# Week 5: geopolitical

Ideas:

Graphene\_Sri Lanka (accessed June 16, 2014)

<http://www.nation.lk/edition/free/item/30213-nanotechnology-carbon-and-its-promise.html>

## Nanotechnology Carbon and its promise

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- See more at: http://www.nation.lk/edition/free/item/30213-nanotechnology-carbon-and-its-promise.html#sthash.tXCe4pVC.dpuf

Carbon is the sixth element of the periodic table. It also is the element that makes the chemical basis for softer biological materials (life) as well as the hardest material of the Mohsscale (The Mohs scale of mineral hardness characterizes the scratch resistance of various minerals through the ability of a harder material to scratch a softer material); diamond. Amorphous carbon and graphite are two other well-known allotropes (different forms of existence of an element) of carbon.  In the recent past two Nobel prizes were awarded for carbon based nanomaterial. The Nobel Prize in Chemistry 1996 was awarded jointly to Robert F Curl Jr., Sir Harold W Kroto and Richard E Smalley ‘for their discovery of fullerenes’ and the Nobel Prize in Physics 2010 was awarded jointly to Andre Geim and Konstantin Novoselov “for groundbreaking experiments regarding the two-dimensional material grapheme.”

At the Rice University’s Smalley labs during an experiment to create carbon plasmas, they observed recurring peak for C60 molecule (a molecule with 60 carbon atoms) in the Mass Spectrum. Trying to solve the mystery of C60 these researchers took their inspiration from Geodesic domes created by the architect Buckminister Fuller and decided that it has a structure similar to the soccer ball with twenty hexagons and twelve pentagons in the structure. These molecules have a diameter of 1 nm and are extremely stable, withstand very high temperatures and high pressures but no applications are commercialized yet using fullerenes.

In 2004, Andre Geimand Konstantin Novoselov in a Friday afternoon experiment used commonly used scotch tape (3M Company, brand name) to lift layers of graphene from ordinary graphite (pencil lead) we know. This was the first time that graphene was produced and the 2010 Physics Nobel prize was awarded to this new wonder material with many useful properties. Simply this is a single layer of graphite (of 0.3 nm thickness) with a two-dimensional sheet (similar to chicken wire) made of hexagonal rings of sp2 hybridized carbon atoms (means carbon will form three bonds with each other with one electron available in a p orbital perpendicular to the sheet). Structure itself makes it very strong (harder than Diamond, about 300 times stronger than steel) yet lighter, transparent, bendable and highly conductive (due to the free electron in the structure). Therefore graphene is predicted to play a part in super fast computing, aerospace industry, automotive industry, energy generation and storage, coatings and paints, communication, medical and many other fields.

A sheet of graphene rolled into a tube (imagine chicken wire roles in a hardware store) is called Carbon Nano Tubes (CNT). CNT exist in nature and it is believed that our wood furnaces may produce some CNT. First reported the synthesis in 1976, there are many varieties on CNT such as Single Wall CNT (SWNT) and multi wall CNT (MWNT), etc. Additionally CNT has other nomenclature such as arm chair, zigzag, etc. depending on how the graphene sheet is folded and mended. The properties of CNT such as very high aspect ratio (ratio of length of the longer side to diameter) combined with high strength (similar bond formation to graphene) and light weight have made them very useful as a reinforcement material. Usually SWNT has a diameter around 1 nm with the tube length of many million times of that. There are few high end tennis rackets, bicycle frames and car bumpers in the market with CNT. The most attractive property of CNT is its ability to conduct electrons with almost no friction. This property has the potential to revolutionize the computer and communications industries by super fast electronics. For example, arm chair CNT’s have conductivity more than 1000 times that of copper wires.  
It is predicted that the Moore’s law, one of the foundations of the information revolution maybe coming to saturation within the next 15 years. Therefore science is gearing up for a post-silicon era (as Silicon based chips are the bedrock of current computers and the Moore’s law is predicting the computing power of Silicon chips). Emergence of CNT and graphene has made many believing that Carbon based computers are just around the corner. Although Silicon is the second most abundant element in the earth’s crust, carbon forms more compounds than all the other elements combined and recycles through the Carbon cycle in nature.

One of the biggest obstacles at this point is the low cost mass scale production of above materials. Therefore all that promise is yet to be materialized. Sri Lanka produces and exports the cleanest graphite in the world but unfortunately controllers of the graphite industry have made this material unavailable to purchase by Sri Lankans. Therefore garage level innovation in low cost manufacture of these nano materials in not a possibility in our country.

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Scotland & independence

<http://www.frogheart.ca/?p=14016>

phytomining (bacteria mining) but neither in BC

<http://www.theglobeandmail.com/news/british-columbia/will-the-mine-of-tomorrow-be-a-mine-at-all/article20104609/>

Russia, China, nano, & geopolitical tensions

<http://www.frogheart.ca/?p=14600>

Storey & Ryan go to China for their air cleaning detergent

<http://www.frogheart.ca/?p=14200>

Food packaging nano style (markets & US/Australia pact re: cherries)

<http://www.digitaljournal.com/pr/2300045>

Canada, India, Sri Lanka (University of Guelph)

Vive Crop

Kathmandu, Nepal

<http://www.ekantipur.com/2014/11/04/national/intl-conference-on-nanotechnology-kicks-off-in-capital/397213.html\>

Nanocellulose, Canada, Oregon (supecapacitor)

<http://www.frogheart.ca/?p=13030>

MIT and building pr

<http://www.nanowerk.com/nanotechnology-news/newsid=38014.php>

Tecnologico de Monterrey story

Alberta & Nano (Lori Sheremeta interview)

<http://www.innovationanthology.com/programs.php?id=200&mode=full>

Graphene & Human Brain win $1B euros each

<http://www.frogheart.ca/?p=9081>

John Rogers

New Yorker article

Brownian motion

<http://www.einsteinyear.org/facts/brownian_motion/>

The Particle Adventure

<http://particleadventure.org/index.html>

Mexico, nanocomposites in aeronautics & construction

<http://www.nanowerk.com/nanotechnology-news/newsid=38137.php>