Research team finds graphene may pave the way for new kinds of optoelectronic devices

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(PhysOrg.com) -- A team comprised of researchers from MIT and Harvard has discovered yet another unique and useful property of graphne, this time it involves optics. As they describe in their paper published in *Science*, when light, or in this case a laser, is aimed at an object with a graphene surface its electrons get hot and remain so for longer than the rest of the object. This property opens up the door to all kinds of possibilities for new kinds of superfast photo-detectors and energy harvesting technology.

The team, led by Pablo Jarillo-Herrero, made their discovery by creating several so-termed p-n nanojunction devices (the boundary that is formed between P and N type semi-conductors) in their lab and then taking careful measurements of each type using laser light to measure the resultant photocurrent produced. They found that as the power to the laser was increased, so too did the photocurrent. During their experimentation, they found that they could produce up to 5 mA/W, even at a low temperature; a number that is 6 times higher than has been demonstrated with any other optoelectronic device based on graphene. They believe this occurs because the electrons in the graphene aren't able to transfer their heat very well due to poor coupling with other materials.

Graphene is a one-atom thick layer of carbon that has all manner of unique properties and because of that, new applications for it have been announced periodically since its discovery in 2004. Until now though, very little progress had been made in using it in optoelectronics devices. This new property, called a hot-carrier regime by the team, is unusual because it's normally only seen in other materials at very cold temperatures. With graphene, however, the effect occurs at low, medium or high temperatures making it a very good candidate for practical applications such as photo-sensing or as part of devices that harvest the energy in sunlight.

The team notes that the discovery of this new property of graphene they describe is likely just the first step in a very long journey. Much more research needs to be done to find out such things as just how efficient can a process using it be made, or what if more layers of graphene are integrated into a device. They plan to continue work in this area, as will others no doubt, now that this new property has come to light.

More information: Hot Carrier–Assisted Intrinsic Photoresponse in Graphene, *Science* DOI:10.1126/science.1211384

ABSTRACT
We report on the intrinsic optoelectronic response of high-quality dual-gated monolayer and bilayer graphene p-n junction devices. Local laser excitation of wavelength λ = 850 nm at the p-n interface leads to striking six-fold photovoltage patterns as a function of bottom- and top-gate voltages. These patterns, together with the measured spatial and density dependence of the photoresponse, provide strong evidence that nonlocal hot-carrier transport, rather than the photovoltaic effect, dominates the intrinsic photoresponse in graphene. This regime, which features a long-lived and spatially distributed hot carrier population, may open the doorway for hot carrier–assisted thermoelectric technologies for efficient solar energy harvesting.

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