Science News

Graphene's Shining Light Could Lead to Super-Fast Internet

ScienceDaily (Aug. 30, 2011) Writing in the journal *Nature Communications*, a collaboration between the Universities of Manchester and Cambridge, which includes Nobel Prize winning scientists Professor Andre Geim and Professor Kostya Novoselov, has discovered a crucial recipe for improving characteristics of graphene devices for use as photodetectors in future high-speed optical communications.

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By combining graphene with metallic nanostructures, they show a twenty-fold enhancement in harvesting light by graphene, which paves the way for advances in high-speed internet and other communications.

By putting two closely-spaced metallic wires on top of graphene and shining light on this structure, researchers previously showed that this generates electric power. This simple device presents an elementary solar cell.

More importantly for applications, such graphene devices can be incredibly fast, tens and potentially hundred times faster than communication rates in the fastest internet cables, which is due to the unique nature of electrons in graphene, their high mobility and high velocity.

The major stumbling block towards practical applications for these otherwise very promising devices has so far been their low efficiency. The problem is that graphene – the thinnest material in the world – absorbs little light, approximately only 3%, with the rest going through without contributing to the electrical power.

The Manchester researchers have solved the problems by combining graphene with tiny metallic structures, specially arranged on top of graphene.

These so-called plasmonic nanostructures have dramatically enhanced the optical electric field felt by graphene and effectively concentrated light within the one-atom-thick carbon layer.

By using the plasmonic enhancement, the light-harvesting performance of graphene was boosted by twenty times, without sacrificing any of its speed. The future efficiency can be improved even further.

Dr Alexander Grigorenko, an expert in plasmonics and a leading member of the team, said: "Graphene seems a natural companion for plasmonics. We expected that plasmonic nanostructures could improve the efficiency of graphene-based devices but it has come as a pleasant surprise that the improvements can be so dramatic."

Professor Novoselov added: "The technology of graphene production matures day-by-day, which has an immediate impact both on the type of exciting physics which we find in this material, and on the feasibility and the range of possible applications.

"Many leading electronics companies consider graphene for the next generation of devices. This work certainly boosts graphene's chances even further."

Professor Andrea Ferrari, from the Cambridge Engineering Department, who lead the Cambridge effort in the collaboration, said "So far, the main focus of graphene research has been on fundamental physics and electronic devices.

"These results show its great potential in the fields of photonics and optoelectronics, where the combination of its unique optical and electronic properties with plasmonic

nanostructures, can be fully exploited, even in the absence of a bandgap, in a variety of useful devices, such as solar cells and photodetectors."

Graphene is a novel two-dimensional material which can be

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Graphene is a novel two-dimensional material which can be seen as a monolayer of carbon atoms arranged in a hexagonal lattice.

It is a wonder material that possesses a large number of unique properties and is currently considered in many new technologies.

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1. T.J. Echtermeyer, L. Britnell, P.K. Jasnos, A. Lombardo, R.V. Gorbachev, A.N. Grigorenko, A.K. Geim, A.C. Ferrari, K.S. Novoselov. **Strong plasmonic enhancement of photovoltage in graphene**. *Nature Communications*, 2011; 2: 458 DOI: 10.1038/ncomms1464

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