CRITICAL
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Your monthly guide to the latest information on the world's strategic metals

Have Your Heard of Graphene?

Graphene was discovered about seven years ago in Britain and since then, the material has been generating tremendous attention. The wonder value of the material is extraordinary—it is 200 times stronger than steel and tougher than diamond yet almost invisible and weightless; it stretches like rubber and is a better conductor of heat and electricity than copper. In fact, some researchers claim it is the most important substance created since synthetic plastic a century ago!

The significance of graphene can be estimated from the fact that in 2010, Professors Andre Geim and Konstantin Novoselov of the University of Manchester were awarded the Nobel Prize in physics for their 'groundbreaking experiments regarding the two-dimensional material graphene.' Their work involved isolating graphene flakes using sticky tape.

Graphene is made from graphite, a mineral largely mined in China, India and Canada, with China producing 70–80% of the mineral. China has already taken steps to retain its graphite resources. In addition to restricting its export quota, China has imposed a 20% export duty and a 17% VAT making graphite prices rise. Depending on flake size, graphite flakes are now selling at $2,000–$3,000 per ton. High-purity, large graphite flakes are an integral part of lithium-ion batteries and in fact, these batteries have ten times more graphite than lithium. The demand for lithium-ion batteries is constantly rising with the rising evolution and demand for electric cars.

Graphite has not quite been the miracle mineral investors have been chasing about so far although its natural strength, stiffness, excellent heat and electricity conducting properties have been known features. However, the immense possibilities of graphene have piqued the interest of many. The demand and supply fundamentals of graphite are like those of rare earth metals. The British Geological Survey has listed both graphite and rare earth metals as those most likely to be in short supply globally.

A sheet of graphene is ultra-thin and is made up of one layer of carbon atoms bonded in a honeycomb pattern. So far, it is the thinnest and strongest known material. The potential applications of graphene include lighting panels and televisions that are wallpaper thin, mobile phones that can be folded away behind the ear, bendy electronic newspapers that could be folded into tiny squares, and a generation of even lighter aircraft. It could replace silicon in the manufacture of computer chips and bring new possibilities in medical advancements. The material could make solar panels more efficient and semiconductors faster. The potential of graphene in the manufacture of stealth military applications and electronic technology is probably still unimaginable. It is not for nothing that graphene is being increasingly referred to as the 'miracle material.'

There are however, some chinks in this unbounded glory. It has been pointed out that making large sheets of graphene is not easy while IBM has mentioned that graphene replacing silicon in computer chips is not easy to 'imagine'. Another practical problem is the high electricity conducting property of graphene. Devices such as transistors control the flow of electric currents but to manufacture these transistors, graphene would have to stop conducting electricity—so far a rather cumbersome problem. Certain analysts are of the opinion that commercial use of graphene would be feasible only after five years or so when prices are also likely to drop. The present problem is one of over capacity.

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Power: The Next Generation

Lithium Manganese Dioxide (LMD) batteries have 4% lithium, 61% manganese and 35% oxygen by atomic weight. Their high power output, low production cost, enhanced safety and thermal stability in comparison to other lithium ion batteries have made LMD batteries very attractive in the electric vehicle market. LMD batteries are already being used by the Chevrolet Volt and the Nissan Leaf.

In 2011, researchers at the University of Illinois used lithiated manganese to create an advanced prototype battery that can be recharged in just two minutes. This is an outstanding achievement given that recharging time is one of the major obstacles in the electric vehicle market.

Early last year, American Manganese Inc. expanded its research scope with British Columbia based Kemetco Research Inc. by including more high value products such as LMD, electrolytic manganese dioxide (EMD) and electrolytic manganese metal (EMM). Larry Reaugh, President and CEO of the company, said, "The company is positioned to take a leading role in providing products to the emerging rechargeable battery market. The manganese extraction process is well suited to produce any or all of the high value added manganese products including LMD."

In a recent status report, Kemetco is reported to have successfully completed its pilot plant testing and is soon expected to begin production of EMD which will be used to produce lithiated manganese powder for the battery industry.

Earlier this month, General Motors signed a worldwide licensing agreement with Argonne National Labs to use the new advanced patented cathode material for lithium-ion batteries. The new material contains an oxide mix of lithium, manganese and cobalt. The unique feature of the material is that it can have a higher specific energy, which translates to lower cost per unit weight. The new material will be used in the next generation of Volt and make them less expensive.

Micky Bly, GM executive director – Electric Systems, Hybrids, Electric Vehicles and Batteries said, "Engineers and researchers at General Motors are working on next-generation battery systems that will reduce cost while providing improved performance, expanding the practicality and affordability of electric vehicles in the future."

A report by IDTechEx estimates that 30 million electric vehicles were sold in 2011 and that number is expected to reach 50 million by 2021. The numbers forecast a golden period for the EMM market.

According to a report released by the CPM Group, a commodities research and consulting company, the global demand for EMM is expected to reach about 2.8 million tonnes by 2021 from the 1.5 million tonnes today. China controls 98% of the EMM market and its share of the demand is expected to increase from 87% to 89% over the next decade. And in the manganese market as a whole, the EMD segment for the battery industry is going to see the fastest growth.

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The Coming Disruption In Rare Earths

In December 2011, the US Department of Energy (DoE) released the 2011 'Critical Materials Strategy', a report that examines the role of materials such as rare earth metals in the 'clean energy economy.' The report cautions that the US runs the risk of facing disruptions in its short-term rare earth supply chain until 2015 at least. Shortage of five critical rare earth minerals—dysprosium, europium, neodymium, terbium and yttrium—could create expensive interruptions in the production of electric vehicles, wind turbines and energy-efficient lighting.

In a statement, the DOE said, "The report found that several clean energy technologies use materials at risk of supply disruptions in the short term, with risks generally decreasing in the medium and long terms. Supply challenges for five rare earth metals may affect clean energy technology deployment in the years ahead."

Prices of many of the 16 materials analyzed have been far from stable over the last 12 months and some have in fact seen ten-fold price rises. The pressure on supplies would be further heightened by laws that demand that incandescent light bulbs be phased out.

The 2010 report raised similar fears when China announced its decision to reduce its rare earth export quota. In its wake, the DOE developed the nation's first critical materials research and development plan. The result is a $20-million amount in the 2012 spending bill towards advancing projects that develop alternate materials, diversify supplies, develop more efficient deployment of rare metals and enable recycling and reuse.

The report recommends that the US begin development of rare earth extraction, processing and manufacturing capabilities and also collaborate with Europe and Japan in attempts to reduce global scarcity.

PricewaterhouseCoopers (PwC) has also sounded an alarm about the possible supply shortage. The PwC report stated, "Demand for rare earth metals is currently expected to outstrip supply by 30,000–50,000 tons in 2012. This shortage is likely to result in a decline in production rate of devices and products such as mobile-phones, TVs, military equipment and wind turbines that require rare earth metal made components."