Graphene may open the gate to future terahertz technologies

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Nestled between radio waves and infrared light is the terahertz (THz) portion of the electromagnetic spectrum. By adding a nanoscale bit of graphene, researchers have found a better way to tune radiation for a THz transmitter.

Researchers from the University of Notre Dame in Indiana have harnessed another one of graphene's remarkable properties to better control a relatively untamed portion of the electromagnetic spectrum: the terahertz band.

Terahertz radiation offers tantalizing new opportunities in communications, medical imaging, and chemical detection. Straddling the transition between the highest energy radio waves and the lowest energy infrared light, terahertz waves are notoriously difficult to produce, detect, and modulate. Modulation, or varying the height of the terahertz waves, is particularly important because a modulated signal can carry information and is more versatile for applications such as chemical and biological sensing. Some of today's most promising terahertz technologies are based on small semiconductor transistor-like structures that are able to modulate a terahertz signal at room temperature, which is a significant advantage over earlier modulators that could only operate at extremely cold temperatures.

Unfortunately, these transistor-like devices rely on a thin layer of metal called a "metal gate" to tune the terahertz signal. This metal gate significantly reduces the signal strength and limits how much the signal

can be modulated to a lackluster 30 percent. As reported in the AIP's journal Applied Physics Letters, by replacing the metal gate with a single layer of graphene, the researchers have predicted that the modulation range can be significantly expanded to be in excess of 90 percent. This modulation is controlled by applying a voltage between the graphene and semiconductor. Unlike the metal gate modulator, the graphene design barely diminished the output power of the terahertz energy. Made up of a one-atom-thick sheet of carbon atoms, graphene boasts a host of amazing properties: it's remarkably strong, a superb thermal insulator, a conductor of electricity, and now a better means to modulate terahertz radiation.

More information: "Unique prospects for graphene-based terahertz modulators" by Berardi Sensale-Rodriguez et al. is accepted for publication in *Applied Physics Letters*.

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