

# Graphene and Portable Devices

Metacog Patent Research

Issue: 1

## At a Glance

With rapid advancements of portable devices - specifically technologies being developed for faster processing, flexible display, and superior connectivity - the researchers and technology companies have now initiated a 'power revolution' for handhelds. The key objectives are to a) increase the longevity of battery, and b) develop easier ways to recharge. In this edition we take a look at the subject of battery management in portable devices (such as mobile phones) - particularly the use of a revolutionary material: Graphene.

## New Developments

Here is a rundown of a few interesting technologies in the quest of improving battery/power in portable devices:

### 1. 'Yolk and Shell' Battery

Researchers at the Massachusetts Institute of Technology (MIT) have developed a technique of using a protective shell made up of nanoparticles around the anode, such that the

anode can expand and contract without affecting the shell.

### 2. Body Heat Harvesting

MIT engineers have also created a battery that can convert body heat into electricity. Further, a team at Korea Advanced Institute of Science and Technology (KAIST) has developed a glass fabric thermoelectric generator that is placed on users' skin, and it converts their body heat into electricity.

### 3. Ultrasound Wireless Charging

uBeam has developed the technology of wireless charging by converting electricity into sound and sending that audio through the air over ultrasound. A portable device receives the sound and converts it back into electricity.

## Enters Graphene

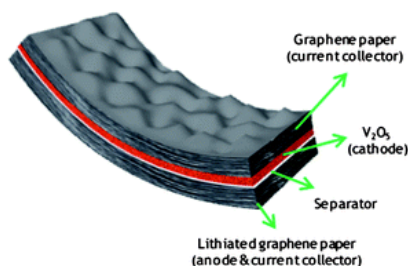
Graphene is a revolutionary material which is a touted as the 'miracle material' of the 21st century. It is made from a singular layer of graphite (the layer is just one atom thick) and involves tightly bonded atoms in a hexagonal structure. This arrangement makes the material strong yet flexible - thereby making it suitable for wearable devices. Graphene is also conductive and transparent, and when stretched across the surface of a phone or a tablet, it can turn any device into a touch screen.

**Figure 1:** Nature Nanotechnology, August 2010 Volume 5 No 8



Graphene is a 'super capacitor', wherein it retains the rapid charge times but increases the amount of storage available - thereby making it an ideal choice for battery management in portable devices.

**Figure 2:** Royal Society of Chemistry - Bendy batteries a step closer



## Technology Overview

The basic technology of incorporating graphene in batteries is implemented by growing graphene layers on top of silicon and restricting the formation of Silicon Carbide. This can permit the charging cell to reach a high density by accommodating the expansion of silicon on a

volumetric basis. The expanded silicon can be adjusted within the graphene layers, also providing large density to the cell to store more charge.

*"Graphene is a single layer of carbon. It's one of the strongest materials ever known, and it's completely flexible."*

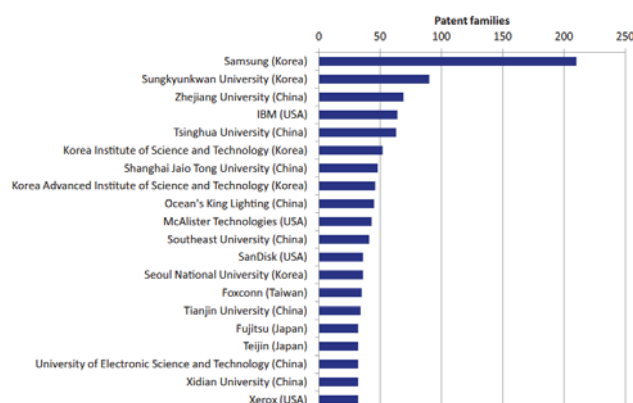
Dr. Richard Kaner, Professor of Chemistry and Biochemistry at UCLA

## Samsung's Strong Hold

Samsung has claimed that it has developed a technique to nearly double the battery life of smart phones by replacing the graphite anode with graphene-coated silicon, hence making batteries with an energy density as much as 1.8 times more than current batteries.

The company is also stockpiling a number of patents on graphene for multiple application areas such as batteries, LEDs, etc. A report published by the UK Intellectual Property Office in 2013 observes "Samsung had over 100 patent families (inventions) published in 2012 and these range from graphene fabrication methods to using graphene as an electrode material in batteries. However, it is interesting to note that almost a quarter of Samsung's Graphene patent published in 2012 relate to graphene-based LEDs (light emitting diodes)"

**Figure 3:** UK Intellectual Property Office - Number of graphene related patent families of top 20 applicants



## Battle Graphene

According to an article published by Bloomberg, the frontrunners of portable devices - Apple, Samsung, and Google - are competing to acquire the graphene related patents. The article discloses that Samsung has over 50 US patents/applications with the term 'graphene', while Apple has two such cases.

## Noteworthy Patents

Let us take a sneak peek at some significant patents related to graphene:

**1. Proton-Battery Based on Graphene Derivatives:** Patent# US20140349211, filed by Nokia in May 2013

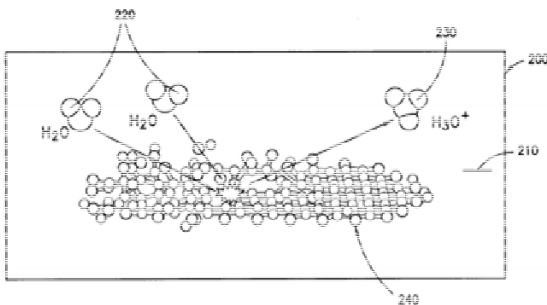
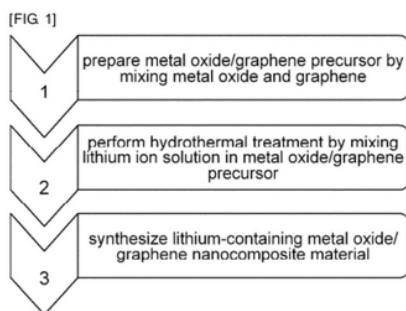


FIG.2

**2. Nanocomposite material, method for preparing the same, and energy storage device including the same:** Patent# US20120258367, filed by Samsung in April 2011



**3. Graphene current collectors in batteries for portable electronic devices:** Patent# US20130095389, filed by Apple in October 2011

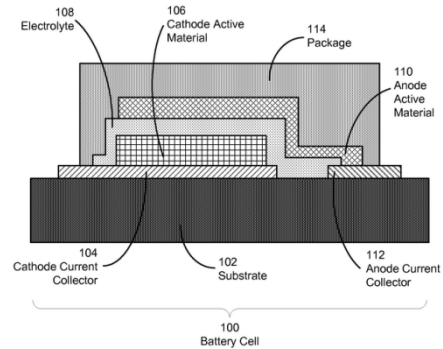


FIG. 1

**4. Graphene-based battery electrodes having continuous flow paths:** Patent# US8758947, filed by US Department of Energy in January 2011

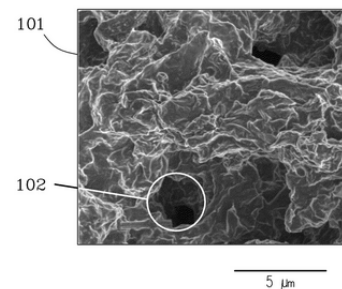
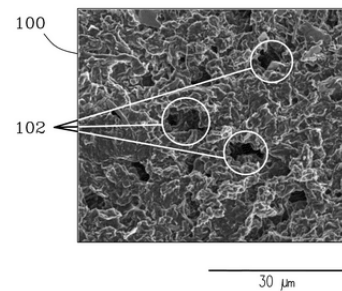


Fig. 1



## References

Nature Nanotechnology. August 2010 Volume 5 No 8. *See*

<http://www.nature.com/nnano/journal/v5/n8/covers/index.html>

Rebecca Brodie. Bendy batteries a step closer. Royal Society of Chemistry. *See*

<http://www.rsc.org/chemistryworld/News/2011/February/25021102.asp>

David L. Chandler. "Yolks" and "shells" improve rechargeable batteries. MIT News. *See*

<http://news.mit.edu/2015/yolks-and-shells-improve-rechargeable-batteries-0805>

Richard Gray. Turn yourself into a walking CHARGER: Battery harvests energy from body heat - and could one day power up mobile phones. Daily Mail UK. *See*

<http://www.dailymail.co.uk/sciencetech/article-2848868/Mobile-phones-charge-batteries-pocket-using-body-heat.html>

Trevor Mogg. Research breakthrough brings body-heat-powered wearables a step closer. Digital Trends. *See*

<http://www.digitaltrends.com/mobile/research-breakthrough-brings-body-heat-powered-wearables-a-step-closer/>

Nick Bilton. Wireless Charging, at a Distance, Moves Forward for uBeam. The New York Times. *See*

[http://bits.blogs.nytimes.com/2014/08/06/ubeam-technology-will-enable-people-to-charge-devices-through-the-air/?\\_r=0](http://bits.blogs.nytimes.com/2014/08/06/ubeam-technology-will-enable-people-to-charge-devices-through-the-air/?_r=0)

Alex Hudson. Is graphene a miracle material? BBC News. *See*

[http://news.bbc.co.uk/2/hi/programmes/click\\_online/9491789.stm](http://news.bbc.co.uk/2/hi/programmes/click_online/9491789.stm)

Martyn Casserly. Graphene battery tech: charge your smartphone in 20 seconds. PC Advisor. *See*

<http://www.pcadvisor.co.uk/feature/tech-industry/graphene-batteries-what-you-need-know-3453389/>

Kelly Hodgkins. Graphene May Be Next Area of Innovation for Apple and Samsung. MacRumors. *See*

<http://www.macrumors.com/2014/05/15/graphene-apple-samsung/>

Sasidhar Kareti. Smartphones Are Coming With Longer Battery Life; Research Started On Graphene Layers Technology. AMFAS Tech. *See* <http://www.amfastech.com/2015/07/Smartphones-with-long-live-batteries-coming.html>

Nicole Arce. Samsung's New Graphene Technology Will Double Life Of Your Lithium-Ion Battery. Tech Times. *See* <http://www.techtimes.com/articles/64353/20150629/samsungs-new-graphene-technology-will-double-life-of-your-lithium-ion-battery.htm>