(Nano Telecommunication) Nanotube Antennas (CNTs) or Multilayer and Graphene Nano Tape (GNRs)

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Note: Nano-telecommunications includes electronic devices and devices , one of the dimensions of which is about one to several hundred nanometers. Accordingly , if the antennas used in nano-components are to be in this range, we should expect the electromagnetic waves used in the communication of these systems and devices to be around tens of terahertz, which will include the wavelengths of infrared, visible and ultraviolet. .

The antenna is considered as the primary means of absorbing electromagnetic waves in space and has its own engineering knowledge, which is very developed and extensive. In general, in order to receive the electromagnetic wave in space, the dimensions of the antenna must be in the order of the size of the input wavelength to its surface. Due to the very low dimensions of nano-sensors, nano-antennas need a very high operating frequency to be usable. The use of graphene greatly helps to solve this problem. Wave propagation velocities in CNTs and GNRs can be up to 100 times slower than vacuum velocities, depending on the physical structure, temperature and energy. Accordingly, the resonant frequency of graphene-based nano-antennas can be twice as low as (nano-carbon) nano-antennas.

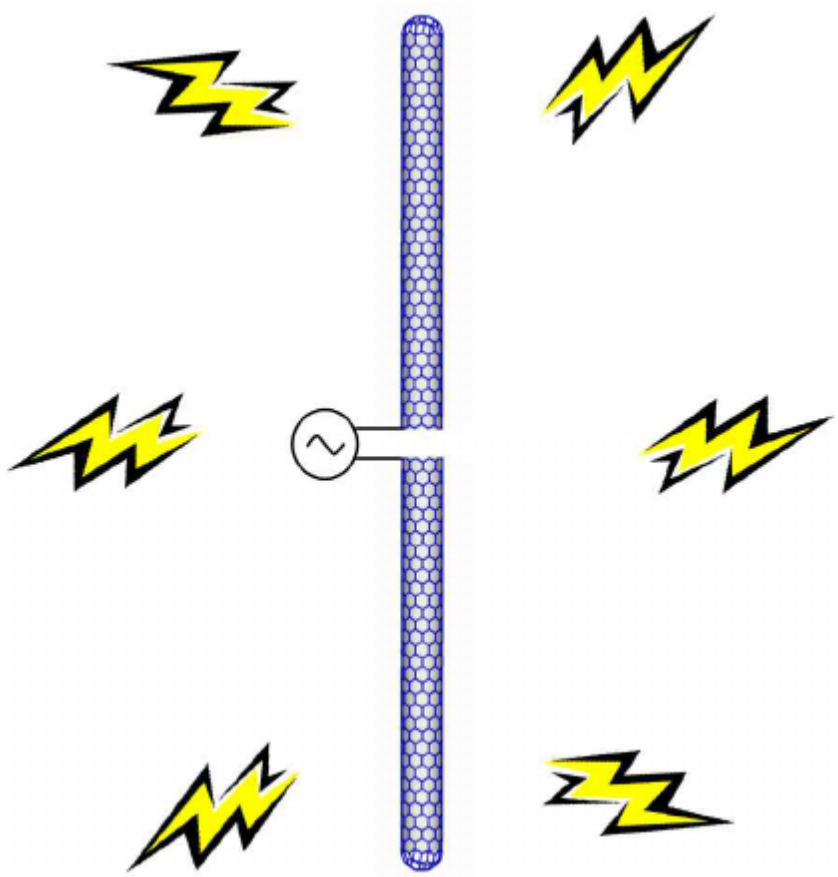

Figure 1: **(nano-carbon) nano-antenna**

One of the most important parameters of any nano-antenna is the current distribution on it. This characteristic determines the radiation pattern, resistance and reactance of the radiation and many important characteristics of the antenna. Despite the possibility of making nanotubes with a length of several centimeters, it is possible to make electrical conductors with a length to width ratio of 7 ˆ 10 . Nanotube antennas at first glance give us the impression that it is similar to the dipole antenna, which is designed in small dimensions. But this is not the case in the main theory of dipole antennas for determining the current distribution on the antenna, where the dipole radius is greater than the skin depth and also the resistance losses are so small that they can be ignored. Due to the fact that the L / d nano-dipole is significantly reduced, it is impossible is used. In single-dimensional electrical conductors such as nanotubes, the skin depth state is completely eliminated. Because here electrons are only allowed to move They have conductors along the strand and therefore the current distribution is effectively one-dimensional. In addition to the electrons moving in only one dimension, two other important issues occur, inductance and large resistance. These properties make nanotube antennas behave very differently from classical antennas. The main difference is that the current distribution is alternating with a wavelength that is 100 times smaller than the open space wavelength for a given thermal frequency. The wavelength of the current distribution depends on the velocity of the wave in that mode. If the wavelength is the same as the speed of light, the wavelength of the current distribution is the wavelength of the electromagnetic waves in the open space. On the other hand, the wave velocity in nanotubes

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is about one hundred times slower than the speed of light. This is because in circuit theory, the wave velocity is equal to the inverse of the square root of the capacitive capacity per unit length multiplied by the inductive capacity per unit length.

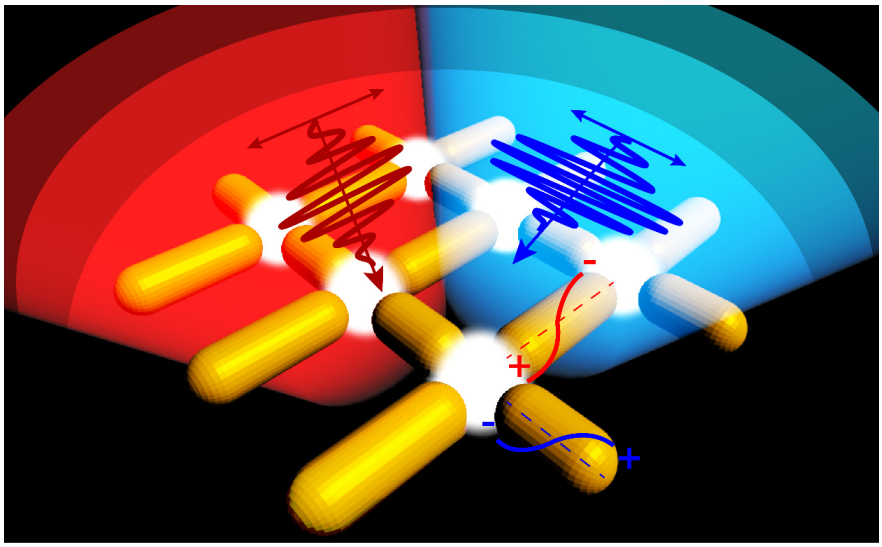

Figure 2: **nanotube antenna**

Kinetic inductance per unit length of nanotubes is ten thousand times greater than magnetic inductance per unit length of conventional antennas. Therefore, the wave speed will be 100 times slower than the speed of light. The efficiency of a classic nanotube antenna is -90dB, which will be due to resistance losses. However, the dimensions of the antenna and the nanosystem or nanosensor set, operating frequency, power losses, range and dimensions of the sensor network, the structure and facilities of the power supply system and the physical communication platform between different parts of a nanosystem, major factors and parameters Each of which is a determinant and determines the ability to build and operate the final system.

Conclusion :

Graphene structures can be used to make nano -antennas, and this valuable structure can play a very important role. Fabrication of nano-antennas in various applications of telecommunication and communication systems with nano-scale systems, new fields and functions of nano-electronic equipment and telecommunication systems are basic.

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References

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