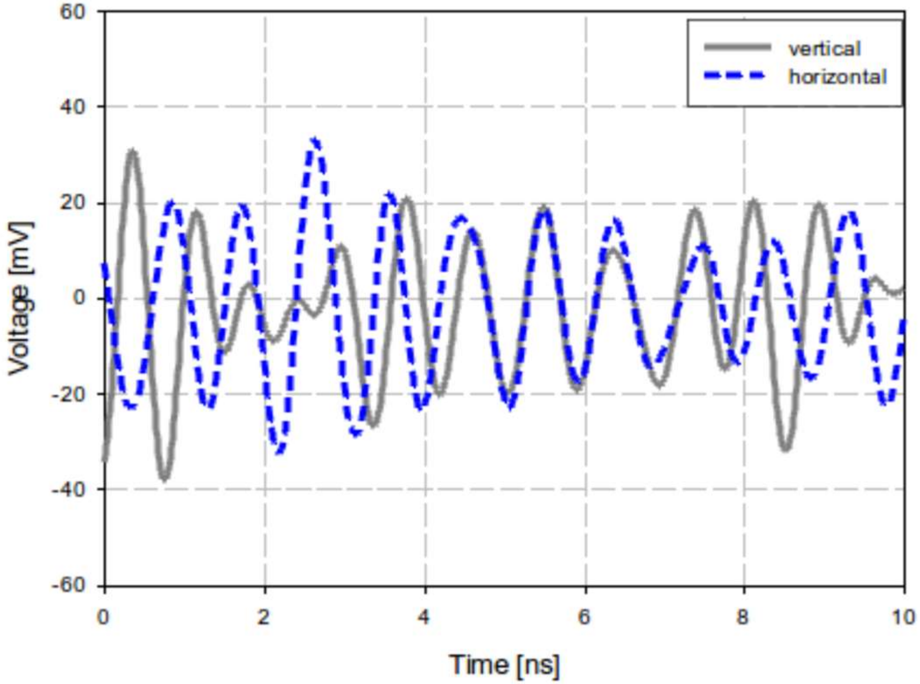


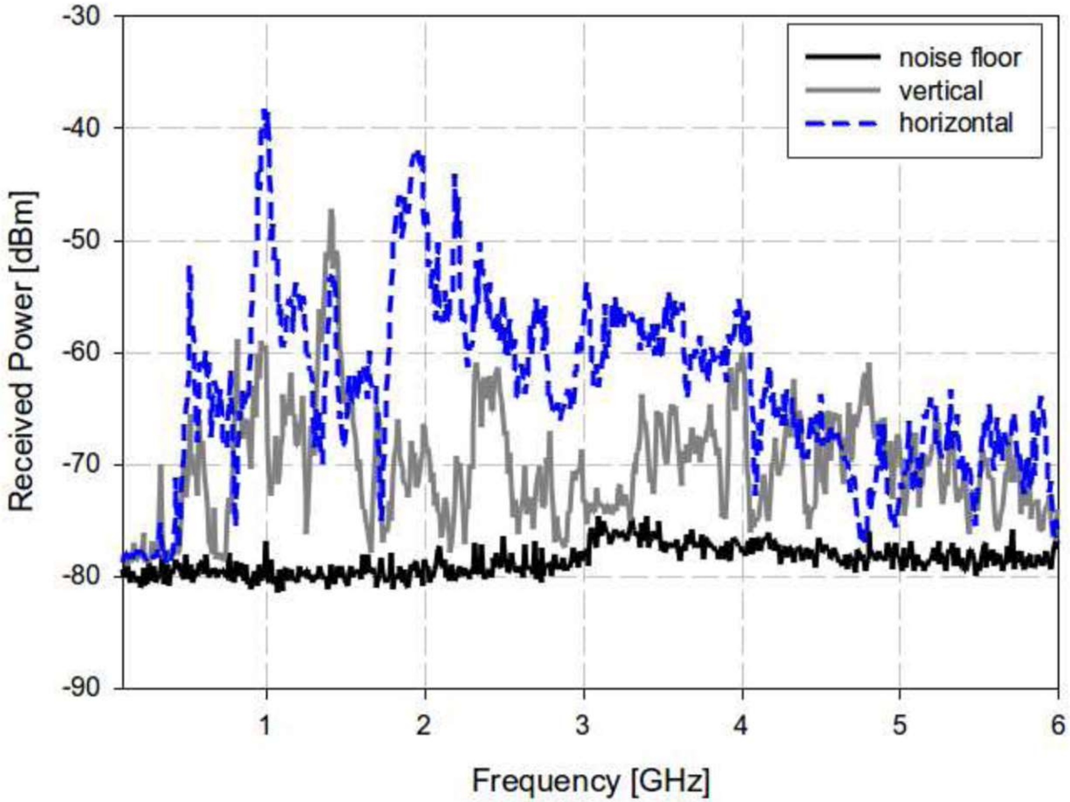
Fig.-3: Measurement setup

Measured time-domain signal during arc discharge





Measured power with and without the graphite rod arc discharge



Conclusion

- Synthesis of CNTs by AC arc discharge in normal air atmosphere is presented.
- SEM & TEM images of the deposited materials at and near the arc discharge region of the graphite roads show the presence of a large variety of multilayer nanostructures like MWCNT, deformed MWCNT, graphitic nanoparticles.
- During arc discharge process, CNTs attached with the graphite rods vibrate and generate EM fields.
- These fields are identified through the measurement in an anechoic chamber.
- This identified field is also compared with the environmental noise of the anechoic chamber when there are no arc discharge.

Thank you

For any interaction please contact:

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