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TECHNOLOGY UPDATE

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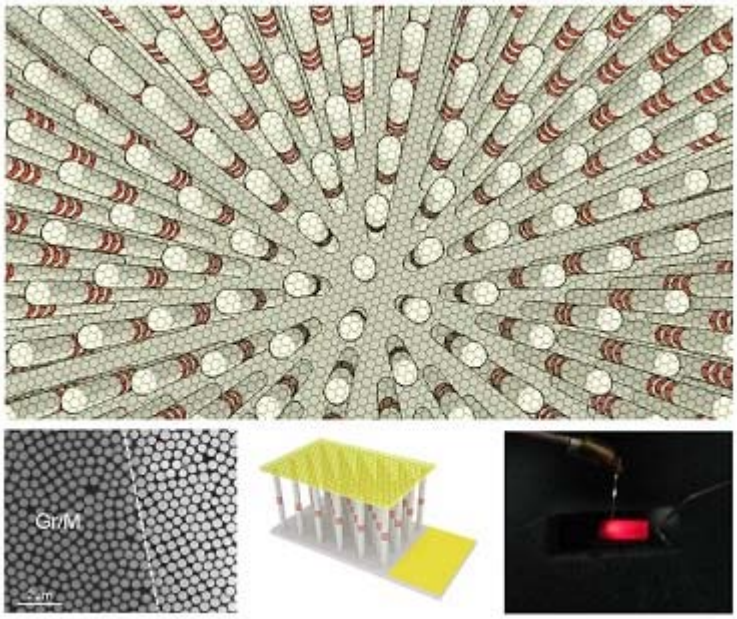
Graphene helps make a new kind of LED

Vertical arrays of 1D pillar superlattices combined with 2D graphene sheets can be used to make a new type of sturdy light emitting diode with good optical and electrical properties. The device, developed by a team of scientists in the US and Korea, also proves that graphene is an ideal transparent electrode material.



(http://images.iop.org/objects/ntw/news/9/8/5/JRogers.jpg)
The nanopillars (http://images.iop.org/objects/ntw/news/9/8/5/JRogers.jpg)

Vertical arrays of semiconductor nanowires and nanorods have unique optical, electrical and mechanical properties thanks to their 1D nature and could be used to make future optoelectronics and electronics devices. When integrated onto pieces of plastic, for example, such arrays can form mechanically flexible devices that would be impossible to construct using conventional semiconductor wafer technologies.

However, researchers need to develop a way to fabricate contact electrodes that can bridge and span the gaps between the nanorods or pillars if the materials are to be used for real-world applications. A team led by John Rogers of the University of Illinois at Urbana-Champaign and colleagues in Seoul, Pohang and Sungnam City has now shown that 2D sheets of graphene transferred onto the tops of nanorods arrays can, literally, step into the

breach here. The researchers demonstrated this by making light emitting diode (LED) devices that exploit arrays of gallium arsenide-based nanorods with spanning sheets of graphene as transparent electrodes.

Graphene sheets are promising alternatives to conventional transparent electrode materials like indium tin oxides for applications in displays, lighting devices and solar cells thanks to graphene's excellent electrical and mechanical properties. Scientists can now synthesize large-area sheets of graphene and transfer these directly onto arbitrary target substrates for making devices. "We have extended these concepts, for the first time, to an application that requires 3D coverage – that is spanning over the tips of nanorods arrays in working LED devices," Rogers told *nanotechweb.org*.

The best of both worlds

Graphene-based nanorod LEDs are a hybrid system that combines mechanically robust carbon-based materials like graphene with high-performance inorganics, such as GaAs, in a way that exploits the key advantages of each, explains Rogers. The array's layout effectively relieves strains in the material to accommodate bending in a finished device and so enhances the amount of light than can be extracted from it. What is more, graphene has excellent electrical and thermal conductivity as well as being mechanically flexible – properties that could come in useful for efficient charge carrier injection, heat spreading and bendability in a finished device, says Rogers.

"These unusual LEDs might be promising alternatives to planar architectures where soft (flexible and stretchable) properties are needed," he added. "More generally, we think that the idea of spanning sheets of graphene as robust, transparent electrodes could provide a

new strategy for electrically interconnecting devices in many areas of electronics, optoelectronics, MEMS and photovoltaics."

The work was published in *Nano Letters*.

About the author

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