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FAR EAST CAPITAL

The Mining Investment Experts

Weekly Commentary

9 April 2022 | *Chart comments as at Friday's close* | Analyst : Warwick Grigor

Cement is providing the inflection point for graphene volume and profitability

ESG is the new driving imperative for graphene

The efficiencies that graphene brings to the table play into the ESG agenda to which all industries are committed. Adding graphene to plastics and polymers makes them both stronger and fire retardant, often to the extent that they are more effective than steel or aluminium, which are high carbon emitters. Rubbers can be made to last longer and recycling of products can be enhanced with very modest additions of graphene, but the most immediate reduction in carbon emissions can come from introducing graphene to concrete.

We have all known that graphene makes stronger and less permeable concrete for at least two years, adding tiny amounts of less than 0.1% to the mixture, but the cement companies told us that … "*There are many ways to make concrete stronger, so why all the fuss*?" Well, that line of reasoning has changed. These same companies desperately want to reduce their carbon emissions as the sector is responsible for 8% of global carbon emissions today. They are starting to appreciate that they can do so by 20% when they add graphene to the clinking stage of the process, with virtually no change in cost or engineering. The penny has dropped and they are lining up to take advantage of this great improvement.

Cement is a US$740bn p.a. global business

The estimated value of the global cement business is US$740bn p.a., or 14 billion m^3. With the specific gravity of concrete being 3.1 to 3.3, that works out at 42 billion tonnes p.a. If you added < 0.01% (1,000 gms) graphene to each tonne the industry would need more graphene than the world can produce, so let's just assume a modest 1% market penetration in markets that are more environmentally conscious. That would require tens of thousands of tonnes of graphene product, which is many times the capacity of the world to produce today. No single company could produce that amount in the foreseeable future so there will be a supply shortage that needs be overcome. There will be room for many suppliers but one company is leading the charge and is streets ahead of the rest at this juncture, both in terms of quantity and quality; First Graphene.

First Graphene is very advanced with cement product

This scenario is of particular interest to me as a large shareholder and director of First Graphene. That company has developed its $PG_{50}Aqua^{TM}$ product as a convenient and easy to use admix for the cement business. It is already in collaboration with more than 25 cement companies around the globe that are evaluating the performance of graphene in their product mixtures, with very positive feedback. These companies alone would require much more graphene than FGR can produce, so it would need to expand its production capacity by an order of magnitude. Suddenly there could be a massive shortage of graphene. The numbers become daunting and the profits could be huge. There are no guarantees yet so this scenario should be seen as speculative, but so far it looks very promising. We should start to see the evidence from Q3 this calendar year.

A postulated thematic that will revive the sector

When the graphene community wakes up to the reality of potential earnings from selling graphene products into the cement industry, led by the the pioneer, First Graphene, there will be a rush to go down the same path. Everyone will be singing the same tune and promoting this as the inflection point for the sector. There are literally hundreds of other products that can benefit from graphene and these will be an important source of demand in the coming years, but nothing offers the short term volume potential like cement, right now. We can see that there are hundreds of millions of dollars to be made by companies that can scale up their production rates, but we still have to consider the quality and the suitability of the graphene made by each of these companies for the intended application. This will take the sector into its next chapter and enable companies to be profitable for the first time.

Disclosure: Interests associated with the author own shares in First Graphene and is the non-executive chairman.

Using graphene in perovskite solar cells

Late last year we published a note on the unlisted perovskite company, Greatcell Energy Pty Ltd, and invested in the same. For those of you who are unfamiliar with perovskite cells, they represent the new, highly efficient future of solar collectors that could challenge the dominance of silicon solar panels, but time will tell.

One of the big advantages of perovskite cells is that they are very thin - as thin as a $20 bill - and don't require the physical mounting fixtures needed for silicon panels. Nevertheless, each cell is composed of eight layers of materials. Greatcell has been using gold as one layer because of strength and conductivity, but it is expensive. In looking for a substitute, Greatcell has found that PureGRAPH performs very well. This could be an important source of graphene demand in due course .

Some graphene sector observations

Graphene was first "discovered" in 2004, by two researchers at The University of Manchester, Professor Andre Geim and Professor Kostya Novoselov. It didn't take long before a swag of promoters and entrepreneurs launched the graphene sector with participants being both

private and stock exchange listed companies. Enthusiasm was high as these companies sought to promote and benefit from the magical qualities of graphene. However, for all its promise, I don't think I can point to one graphene company that is yet making profits. That is not to say that they sector is a dud, but it does emphasise the time that it takes for a disruptive new nanotechnology to mature to the point that it becomes commercially viable.

In most cases the speculators that bought the sector for its novelty and promise have lost patience and moved on to more exotic opportunities as their expectations of instant gratification have not been met. First mover companies are being called to account and some of the early high flying companies have been sold down heavily, but at the same time we have seen new entrants to the sector in 2021, that have been aggressively supported by the stock market.

This article has been written to help investors place the last five years of graphene activity into perspective and provide some insight as to what we can realistically expect for the next five years. It did finish with a discussion of what could be the near term killer application that underwrites the sector, for those companies that are appropriately positioned - cement, but given its significance, we have moved this to the top of the column.

Making a < 10 atom thickness was the first step

Many of the early companies came with a business model promoting a range of applications that would benefit from the introduction of graphene. The making of graphene was believed to be conceptually simple. All you had to do was reduce carbonaceous material such as graphite to a nanoscale, or crack hydrocarbon gases into their base carbon constituents, enabling the formation of graphene on a substrate (CVD process). A number of processes were developed and each of them had their pros and cons, but just making particles less than 10 atoms thick was just the beginning of what has turned out to be a more elongated journey.

Funtionalising graphene was the next step

The real subsequent science has been in refining the production processes and engineering the graphene particles to achieve functionality for end use, across a wide range of applications. Just like in the saying "*oils ain't oils*", "g*raphene ain't graphenes*". There is a range of quality and sizes to consider in assessing graphene's suitability for various applications. That is why it is difficult to see that graphene will be a commoditised product at any stage soon.

Batch production methods v's continuous methods

Naivity, or perhaps more kindly, inexperience, has been one of the primary obstacles to faster commercialisation of graphene. Another has been the variety of processes by which graphene has been made. It is fine to make graphene in a very controlled laboratory environment, but scaling it up to commercial levels presents a raft of challenges. Batch production methods have been plagued with inconsistencies in quality from one batch to the next, meaning potential customers have not been able to confidently develop graphene-enhanced products in many instances. At the same time, the commissioning of a continuous process requires active sales at the end of the production cycle in order to prevent building of stockpiles. Nevertheless, potential buyers need to see evidence of a continuous process, and the product quality it can achieve, before it will commit to introducing it to their product lines.

Making graphene is not the end game. It is about what you do with it.

Any forecasts for graphene demand must factor into the equation the reality that graphene is not itself the commercial objective. Making pristine graphene on its own is not the end game, though it is the first critical step. It is about what you do with the graphene. It is about the improvements in the end application's performance that offers a commercial advantage. Knowing how to functionalise graphene and then engineer it so that it best combines with the target material is the greater skill. In some cases the graphene manufacturer will develop this skill base but in other cases it will be the application company that develops the know-how and the IP. Using graphene is the means to an end, not the end itself.

Pricing is a red herring

In the early days the lesser informed commentators opined that graphene was too expensive at the nominal price of US$200/kg, but that was a blunt generalisation. There will certainly be some products that won't be able to use graphene irrespective of how good it performs because profit margins are too low e.g. cheap gumboots at Bunnings, but top quality brands will likely benefit. The higher the quality and the asking price for consumer products, the more likely the graphene cost will readily be absorbed.

One of the skills in building a sales book is to understand what graphene can be added to in order to bring the cost down and still benefit from the graphene improvements. It is about being able to tailor product to match a customer's price point, as well as achieving observable improvements to distinguish the products from low quality items.

Graphene manufacturers have to develop the market

A real issue for any prospective graphene company is the lack of an instantaneous market in which to sell product. New markets have to be developed and potential customers have to be educated, and that takes time. However, with the passage of time the know-how will expand and market penetration will accelerate as innovative leaders show the path to better products. Volumes will snowball once the benefits become more widely appreciated and techniques are developed.

Wonderful efficiency is another hurdle

Maybe you could say that, counterintuitively, efficiency is actually a problem … on two fronts. Firstly, a little graphene goes a long way. Adding 1% or less by volume means that initially the sales volumes will be minimal. A lot can be achieved with only 50 kgs, a typical order size for companies experimenting with graphene. Even an order 10x that size is only worth about US$100,000 if you assume a generic price of US$200/kg. We recently heard of a company that made 1,000 pairs of shoes with adding only 40 kg of PureGRAPH.

The qualification period for proving suitability of graphene can easily be one to two years. Thereafter we can anticipate that the ball really starts rolling and serious size graphene orders will be forthcoming, but it does take time.

The efficiency of graphene is also a problem if it means that products last much longer. We have all heard about inbuilt

obsolescence, whereby companies want you to regularly replace exist units and where products are made now that can't be fixed, so you have to throw them out and buy new ones. The iPhone is a classic example. Many manufacturers will work to resist innovation that might undermine their sales volumes. They actually don't want better efficiency. Making the lining of a bucket wheel reclaimer last six times longer sounds like a great step forward, but we have to move aside the luddites that want to stand in the way of progress and efficiency. Yet, shouldn't we all be trying to make things last longer if it helps reduce carbon emissions?

Universities and academics versus commercial businesses

In the early days of graphene the universities were an important source in research and experimentation as the nature of graphene and its relationships with other materials were being investigated, but the sector needs to move beyond this phase to something that is much more commercially focused. Academics are more concerned about tenure and job security and they have little regard to times frames. They see no merit in doing things quickly. Commercial businesses are completely different. They need as short a time frame to earnings as possible and are less concerned with perfection than they are with getting a product to the market. Start earning revenue and you can progressively bring improved versions to the market as they are developed.

Application engineering is complex and time consuming, and it is best done by motivated industry partners rather than academia. Investors should focus on companies that are at this stage of their development.

Time frames have been affected by the above …

All graphene companies are dealing with the issues mentioned above, to a lesser or greater extent. They have to sell into a wide range of products and applications in order to achieve meaningful sales volumes, particularly at this early stage. Eventually, when momentum gathers, they maybe able to concentrate on a more specialised range of graphene enhanced products assisted by growing volumes, but that takes time.

… but what of the future?

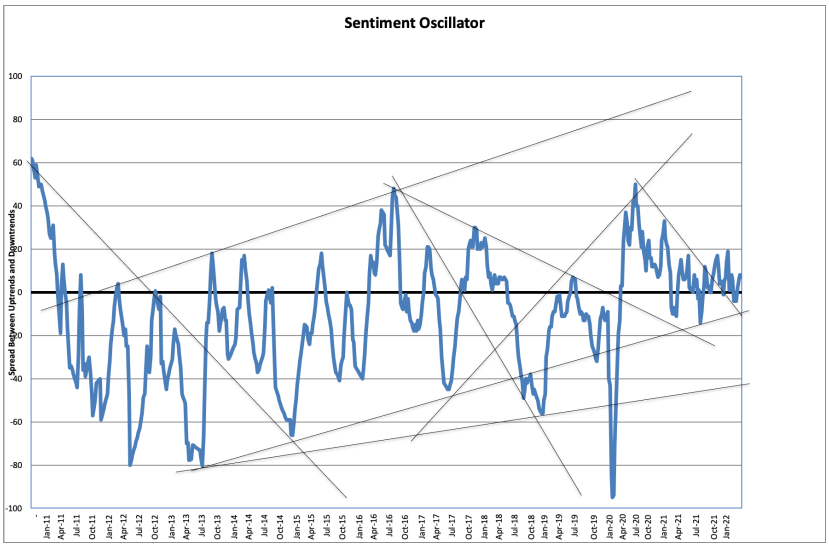
You can continue to be very optimistic about the future of graphene. So far, on a very steep learning curve, we have only been scratching the surface of what graphene can do and what it can be mixed with to achieve great improvements in efficiency and performance. Within reason, I said, "*it makes almost everything better*". One guy in a recent presentation in New York quipped back "*you mean like bacon*". Up until now, in the embryonic stage of the industry, producers have been forced to deal with a wide range of customers in various product lines in order to build sales volumes. However, that is about to change due to the ESG benefits graphene will bring to the cement business.

Real graphene versus micronised graphite

In talking about quality, it is important to recognise the distinction between graphene that is < 10 layers thick, and micronised graphite. They are different materials and they perform differently. Graphene is a nanomaterial whereas micronised graphite is likely to be just tiny graphite pieces - graphite ground down to as small a piece possible through mechanical means. Some less scrupulous companies are happy to have you think they are producing graphene just because they say so, but without proof of quality. Beware of such false representations.

The First Graphene process relies on electrochemical exfoliation to make graphene, which is more gentle than grinding. It results in fewer defects and larger aspect ratios that are important in providing strengthening properties in cement.

We have added Anteotech and Arizona Lithium to the chart coverage.



Sentiment Oscillator: Sentiment has improved. There were 40% (35%) of the charts in uptrend and 32% (29%) in downtrend on Friday's close. The chart shows an interesting pattern - one of confusion really. There has been nothing quite like it in the previous 10 years.

Detailed Chart Comments

NB. Only the bold comments have been updated. Comments in grey type are from previous weeks and will be less relevant. Please note that this list is a cross section of the market. It IS NOT a list of recommendations.

Indices	**Code**		**Trend Comment**	
All Ordinaries	XAO		much stronger	
Metals and Mining	XMM		near highs	
Energy	XEJ		strongly higher	
Information Technology	XIJ		new uptrend	
Stocks	**Code**		**Trend Comment (updated comments in bold)**	**Main Interest**
Alpha HPA	A4N		uptrend	HPA
Adriatic Resources	ADT		breached downtrend	zinc, polymetallic
Alkane Resources	ALK		rising	gold
Alicanto Minerals	AQI		sideways through downtrend	base metals, silver, gold
Altech Chemical	ATC		at apex of wedge	HPA, anodes
Anteotech	ADO		collapsed	silicon anodes, biotech
Alto Metals	AME		sideways	gold exploration
American Rare Earths (was BPL)	ARR		off its highs	rare earths
Antilles Gold	AAU		still down	gold
Arafura Resources	ARU		rising	rare earths
Ardea Resources	ARL		strongly higher	nickel
Aurelia Metals	AMI		new uptrend	gold + base metals
Australian Potash	APC		breached steepest downtrend	potash
Australian Rare Earths	AR3		down	rare earths
Auteco Minerals	AUT		rallying	gold exploration
Arizona Lithium	AZL		uptrend	lithium
Azure Minerals	AZS		weaker	nickel exploration
BHP	BHP		stronger	diversified, iron ore
Beach Energy	BPT		new uptrend confirmed	oil and gas
Bellevue Gold	BGL		testing downtrend	gold exploration
Benz Mining	BNZ		testing downtrend	gold
Blue Star Helium	BNL		down	gas, helium
BMG Resources	BMG		new low	gold exploration
Boab Metals	BML		breached downtrend	silver/lead
Breaker Resources	BRB		heavy fall from highs	gold exploration
Buru Energy	BRU		testing uptrend	oil
Calidus Resources	CAI		surged higher	gold
Capricorn Metals	CMM		surge to new high	gold
Caravel Minerals	CVV		rallied to meet resistance line	copper
Celsius Resources	CLA		rallying	copper
Chalice Mining	CHN		down	nickel, copper, PGMs, gold exploration
Chesser Resources	CHZ		rallied off lows	gold exploration
Cobalt Blue	COB		surge to new high	cobalt
Cyprium Metals	CYM		surge out of downtrend	copper

Danakali	DNK		downtrend accelerating	potash
De Grey	DEG		on support line	gold
E2 Metals	E2M		down	gold exploration
Ecograf	EGR		down	graphite
Element 25	E25		down	manganese
Emerald Resources	EMR		recovered to highs	gold
Empire Energy	EEG		breached uptrend	gas
Euro Manganese	EMN		down	manganese
Evolution Mining	EVN		resumed uptrend	gold
Firefinch	FFX		regained uptrend	gold
First Graphene	FGR		testing uptrend	graphene
Fortescue Metals	FMG		rallying after heavy fall	iron ore
FYI Resources	FYI		down	HPA
Galena Mining	G1A		still down	lead
Galilee Energy	GLL		down	oil and gas, CBM
Genesis Minerals	GMD		raleighing	gold
Genmin	GEN		new uptrend breached	iron ore
Global Energy Ventures	GEV		testing downtrend	hydrogen
Gold Road	GOR		rising	gold
Great Boulder Resources	GBR		sideways to down	gold exploration
Hastings Technology Metals	HAS		testing uptrend	rare earths
Hazer Group	HZR		breached downtrend	hydrogen
Highfield Resources	HFR		back to resistance line	potash
Hillgrove Resources	HGO		long term uptrend	copper
Iluka Resources	ILU		new high	mineral sands
Image Resources	IMA		new uptrend	mineral sands
ioneer (was Global Geoscience)	INR		back to highs	lithium
Ionic Rare Earths (Oro Verde)	IXR		new high	rare earths
Jervois Mining	JVR		shallower uptrend	nickel/cobalt
Kingston Resources	KSN		sideways	gold
Kingwest Resources	KWR		drifting lower	gold
Legend Mining	LEG		sideways	nickel exploration
Lepidico	LPD		rising again	lithium
Lindian Resources	LIN		surge higher	bauxite
Lion One Metals	LLO		spike higher	gold
Los Cerros	LCL		rallied to hit resistance line	gold exploration
Lotus Resources	LOT		holding long term uptrend	uranium
Lucapa Diamond	LOM		shallow downtrend	diamonds
Lynas Corp.	LYC		sharp pullback	rare earths
Magnetic Resources	MAU		shallow downtrend	gold exploration
Mako Gold	MKG		breaching support	gold exploration
Marmota	MEU		sideways	gold exploration
Marvel Gold	MVL		breached uptrend	gold exploration
Matador Mining	MZZ		new low	gold exploration

Mayur Resources	MRL		slump to new low	renewables, cement
Meeka Gold	MEK		strong rise but still LT downtrend	gold
Megado Gold	MEG		rallying	gold exploration
Meteoric Resources	MEI		sideways through downtrend line	gold exploration
MetalsX	MLX		new high	tin, nickel
Metro Mining	MMI		new uptrend confirmed	bauxite
Mincor Resources	MCR		new high	gold/nickel
Mithril Resources	MTH		down	gold/silver
Musgrave Minerals	MGV		testing downtrend	gold exploration
Neometals	NMT		new high	lithium
Northern Minerals	NTU		rising	REE
Northern Star Res.	NST		breached downtrend	gold
Nova Minerals	NVA		uptrend	gold exploration
Oceana Gold	OGC		rising	gold
Oklo Resources	OKU		down	gold expl.
Orecorp	ORR		down	gold development
Oz Minerals	OZL		back to support line	copper
Pacific American	PAK		back to lows	coking coal
Pantoro	PNR		down	gold
Panoramic Res	PAN		rising	nickel
Peak Minerals	PUA		strong rally	copper exploration
Peak Resources	PEK		down	rare earths
Peel Mining	PEX		sideways	copper
Peninsula Energy	PEN		on support line	uranium
Poseidon Nickel	POS		drifting lower	nickel
Perseus Mining	PRU		off its highs	gold
PVW Resources	PVW		down	rare earths
Queensland Pacific Metals	QPM		testing downtrend	nickel/cobalt/HPA
Red River Resources	RVR		longer term uptrend	zinc
Regis Resources	RRL		rising	gold
Renergen	RLT		new high	gas, helium
RIO	RIO		new uptrend	diversified, iron ore
Rumble Resources	RTR		breached downtrend	gold exploration
S2 Resources	S2R		consolidating after steep rise	gold exploration
St Barbara	SBM		testing downtrend	gold
Sandfire Resources	SFR		breached uptrend	copper
Santos	STO		uptrend	oil/gas
Saturn Metals	STN		sideways	gold exploration
Silex Systems	SLX		turning up again	uranium enrichment technology
Silver Mines	SVL		sideways	silver
South Harz Potash	SHP		rising	potash
Stanmore Coal	SMR		pullback	coal
Strandline Resources	STA		surge to new high	mineral sands
Sunstone Metals	STM		downtrend	exploration

Talga Resources	TLG		testing downtrend	graphite
Technology Metals	TMT		down	vanadium
Tesoro Resources	TSO		spiked through downtrend	gold exploration
Theta Gold Mines	TGM		down	gold
Thor Mining	THR		spiked higher	gold exploration
Tietto Minerals	TIE		breached uptrend on placement	gold
Titan Minerals	TTM		breached downtrend	gold
Turaco Gold	TCG		downtrend	gold exploration
Vanadium Resources	VR8		new high	vanadium
West African Resources	WAF		holding uptrend	gold
Westgold Resources	WGX		down	gold
West Wits Mining	WWI		back to support line	gold
Whitehaven Coal	WHC		secondary uptrend	coal
Wiluna Mining	WMC		breached uptrend	gold
Yandal Resources	YRL		breached uptrend	gold exploration
Zenith Minerals	ZNC		surge to new high	gold exploration
Zinc Mines of Ireland	ZMI		sideways	zinc
Totals	40%	55	Uptrend	
	32%	45	Downtrend	
		139	Total	

Guides to Chart Interpretations

- Charts usually go pass from one trend (up or down) into the other via a period of indecision and uncertainty during which the trend can either recover or change. This period is signified by the orange colour. The orange represent both the greatest risk and greatest reward possibilities.
- Once a chart is in confirmed up or downtrends it is not uncommon for 10-20% of that trend to have already transpired.
- There are trends within trends. The focus of this chart review is the immediate trend that affects the sentiment i.e. it can be a downtrend within a long-term uptrend.
- Not every chart warrants a new comment every week. The new comments are in bold type. Grey type comments may be dated.
- Individual charts provide a single view. It is valuable to look at charts of other companies in similar commodities, and the overall sentiment is also very valuable. Not many stocks can swim against the tide.
- We periodically add or delete charts, some times for obscure reasons. If a chart consistent gives poor signals or is very erratic, we may delete it. Sometimes we add a chart because we want to see what all the fuss is about. We do have a preference for charting stocks that we cover in our research as well.
- Errors and omissions may occur from time to time, especially in fast moving markets.

Amber Lights in Tables: Just a reminder if when the amber light is used in the table – it is when the charts are ambiguous or when there is a change of trend taking place. If a chart is breaching a downtrend it can either be a positive sign or a trap. Only once it has done more work can it be confirmed as a new uptrend. Maybe it is a new uptrend (or conversely a new downtrend); the risk takers can decide to jump on board early (or sell). They will maximise their profits (or minimise their losses if indeed it is the start of the new uptrend (downtrend). More risk-averse investors should wait a little longer, being prepared to give up some of the gains in return for greater certainty.

Weightings of Sectors Represented in the Company Charts

Sector	No. of Companies	Weighting	
Gold	**30**	**21.6%**	
Gold Exploration	**24**	**17.3%**	

Nickel	**11**	**7.9%**	
Copper	**10**	**7.2%**	
Rare Earths	**9**	**6.5%**	
Oil/Gas	**7**	**5.0%**	
Iron Ore/Manganese	**6**	**4.3%**	
Lithium	**4**	**2.9%**	
Potash/Phosphate	**5**	**3.6%**	
Graphite/graphene	**4**	**2.9%**	
Uranium	**3**	**2.2%**	
Zinc/Lead	**4**	**2.9%**	
Mineral Sands	**3**	**2.2%**	
Silver	**3**	**2.2%**	
Coal	**3**	**2.2%**	
Bauxite	**2**	**1.4%**	
Cobalt	**1**	**0.7%**	
Tin	**1**	**0.7%**	
Diamonds	**1**	**0.7%**	
Other	**8**		
Total	**139**		

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