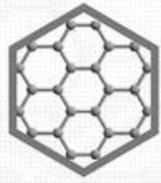


<http://www.thegraphenecouncil.org/blogpost/1501180/266983/NanoXplore-Brings-Unique-Perspective-to-Graphene-Production?hhSearchTerms=%22nanoxplore%22&terms=>



The Graphene Council

Research, Development and Application



GROUP
NANOXPLORE
INC.

GRAPHENE

THE MOST ELECTRICALLY AND THERMALLY
CONDUCTIVE MATERIAL EVER KNOWN.



NanoXplore Brings Unique Perspective to Graphene Production

By Dexter Johnson, IEEE Spectrum, Thursday, January 26, 2017

After Montreal-based NanoXplore launched in 2011, its initial business was contract research in the field of carbon-based technologies. But its identity as a contract R&D company changed in 2014 when it filed a series of patents focused on graphene production.

As the company further developed its technology since then, the main focus of the company has become providing graphene-enhanced polymers for plastics that have enhanced electrical, thermal and mechanical properties.

The company website suggests that these graphene-based polymers have a variety of applications, ranging from photovoltaics to supercapacitors.

We wanted to get to know how a relatively new company that started out as an R&D contractor evolved into a graphene-enhanced polymer manufacturer and how they now see the downstream market for their product. To do that, we took the opportunity of NanoXplore becoming a corporate member of The Graphene Council to talk to the company's chief operating officer, Paul Higgins, and here is that interview.

Q: NanoXplore started out as an R&D contractor in carbon-based technologies. How is it that the company was able to file a patent in graphene production patent just two years after being formed? Were you always doing research in this area, or did you make a concerted effort to find a place in the graphene market?

Working with other carbon-based materials, especially CNTs, it became evident that many commercialization challenges were due to the production processes. The processes had been developed in research environments and were not designed from the ground up with an industrial mindset. We focused from the beginning on low cost, high-yield processes, using existing capital equipment, and with no pre- and post-processing. For example, our graphene production process functionalizes the graphene in-situ, avoiding costly functionalization post-processing for most applications. We were also very cognizant of the need for sustainable, "green" processes; our patented process is water-based, uses no strong acids, and no organic solvents.

A key insight underpinning our patents is that high energy and strong chemical processes create many downstream problems in graphene production. High-energy processes are inefficient and create defected planar structures, resulting in graphene with poor electrical and thermal benefits, in turn requiring high, non-economic loadings of graphene in nanocomposites. Strong chemical processes require complicated post-processing and recycling processes to be cost effective and require very tightly controlled production environments, adding costs.

Once we had established the frame of potential solutions based upon the above, developing our new technology platform was relatively straightforward.

Q: Were you looking to enter a particular niche of the graphene supply chain or did the process you came up with dictate somewhat the point in the supply chain that you now occupy?

Our process is high yield, large volume, low cost, and produces graphene powder with very high quality. This allows us to target mass industrial material markets such as polymers, markets requiring large volumes of material. And due to the quality of our graphene, we can provide significant benefit to industrial materials at low loadings and viable price points.

Of course, the graphene must be effectively mixed into the polymer matrix. To do this we have developed production processes for the manufacture of graphene-enhanced plastic masterbatches. These masterbatches, which we have been manufacturing and selling since early 2016, are the perfect form factor for the plastic industry. Plastic formers, such as injection and blow molders, and compounders are very comfortable with masterbatches and easily incorporate them into their existing processes.

Q: Do you see the company evolving to develop products further up the supply chain? For instance, it appears you're involved in energy storage technologies enabled by graphene. Is this where you see your business moving or do you see this is just diversification of your portfolio?

NanoXplore is focusing our current commercial efforts on graphene-enhanced polymers. We see this as a large market, hungry for innovative materials, where our graphene has a strong competitive advantage.

We also have a patent on a unique graphene-graphite composite material that is useful for energy storage applications. This material was the impetus for our original research in the energy field. This initial research showed great promise and leads us into development of a range of materials for Si-graphene anodes and S-graphene cathodes.

From our current polymer efforts and the emerging energy storage materials, we see a sustainable growth model for the company. Our core research efforts develop graphene-based technologies for a target market, and then transition to product development. During the transition, we will develop technologies for the next target industry. And repeat. Graphene is so broadly applicable that we foresee being able to continue in this vein for some time.

Q: How does your company envision the landscape for the graphene market evolving over the next five years, i.e. are there particular markets that will be winners and losers, what applications are not being sufficiently targeted, etc.?

The graphene market has changed significantly over the last three years. Three years ago the challenge for end users was to obtain decent material, in volume, at a reasonable price. Today there are several producers, including NanoXplore, producing large volumes of good quality graphene. Prices per kg for high quality graphene have fallen during this period from \$30,000/kg to \$100/kg and are set to fall to \$30/kg over the next five years.

[NB: Above and subsequent comments pertain to high quality - low defect, functionalized few layer graphene and graphene nanoplatelets. Graphene from CVD is excluded as is reduced Graphene Oxide (rGO)].

The current challenge for the graphene industry is to incorporate graphene into real-world products and industrial processes. One of the major hurdles is that graphene is sold into a supply chain, with many players between the graphene producer and the final product. And each of these players has their own calculus of risk versus benefit. To be successful the graphene producer must demonstrate benefits to each player at every step along the supply chain, while meeting standards, helping to modify processes, overcoming regulatory hurdles and minimising supply chain disruptions. The successful companies will expand to cover several steps in the supply chain – for example graphene material, polymer compounds, plastic forming – and develop partnerships with other key supply chain players.

Over the next 3-5 years, one can imagine the commercial introduction of novel graphene enabled subsystems and systems. This category of products will include strong, light weight and highly

functional nanocomposites for electric transportation vehicles, greatly improved energy systems (e.g., next generation batteries), high barrier packaging, smart textiles, and others. Solutions for highly regulated industries (e.g., medical, aerospace), some being demonstrated today, will start to exit their testing regimes and enter the marketplace.

Ultimately graphene will be part of building a sustainable future, playing a significant role in the replacement of costly, single function, or scarce materials with abundant, cheaper, and higher-performing ones. It will replace multiple and occasionally toxic additives with a single multi-functional material. It will reduce weight while increasing strength for a wide range of structural polymers and composites often leading to significant fuel savings in vehicles. It will extend the useful lifetime of paints, coatings and lubricants. And it will improve thermal management and energy storage in a wide range of applications, again improving efficiency while husbanding scarce resources.

NanoXplore is very well positioned to help customers participate in this emerging new world. With the combination of high quality graphene material, expertise in mixing graphene with a wide array of industrial materials, and a team of seasoned business leaders and material scientists with broad industrial experience, NanoXplore enables customers to achieve significant and affordable product improvements with very little added graphene.