Graphene: the gold rush that is going to change the world… but when?

Walked in this morning to my desk covered in WSJ copies of a story entitled ***Wonder Material Ignites Scientific Gold Rush*** about graphene. For the record, I had already read it and it's my professional commitment to narrate and navigate how this amazing material has ignited a scientific land rush. Indeed this is a gold rush that is sending companies and universities racing to understand, the patent cavalcade is on (**partnered with** Hydro-Québec, Grafoid Inc. recently filed for a major graphene patent for its MesoGraf™) – as entrepreneurs everywhere eye potential profits from the "skinnier, more glamorous cousin of ordinary pencil lead."

So, graphene… what is it, how is it made and what can it do? And this patent-pending graphene frenzy, what products are leading the charge that *may* make graphene more financially viable for commercial-scale application?

Graphene 101, for those of you new to the hottest trend in most scientific journals, is a material derived from standard graphite, like the kind found in everyday pencils. But when graphite is shaved to extreme thinness; it is the thinnest material known, and behaves in truly *astonishing*

ways. Exceedingly strong, light and flexible, it is exceptional at conducting electricity and heat, and can absorb and emit light.

Tracy is constantly telling me that graphene can make a MIG invisible and is interested in the impact on solar energy, but let's consider the realities regarding graphene and how its widespread use still face hurdles. For example, graphene is still far too expensive for mass markets, it doesn't lend itself to use in some computer-chip circuitry and scientists are still trying to find better ways to turn it into usable form. Currently, graphene is a complicated technology to deliver and the biggest factor holding graphene back is cost (the quality of graphene affects the price). But that may soon change, if Grafoid has anything to say about it. Graphene's widespread usage is no longer an issue of *if*, but *when*.

So let's ask an expert. When I spoke to Gary Economo, President and CEO of both Focus Graphite Inc. (TSXV: FMS | OTCQX: FCSMF) and Grafoid Inc., he stated: *"Graphene science is sitting on the precipice of commercialization. The markets haven't locked on to graphene's value yet because industry hasn't been able to distinguish one producer's graphene from another – until now. Grafoid's patent-pending MesoGraf now sets the global standard for a stable, reliable and affordable graphene that can be adapted to most any industrial material or product development for economic scalability. The industrial world is knocking on our door now to close the commercialization loop that began nearly 10 years ago with Professors Geim's and Novoselov's graphene discovery. What started with the mechanical exfoliation (the scotch-tape method) of graphene from graphite in their U.K. labs, has grown into an industry of its own with the potential for unlimited and exponential growth."*

I asked Economo how MesoGraf would impact the current graphene industry. *"We see MesoGraf as the catalyst that leads graphene out of obscurity and into the marketplace because of its*

matchless, high-energy density and its economic scalability on a pan-industrial basis," explains Economo. *"As the supplier of Grafoid's source material – raw, unprocessed graphite from Focus Graphite's high-grade Lac Knife resource – we have great expectations for MesoGraf's disruptive technological impact as the global standard for graphene. Graphene does indeed have the ability to change our lives, so, standby; the story is about to unfold and there's a market waiting for a really good news story."*

There is a race underway to move graphene swiftly from the research lab to the consumer marketplace, driven by demand from industries where such super materials are required (i.e. energy storage, electronics, communications, aerospace, automotive, coatings and paints, sensors, solar, oil, etc.). Admittedly, it could be many years before graphene is widely found in consumer products… but the race to get there first is already on.

Ty Facts:

- Graphene is the lightest, thinnest and strongest material on earth. It is approximately 300 times stronger than steel. It would take an elephant balanced on a pencil to puncture a graphene sheet the thickness of Saran Wrap.
- Russian-born scientists, Sir Andre Geim and Sir Konstantin Novoselov, from the University of Manchester discovered the first crystals of graphene in 2004, while researching graphite's potential as a transistor and went on to win the Nobel Prize in Physics in 2010 for their experiments with the material.
- Graphene was discovered using pencil lead and scotch tape.
- There are hundreds of laboratories all over the world deal with different aspects of graphene research.
- Many billions of dollars have been spent funding graphene research and development.

- Graphene is only one atom thick. It is the first material that is, mathematically, two-dimensional (the first two-dimensional material) and one of the thinnest materials imaginable. When viewed at the molecular level, its hexagon lattice structure looks just like chicken wire.
- It would take 1,000,000 sheets of graphene to be just 1 millimeter tall.
- Graphene is a transparent material.
- Graphene is pliable and can take any form desired.
- The unique super material gave birth to a new class of crystals that are also just one-atom thin. And what's more fantastic is that these six new materials can be combined with each other to engineer new materials to meet the special needs of different industries.
- Presently, graphene is pretty pricey to manufacture. Enough graphene to cover the head of a pin would cost upwards of CAD$1,700.
- Mass-production methods are intensively being developed to commercialize graphene.
- Graphene stretches up to 25% of its length and is extraordinarily hard. Graphene is the hardest material known to man – harder than a diamond, which like graphene, also originates from carbon.
- Graphene can be made through chemical reactions, synthesis or by breaking up graphite layers with chemicals.
- Graphene can be curved into different shapes as nano-sized carbon building blocks (graphitic carbon nanomaterials); i.e. nanontubes or fellerenes.
- Graphene is the most impermeable material discovered. Helium atoms can't even get through graphene. This means it is great as gas detector and as a desalination tool.
- Graphene has huge potential for biofuel production.
- The cumulative number of published patent applications for graphene globally, as of May 30, 2013 is: 9,218 (source: Cambridge Intellectual Property). That number

is up 19% from a year earlier. Over the past five years, the cumulative number of graphene patent filings has quintupled. Chinese entities had filed for the most graphene-patent applications, followed by South Korean filers. Samsung accounted for the single-most patent filings.

- Graphene conducts electricity much better than copper. Graphene's current density is 1,000,000 times greater than copper and its intrinsic mobility is 1,000 times more conductive than silicon.
- Graphene conducts heat better than any other know material in thermal conductivity. Oddly, it actually shrinks when it is warmed and expands when it's cooled. This fact makes graphene the only known example of what scientists call "an electrically conductive membrane".
- Graphene is fantastically good at electricity; its current density is 1,000,000 times greater than copper's and its intrinsic mobility is 100 times greater than that of silicon. Electrons move through graphene with virtually no resistance and without mass. This means that graphene can carry electricity more efficiently, precisely and faster than any other material. It is anticipated that graphene will enable lithium batteries to have more than 10 times the electrical retention/capacity as anything presently in use.
- *"Atoms might struggle to get through graphene, but electrons don't,"* according to Sir Geim. *"Graphene will make possible experiments in high-speed quantum physics that even scientists are CERN* (the European Organization for Nuclear Research) *can't manage."*