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TECHNOLOGY UPDATE

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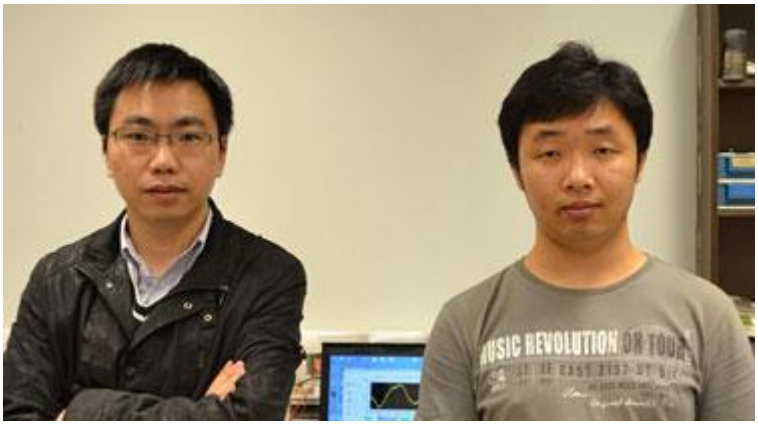
Graphene in new battery breakthrough?

Researchers at Hong Kong Polytechnic University claim to have invented a new kind of graphene-based "battery" that runs solely on ambient heat. The device is said to capture the thermal energy of ions in a solution and convert it into electricity. The results are in the process of being peer reviewed, but if confirmed, such a device might find use in a range of applications, including powering artificial organs from body heat, generating renewable energy and powering electronics.



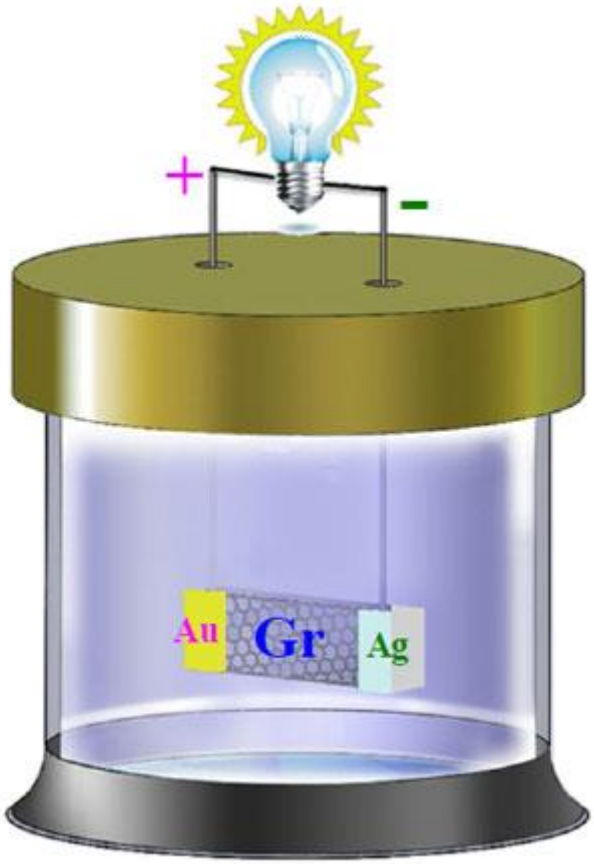
Graphene battery pioneers

Ions in aqueous solution move at speeds of hundreds of metres per second at room temperature and pressure. The thermal energy of these ions can thus reach several kilojoules per kilogram per degree. However, until now, little work had been done on finding out how to tap into this energy and produce power from it.

Zihan Xu and colleagues made their battery by attaching silver and gold electrodes to a strip of graphene. In their experiments, the researchers showed that six of these devices in series placed in a solution of copper chloride ions produced a voltage of more than 2 V. This is enough to drive a commercial red light-emitting diode.

The technology is quite different to conventional lithium-ion batteries, for example, explains Xu, which convert chemical energy into electricity. “The output of our device is also continuous and the device works solely by harvesting the

thermal energy of the surrounding copper chloride ions, which, in theory, is limitless," he told *nanotechweb.org*. "Theoretically, the power output will last forever unless the device is destroyed." No other batteries of this kind exist, he insists.



The device

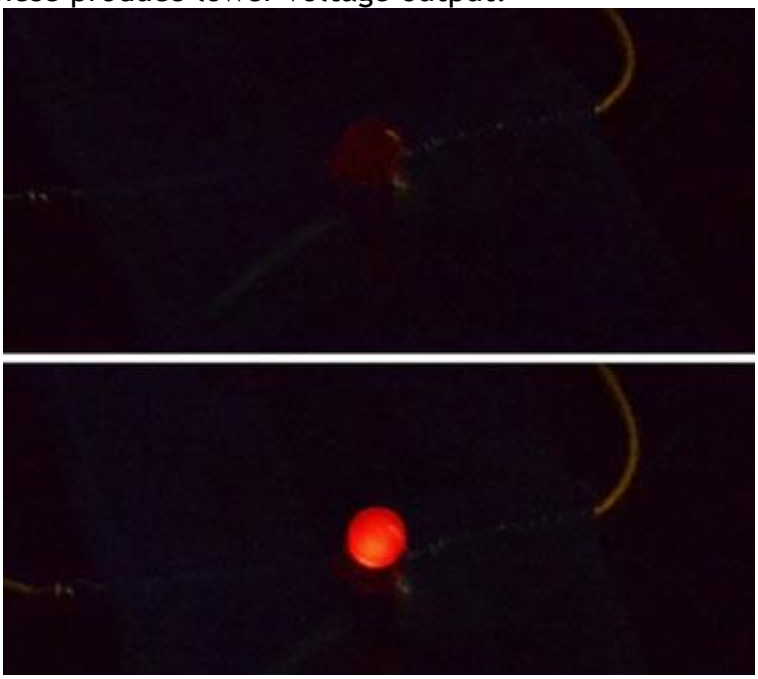
According to the researchers, the battery works rather like a solar cell. The copper ions (Cu^{2+}) continually collide with the graphene strip making up the battery. This collision is energetic enough to displace an electron from graphene. This electron can then either combine with the copper ion or travel through the graphene strip and into the circuit.

Since electrons move through graphene at extremely high speeds (thanks to the fact that they behave like relativistic particles with no rest mass), they evidently travel much faster in the carbon-based material than in the ionic solution. The released electron therefore naturally prefers to travel through the graphene circuit rather than through the solution. This is how voltage is produced by the device, explains Xu.

Increasing voltage output

The researchers also found that the amount of voltage produced by the device could be increased by heating up the ionic solution and accelerating the Cu^{2+} ions with ultrasound. Both of these methods work because they increase the kinetic

energy of the ions. The voltage also increases if the copper chloride solution is more concentrated in Cu^{2+} ions because the density of Cu^{2+} on graphene is then greater. Other cationic solutions can be employed too, such as Na^{+}, K^{+}, Co^{2+} and Ni^{2+}, although these produce lower voltage output.



Battery powers LED

The unique atomic-layer nature of graphene is crucial for this battery, say the researchers, who also experimented with graphite and carbon nanotube thin films. They discovered that these materials only produced low voltages of around microvolts, which could be regarded as noise.

Bor Jang of Nanotek Instruments in Dayton, Ohio, who has worked on making supercapacitors from graphene, says that the concept described looks “very interesting” but that “more work will be needed to assess whether the approach could provide sufficient energy or power density on a per kilogram basis (Wh/kg and kW/kg) for practical uses".

For its part, the Hong Kong team now plans to improve the power output of its graphene-based device and further investigate how it works.

The work is described in a preprint on *arXiv*.

About the author

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