**Motivation**

- As predicted by the Edholm’s Law of Bandwidth, wireless data rates have been doubling every 18 months for the last 3 decades.
- Following this trend, we expect to have Terahertz (THz) band communications within the next 5 years.
- Graphene-based nano-devices are envisioned as one of their key technologies to enable practical communications in the THz band.

**Problem**

- Current graphene-based nano-antennas radiate very little power.
- We need to find a way to increase the signal strength and improve communication range.

**Solution**

- The strength of an antenna can be increased by combining multiple antennas into an array.
- Each element in the array adds to the available transmitting power.
- When the electric fields of each element combine constructively the array exhibits gain.
- The minimal distances between elements, and hence the power density, is determined by mutual coupling effects.

**Methods**

- The computational modeling program COMSOL Multiphysics is used to design a model and simulate the propagation characteristics with full wave analysis, and is supported by analytical modeling.
- First, a simple two element array is analyzed to determine the minimum separation needed to avoid unwanted mutual coupling.
- Using the resulting minimum element separation distance, multiple element arrays are simulated to analyze their radiation power and gain characteristics.

**Results- Mutual Coupling**

- Mutual coupling effects were determined through the analysis of the input impedance of the antennas.
- Simulations show that in a graphene-based array the mutual coupling effect becomes significant only for separations in the order of the SPP wavelength.
- Enables separation distances much smaller than the free space wavelength!

**Additional References**


**Conclusion**

- Analysis shows that a well designed nano-antenna array can alleviate the problem of weak output power by constructive addition of multiple radiating fields.
- Array elements can be placed much closer to each other than is possible in metallic arrays before coupling becomes significant.
- Graphene nano-arrays have the potential to overcome low power and high path loss to enable terahertz communication networks.
- Next step: Can we experimentally build such nano-antenna array? Coming soon...

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