APEEJAY STYA UNIVERSITY

GRAPHENE – FUTURE OF TOUCHSCREENS

REVIEW REPORT

SUBJECT – WORLD OF NANOSCIENCE

Course Code : ETEC- 162

Session : Jan –May, 2016

Submitted by

Neelanja Chaturvedi (ASU2013010200042)

Poojita Suri (ASU2013010200049)

Siddharth Sudhakar (ASU2013010100076)

(B.Tech CSE, 6th semester students)

Submitted to

Dr. Sonam Raheja

Assistant Professor, Dept. of Physics

Apeejay Stya University

Table of Contents

GRAPHENE – FUTURE OF TOUCHSCREENS

Abstract

This review paper analyses some of the properties of Graphene that makes it highly suitable for manufacturing touchscreens for smartphones. It also discusses the technique used to create touchscreens from graphene based Nano-wires. It also goes on to explore the other uses for graphene for mobile devices that have been explored till date. Since this is a very recent development in the field of smartphones, and is still being extensively researched, the data collated is not complete in nature.

1 Introduction

Graphene is a one-atom thick planar sheet allotrope of carbon packed in a honey comb crystal lattice. It is the strongest and the thinnest known metal, with a strength 100 times that of steel. It is the basic structure element of other such as graphite, charcoal, fullerenes and nanotubes [1].

1.1 Structural properties of Graphene

Graphene is a two-dimensional allotrope of carbon with sp^2 hybridization of the carbon atoms, where each atom has four bonds – one sigma bond with each of its three neighbors and one pie bond that is oriented out of plane. Graphene is a highly stable element, and its stability can be attributed to its sp^2 orbital hybridization - a combination of orbitals s, p_x and p_y that constitute the σ-bond. The final p_z electron makes up the π-bond. The π-bonds hybridize together to form the π-band and π∗-bands. These bands are responsible for most of graphene's notable electronic properties, via the half-filled band that permits free-moving electrons. Graphene can self-repair holes in its sheets, when exposed to molecules containing carbon, such as hydrocarbons. Bombarded with pure carbon atoms, the atoms perfectly align into hexagons, completely filling the holes. Graphene is the strongest material ever tested, with an intrinsic tensile strength of 130 GPa and a Young's modulus (stiffness) of 1 TPa (150000000 psi) [2].

1.2 Potential Applications of Graphene

While the properties of graphene are important, they do not express well their significance because they alone are just numbers. What graphene’s properties mean for the future of technology and the potential of its exploitation is where the true importance of further research lies. Graphene has many potential applications that are very enticing towards today’s technological society. In the realm of solar panels, its optical transparency and high electrical conductivity make graphene a viable option for use. The material is an excellent transparent conductor due to its 2.3 percent absorption rate of visible light. The fact that it has zero bandgap means that a sheet of graphene does not scatter energy carriers which increases efficiency.

Increased research in graphene application for solar panels could lead to innovative design and more cost-effective solar powered energy systems.
Research from the Institute of Photonic Sciences has claimed that "solar cells made with graphene could offer 60% solar cell efficiency – double the widely regarded maximum". This is because graphene is able to produce numerous electrons from photons unlike silicon, which can only make one electron. An extremely important application of graphene lies in the world of electronics. Its high conductivity and mechanical flexibility allow graphene nanotubes to improve the makeup of devices such as televisions, smartphones, batteries, and more. Graphene nanotubes can be pictured as the thin layers of the material rolled up like carpets on nanoscale proportions. The rolled layers of graphene are very beneficial to modern electronics. Currently, silicon is the king of the hill of electronic internals as it has been the most producible and efficient material for the job. However, since graphene surpasses silicon in many aspects, some people are pushing for advanced research to make graphene a usable option. On the outside of appliances, graphene can be used to make very flexible touch screens for any device. On the inside, graphene nanotubes can be used to make faster and more reliable devices and play an important role in excellent integrated circuits. The material serves as a channel component in the circuit that is used in a field-effect transistor. A field-effect transistor uses an electric field to control the shape/conductivity of a charge carrier's channel. The smallest transistor so far, one atom thick by ten atoms wide was made of graphene in 2008. In the same general area of electronics graphene powder can also be used in batteries to make them last longer and increase efficiency [3].

1.3 Use of Graphene in Smartphones

Graphene makes that science fiction smartphone a reality. The most obvious starter use of graphene is in a smartphone display. Since it conducts electricity so well it can make touch screens more responsive and also allow them to draw less power, increasing battery life. Given that graphene is only a few atoms thick, a graphene display can reduce the thickness of a current smartphone by 20% immediately--and that's before graphene is even used in the body of the device or its internal components. But more than making the smartphone thinner, it could actually lead to the end of smartphones--that is devices between 4-6-inches in size--as we know them. Since graphene can be folded and rolled up without being damaged, smartphones of the future could have the capabilities to be folded out from a 5-inch (or even 1-inch) screen to a screen the size of the current iPad. We'll no longer have to decide what sized device we want to carry with us. We can have multiple screen sizes in one device [4].

2 Technical Discussions

“Future developments of mobile radios will require major breakthroughs, in particular in the radio front end components”. Graphene has several advantages. Its capability for ultra-high frequencies has been quite convincingly. A design concept for a bendable phone enabled by nanotechnology [Figure 1]. It has higher thermal conductivity than silicon and graphene transistors are much thinner than CMOS structures, which can help to reduce the operation temperatures of circuits and thus relieve the biggest obstacle to high-performance mobile computing: the heat [3].

Figure 1 – Design concept of a bendable phone

The researchers engineered these large graphene films into transparent electrodes, which were incorporated into touchscreen panel devices. Using a roller, the graphene face can then be pressed against an adhesive polymer support and the copper etched away, leaving the graphene film attached to the polymer. The graphene can then be pressed against a final substrate - such as polyethylene terephthalate (PET) - again using rollers, and the polymer adhesive released by heating [Figure 2]. Subsequent layers of graphene can then be added in a similar way.

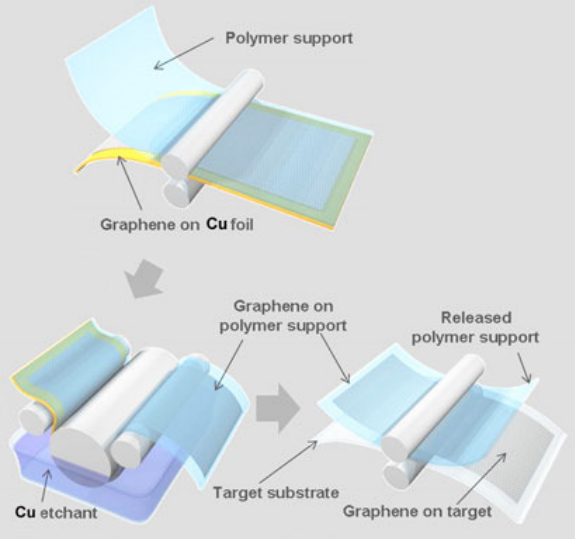

Figure 2 - Graphene Film attached to Polymer

The graphene was doped by treating with nitric acid and in this form the graphene sheet can act as a large, transparent electrode and was demonstrated to work in a touchscreen device. Typically, transparent electrodes used in such applications are made from indium tin oxides (ITO). The researchers say that the graphene electrode has better transparency and is tougher [5].

3 Commercial Experiment

Samsung and Nokia have already shown off concepts for "bendy" phones – such as the newly unveiled Samsung "YOUM" screen or the Nokia morph concept -with shapes unlike anything seen today. Although less extreme versions of some of these concepts may first be brought to market using more conventional technology, Nokia researchers believe that "graphene may well be one of the crucial elements of making Morph reality".

Although these kinds of concepts excite the imagination and show the possibilities of graphene, durability is where the greatest interest lies. What the industry really wants is a touch screen a user can stab thousands of times a day without fear of the electronics ever giving out. Again, that's what makes graphene so attractive.

Of course it has to be cost effective, too. As recently as 2009, it was only possible to manufacture samples of graphene that were a few centimeters across. But in 2010, Samsung-backed researchers at Sungkyunkwan University in South Korea showed it was possible to create roll of meters of the material, and demonstrated it on touch-sensitive tablet screens. And since then Sony has built a machine that can create rolls of the material 100m long – claimed to be the largest sheets in the world.

Samsung have also shown they can integrate onto the graphene sheets organic light-emitting diodes– the light sources used in most smartphones. What's more the OLEDs wired up this way are more efficient and brighter than those based on indium-tin-oxide, so they'll help batteries last longer [6].

4 Conclusion

Graphene has the potential of making communication even faster as compared to other material deployed today. The high conductivity and high mobility make graphene the best candidate to use for communication. Poor band gap and lack of current saturation in graphene are challenges due to which its electronic properties are not at par with current alternatives like silicon. New techniques and processes (by companies like Samsung & Sony) are being developed to induce the band gap and current saturation in graphene. If the cost and quality can be made acceptable then monolayer or few-layer graphene can be adopted for use in special applications requiring transparency and flexibility. The first applications shall be in transparent and flexible conducting electrodes in touch screen panels, but even there the competition with other technologies such as copper of silver wires will be fierce. Depending on the quality of the graphene, also roll-to-roll manufactured flexible analogue or semi-digital circuitries might be possible. Also if further research could overcome the challenges that graphene has, in future, graphene would dominate the mobile communication devices through its presence in even circuit for such devices.

References

[1] http://www.slideshare.net/nehhalpota/mobile-phones-using-graphene
[2] https://en.wikipedia.org/wiki/Graphene#Properties
[3] Anju Gupta, "A review of prospects on Graphene in communication" International Journal of Trend in Research and Development, Volume 3(1), ISSN: 2394-9333
[4] http://www.knowyourmobile.com/mobile-phones/graphene/22184/graphene-bringing-futuristic-super-tech-2016
[5] Zackary Philpot, "ETHICS IN GRAPHENE RESEARCH"(online article)
[6] http://www.bbc.com/future/story/20130306-bend-and-flex-for-mobile-phone