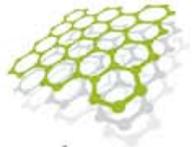


# ASX Announcement

23 October 2017



**first graphite**  
Australia's leading graphene company

## Graphene Technology Update

Advanced materials company, First Graphite Limited (FGR) is pleased to provide shareholders with an update of the Company's progress on its graphene technology and commercialisation strategy.

### HIGHLIGHTS

- Construction of the graphene production facility is on schedule and below budget
- Positive test results for graphene additive in thermoplastics
- Excellent test results and economics on FireStop™ fire retardant
- Nearing first prototype for the BEST Battery™
- Successful generation of graphene in proof of concept tests
- Testing suitability of FGR graphene for concrete enhancement
- Adding to graphene skill base with appointment of experienced personnel
- Name changing to First Graphene Limited to better reflect the focus of the company

### SUMMARY

First Graphite has clearly demonstrated it is now one of the lowest cost, highest quality, jumbo platelet size graphene producers in the world with feedstock carbon grades four times higher than the nearest competitor. The construction of the commercial-scale production facility in Henderson is on schedule for completion by the end of 2017, at a capital cost which would be the envy of every other prospective graphene supplier. With this capability, FGR will have effectively de-risked its graphene production division, and it will be able to deliver into commercial orders in 2018. The modular layout of the Graphene Cells on the production floor will enable a progressive ramp-up to meet these orders while facilitating strict operating cost control.

Working with some of the best scientific minds in Australia, there is now an increasing focus on the development of graphene applications and associated intellectual property (IP). This will grow the demand for graphene products while also opening the door to repeatable revenue streams from license fees and royalties.

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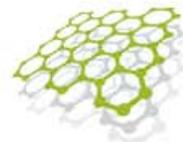
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# Graphene Technology Update

One of the earliest sources of income could be the sale of graphene to a European manufacturer of fire retardants for use in thermoplastics. There is clearly a need for better quality, toxic free fire retardants in the construction industry. Working with the University of Adelaide, we are developing FireStop™, a toxic free and low cost fire retardant for the building industry which could be instrumental in preventing future fire disasters. The effectiveness of this product combined with its simplicity could see its commercialisation as early as 2018. FGR will keep the market informed as demonstrations and approval processes are advanced.

While markets are becoming excited about battery raw material supply lines again, be it for lithium, cobalt, nickel or a range of others, this excitement will eventually be overtaken with the realisation there will be better, disruptive technology coming along. FGR has been fortunate that it has identified one of the most exciting opportunities in this space for its shareholders, namely the BEST Battery™. Swinburne University of Technology is close to completing its first prototype for public demonstration at the IDTechEx conference in California in November. An independent technical assessment of this technology has confirmed the validity of the science which will potentially enable the recharging of mobile phones, for example, in less than 30 seconds and recharge cycles exceeding 10,000 times, which is 10x better than current lithium-ion technology.

Flinders is the third university with which FGR is working closely. Its development of the Vortex Fluidic Device has enormous implications for the future of organic chemistry using the recently discovered phenomena which occurs when gravitation forces interact with centrifugal forces to facilitate amazing outcomes. Additionally, it offers the opportunity to make high quality graphene from graphite and functionalise the material in the process. It is also showing an ability to make graphene oxide in an environmentally acceptable process which could represent a major breakthrough when compared to existing low volume and expensive methods. FGR has a 50% equity in the company owning the graphene IP to the VFD with the option to move to 70%.

There is no doubting graphene is a revolutionary new nanomaterial which offers an exciting growth curve for industry participants. FGR is continuing with its objective of being in the lowest cost decile for graphene production and will use this foundation to ensure it's shareholders are maximising their chances of success in this exciting new field.

**Based on our progress FGR knows the commercialisation of the Company's graphene products is becoming a reality and is much closer than many people think.**

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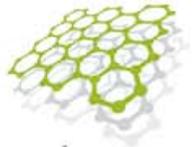
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# Graphene Technology Update

## 1. Progress with the Commercial Graphene Facility

All orders for the construction and equipment have been placed with suppliers. The steel fabrication work has been completed (see Figure 1). The suppliers of the new graphene cell have nearly completed its construction (see Figure 2) and it will be installed now the steel work has been finalised.

The facility is on course to have construction completed by the end of calendar 2017.



Figure 1: Completed steel frame work – Henderson

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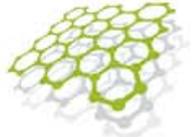
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# Graphene Technology Update



Figure 2: Large scale production graphene cell under construction

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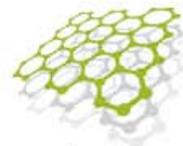
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# Graphene Technology Update

## 2. Graphene for Fire Retardants in Thermoplastics

### Background

Early in 2017, FGR was approached by a major European plastic master-batching company which had previously undertaken 1,300 hours of independent research and demonstrated that graphene provides superior fire retardancy in thermoplastics. A key benefit is the replacement of current, toxic retardant materials.

### Recent Test Work

Test work has confirmed the FGR graphene works to the highest standard and is very suitable for use in the fire retardant mixture. A second round of testing is now in progress on a modified version of the FGR graphene to see if the results can be further improved.

FGR is optimistic that at the completion of the current tests it will prove its graphene is suitable for the masterbatch and this will lead to a new revenue stream from fire retardant additives to the thermoplastics industry.

## 3. The University of Adelaide (UoA)

### Background

FGR's involvement with the University of Adelaide extends back to the initial test work done on the vein graphite performed by the UoA in 2015, which confirmed this material is by far the best feedstock for our electrochemical exfoliation method of producing graphene. Continuing work led FGR to construct the prototype Graphene Cell (see Figure 3), which is the core modular component of the graphene production facility now being constructed at the Henderson site in WA.

In June 2017, FGR signed up as the **lead industry partner** in the Australian Research Council (ARC) Research Hub for Graphene Enabled Industry, designed to bring together scientists and industry for the development of applications for commercialisation. The following slides have been lifted from a paper presented by Prof. Dusan Losic at the GraphChina 2017 conference in China. Figure 4 demonstrates the scope of the ARC Graphene Research Hub. Figures 5 and 6 are also slides from Prof. Losic's presentation.

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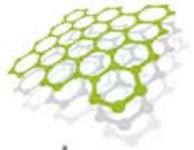
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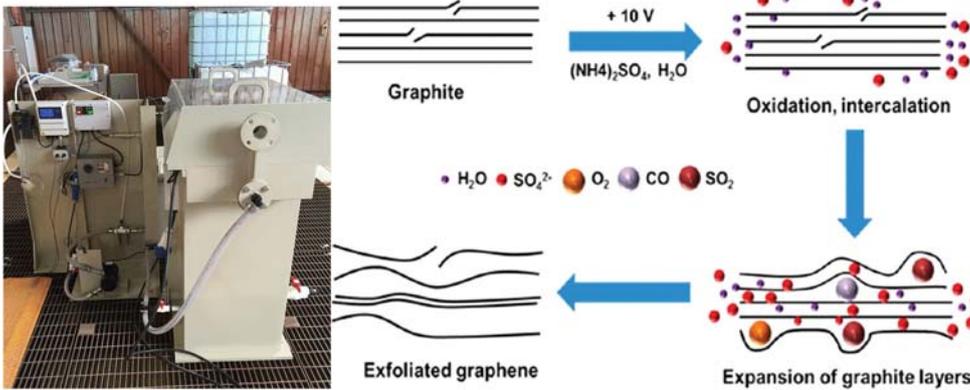
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## Graphene Technology Update

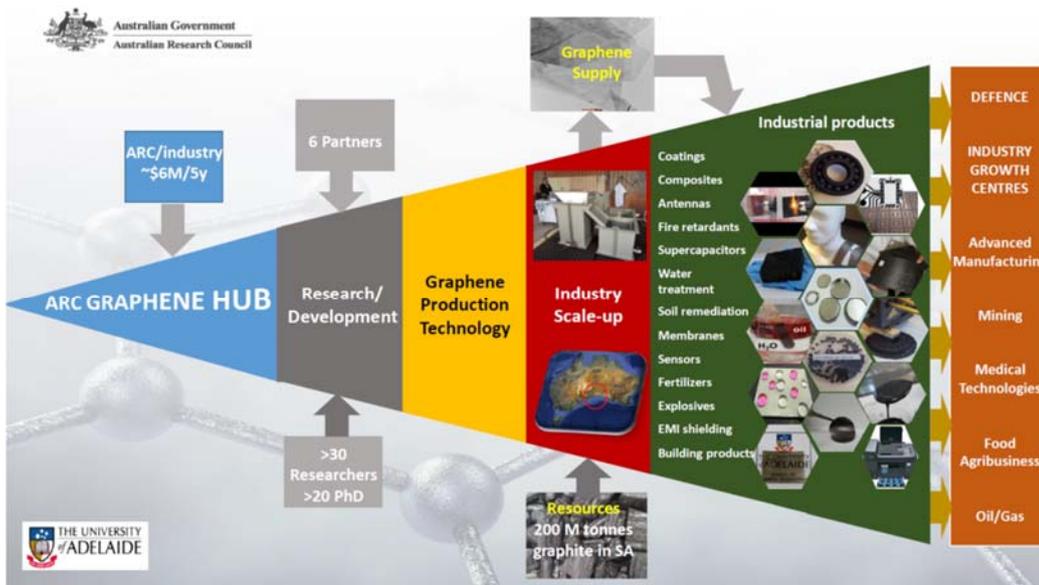
Electrochemical Graphene (EGR) Production: New Generation of Graphene Materials



First Electrochemical Industrial production of pristine graphene

Simple, Low-cost, environmentally friendly production

Figure 3: Pilot Graphene Cell



The first National Integrated program on translation of graphene research \$6M funding, 4 universities and 6 Industry partners, > 30 researchers, >20 PhD

Figure 4: Showing the scope of the Hub.

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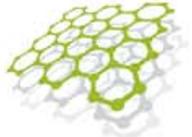
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## Graphene Technology Update

**"Jumbo" pristine graphene (ECR) by electrochemical process: new type of graphene with unique properties**

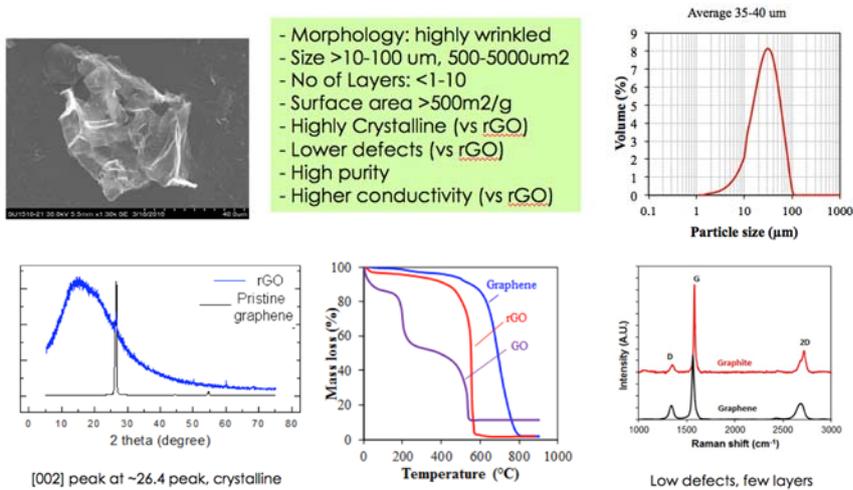


Figure 5: Showing the characteristics of FGR graphene as tested by UoA.

Outstanding conductivity of "Jumbo" pristine graphene (ECR)



### Applications of EGR

- Additive manufacturing (3D /2D printing): **high conductivity**
- Composites materials: **high surface area**
- Protective coatings: **high surface area, barrier properties**
- Fire retardants: **high surface area, barrier properties**
- Conductive inks/paints (thin films): **high conductivity**
- EMI/radiation shielding, antennas etc: **shielding properties**
- Sensors and devices: **high conductivity**

Figure 6: Showing the superior conductivity characteristics of FGR graphene

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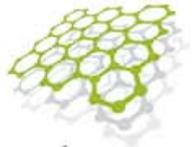
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# Graphene Technology Update

Membership of the Hub is already providing FGR with valuable intellectual property and support for graphene commercialisation activities. The most notable example is the licence agreement covering FireStop™ a graphene-based fire retardant which has demonstrated superior performance and cost advantages when compared with existing fire retardants.

### Recent Progress

The UoA has reported extensive test work on FireStop™ using FGR's graphene as the primary ingredient, confirming it is well suited for the purpose. Test work has involved bench scale tests for the preparation of FireStop™ solutions at different graphene concentration levels. All results have been very positive to date with the large platelet size of the FGR graphene offering useful advantages.

Different coating thicknesses are being evaluated and initial results show that FireStop™ coatings are effective at only 33% of the thickness of competitor products. This has obvious commercial advantages, particularly if effectiveness is achieved with only one coat. Early stage analysis has shown the cost of FireStop™ is significantly less than competitor products making it a preferred product both on technical and economic grounds.

Going forward, we will focus on the optimal mixture and application methods to achieve a product which will be sent to an independent organisation such as the CSIRO for third party testing. Field tests will be arranged on wooden structures coated with FireStop™ and compared with non-treated structures and on those treated with existing fire retardant products.

The outstanding features of FireStop™ will be verified by independent testing and government certification making it a compelling product for building materials, such as cladding. Not only will FGR benefit from selling its graphene products, but it will also earn revenue from licencing the application IP to third party manufacturers of retardants.

These developments are of particular value at a time when many standard industry fire retardants contain halogenated materials and these are being phased out for environmental reasons.

A video showing the effectiveness of the retardant can be viewed on the following You Tube links: <https://youtu.be/v82SrC72R0s>.

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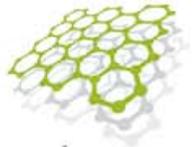
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# Graphene Technology Update

A recent report by Global Market Insights, Inc. states the non-halogenated flame retardants market will surpass US\$3.4bn by 2024. Strong construction output with increasing spending on safety equipment in both commercial and residential sectors will drive the global fire door market growth to more than US\$16bn by 2014, as the focus on fire safety and prevention of flame spreading intensifies.

### Concrete, Thermoplastics and Coatings

Other research work has been focusing on the application of graphene in thermoplastics, coatings and concrete. Previously, the UoA had tested graphene oxide (GO) for use in concrete with the attraction being the hydrophilic nature of graphene oxide, which helped it combine with concrete materials. Very low concentrations of GO were demonstrated to improve performance in the range of 30-60% but as the concentration levels increased to 0.5 wt% the performance reduces due to aggregation of the GO materials.

The UoA is now testing FGR graphene, starting with concentrations of 0.1wt%, with the aim of making "smart cement" with better mechanical performance which would address the concerns of cracking and corrosion. Further, the introduction of conductive graphene flakes may provide conductivity for better monitoring the health of concrete structures.

The concrete admixtures market is estimated to be worth US\$18.10bn by 2020. The drivers identified for the concrete admixtures demand are growing infrastructure requirements in developing economies, improving economics of construction, and shifting preferences of population towards urbanisation.<sup>1</sup>

### Polymers and Coatings

Scientists around the world have been working on functionalising graphene and developing applications in the fields of thermoplastics and coatings. As previously mentioned the challenge with thermoplastics is to achieve homogeneous distributions. Coatings involve a complex formulation of materials depending upon which market is being targeted: domestic and commercial paints, anti-corrosive surfaces or other coatings such as marine anti-fouling paints. The UoA is working with FGR and other Hub partners to advance products in these fields for use in industry.

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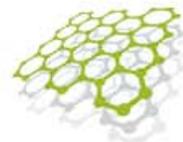
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<sup>1</sup> <http://www.marketsandmarkets.com/PressReleases/concrete-admixtures.asp>



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The global market for Electroactive Polymers (EAP's) is projected to reach US\$5.2bn by 2022, driven by developments in the field of electrochemistry and focus on sustainable development of intelligent materials.<sup>2</sup>

## 4. Flinders University – The Vortex Fluidic Device

### Background

FGR has been working with Flinders on a number of fronts and has been benefiting from different strands of research and expertise which complement those offered by the UoA. A strategic decision was made to purchase up to a 70% interest in the company owning IP associated with the Vortex Fluidic Device (VFD) which was of initial attraction due to its ability to produce graphene from raw graphite and flake graphite concentrates. Thus, it was seen as a potential alternative to our electrochemical exfoliation method. It can also be used as a secondary process step to enhance and functionalise graphene products from the Graphene Cell.

As the Company learns more of the capabilities of the VFD it is beginning to understand the significance of this exciting technology for applications throughout many aspects of industry that go well beyond graphite and graphene. It is capable of accelerating and increasing the efficiencies of chemical and biochemical reactions which would otherwise be difficult to achieve. It has the potential to redefine organic chemistry. As such it is an example of the advanced science and technology which FGR has been developing in pursuit of commercial gain. The following link provides an excellent exposition of how the VFD works, using the example to "unboil an egg". <https://www.youtube.com/watch?v=CHMY4G9gTPA>

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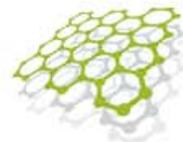
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<sup>2</sup> [http://www.strategyr.com/MarketResearch/Conductive\\_Polymers\\_Market\\_Trends.asp](http://www.strategyr.com/MarketResearch/Conductive_Polymers_Market_Trends.asp)



## Graphene Technology Update

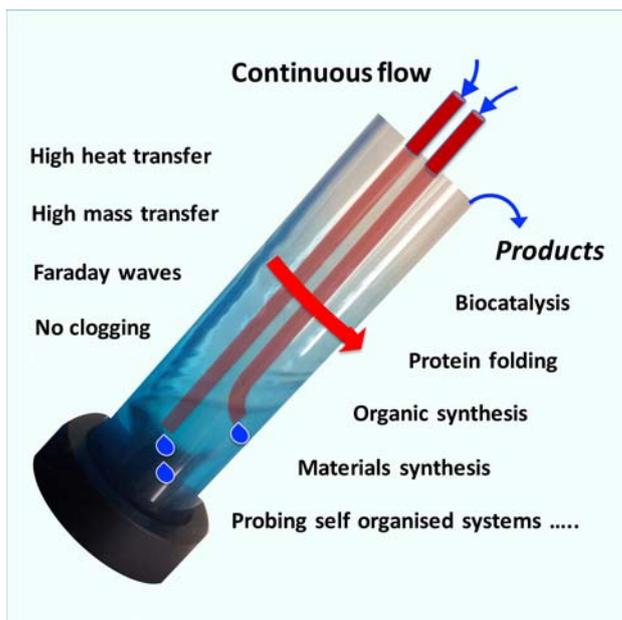


Figure 7: Schematic of VFD

### The VFD Explained

Whereas solution-based methods have been used for the synthesis of graphene from graphite or graphite oxide using high-energy sonication for the exfoliation into graphene layers the associated cavitation process is known to cause defects in the graphene. In contrast to this method the VFD offers a less energy intensive shearing process within the vortex fluidics in a rapidly rotating tube.

The ground breaking science used in the VFD relates to the interaction between centrifugal and gravitational forces which are witnessed when the unit operates at a 45° angle. Unexpected phenomena in chemistry and physics occur enabling exfoliation of a range of laminar materials in a controlled method, in contrast to high-energy processes such as wet ball milling or high power sonication.

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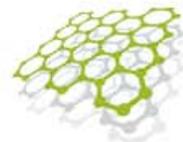
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## Graphene Technology Update

The application of this technology to dynamic thin films with its ability for high heat and mass transfer, shear stress and micro-mixing can lead to the improvement in synthesis of polymers, chemicals and materials.

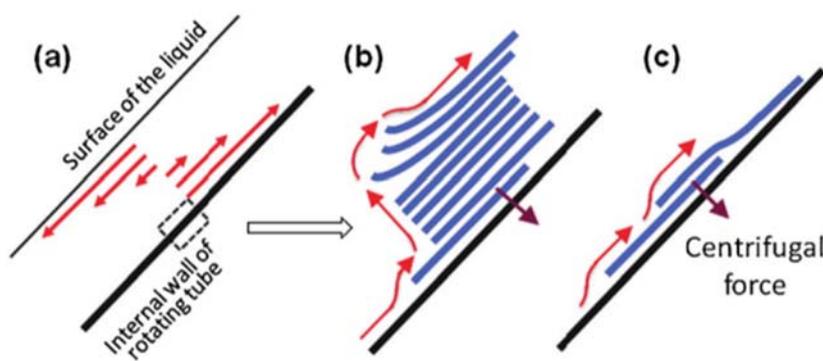


Figure 8: The exfoliation of particles using the VFD, with graphene platelets sliding apart as would a pack of playing cards to achieve nanoscale particles.

### The VFD for Graphene Oxide (GO)

Graphene oxide is a material that is often quoted as having excellent qualities for nanomaterial applications and in some situations it performs better than graphene. As good as GO is in laboratory test work, there continues to be serious challenges to producing it at scale, at acceptable quality. The conventional way of producing GO is with the Hummers Method but this involves nasty chemicals and pollutants which have prevented effective commercialisation of GO enhanced products.

Flinders University has been using the VFD to test its ability to make GO. Initial test work has been positive with GO being generated, but further testing and innovation is required.

There is enormous incentive for FGR and Flinders University to continue with the research to improve the process to a point of commercialisation. Existing GO sources are very expensive; prohibitively expensive in most cases. If the targets can be achieved it would represent a world leading breakthrough and open up the development pathway for GO applications with impressive earnings potential.

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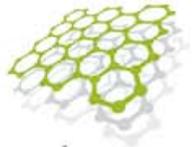
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# Graphene Technology Update

## 5. Swinburne University – The BEST Battery

### Background

Graphene has the ability to significantly enhance existing chemical batteries when it is added to graphite in the anodes with performance improvements of 20% or greater being readily achieved. While FGR is capable of supplying graphene to these companies we have also chosen to advance a novel energy storage device which will deliver a generational change over chemical batteries and existing supercapacitors.

### Technical Aspects of the BEST Battery

The BEST Battery is based on principle of creating nanopores within stacks of reduced graphene oxide structures. and those nanopores are the key to increasing the energy density. The electrolyte is stored in the nanopores and the nanopores are created with a unique laser patterning technique, where the spatial accuracy of the laser is in the region of one micron.

Additionally, the conventional sandwich design of supercapacitors has been replaced with an interdigital design that rearranges anodes and cathodes in a plane, thereby delivering a much shorter ionic path.

Expressed simply, electricity will not be generated via chemical reactions that come with a range of operating and safety issues. Instead, energy will be stored through capture in the unique nanopore structure in a very quick process. The release of this energy will occur at a controlled rate through the use of a switching mechanism delivering the desired power level for a specified time frame to match the needs of the device being powered.

While there are numerous other research groups attempting a breakthrough in the field of supercapacitors and there is a generally held view that these energy storage products will at some point supersede chemical batteries, FGR understands that the Swinburne sourced technology is one of the most simple and advanced. In reality the market will be large enough to accommodate a range of supercapacitor based batteries, just as there is a large range of chemical battery products in the market today. The important point is that FGR has a seat at this table.

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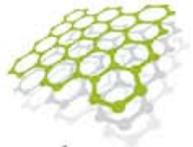
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## Graphene Technology Update

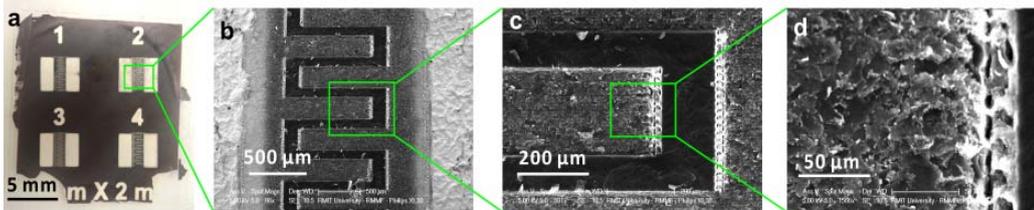


Figure 9: (a) Photo of fabricated GO supercapacitors. (b) – (d) Scanning electron microscopic (SEM) images of one of the supercapacitor

### Recent Progress

Test work with a water-based electrolyte (1 volt working window) has enabled energy density of  $0.02 \text{ Wh/cm}^3$ , which has already exceeded all commercial supercapacitors and the Li thin-film battery. Progression to an ionic liquid (3.5 volt working window) has the potential to further enhance the energy density.

The first few months of the project have involved the recruitment of advanced material scientists and the ordering of equipment needed to produce larger scale versions of the BEST Battery™. A number of devices have been made to demonstrate some of the basic principles of the Battery, with positive results.

Good progress has been made with the construction of a working prototype BEST Battery™ that will be presented at the international IDTechEx Conference on Sana Clara, California in November. Swinburne scientists will accompany FGR personnel in showcasing the product for the first time.

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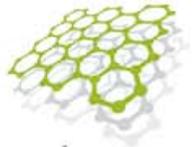
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### ASX Symbol

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## ASX Announcement

23 October 2017



**first graphite**  
Australia's leading graphene company

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### Potential Applications for the BEST Battery

The initial focus for the program with Swinburne is the design of batteries for hand held devices commencing with AA and AAA batteries, but without limitation to these popular consumer oriented devices. The future of batteries is increasingly becoming more the flat pack style, such as in mobile phones.

With further development we anticipate the technology may be applicable to a host of applications e.g. unmanned vehicles, electric bikes, vehicle batteries, electrical vehicles, military applications, biomedical applications, biosensors, smart grids and RFID tags. Of key benefit will be potential reduction in weight and size by (up to 75%) with much safer units which will not suffer from the risks associated with chemical reactions. Thermal stability will improve significantly as well, making devices useful in extreme temperatures.

The opportunities in the energy storage market are significant. IDTechEx, a leading global market researcher on emerging technologies, estimates the energy storage market could grow to \$2bn by 2026 and supercapacitors could meet up to 50% of demand.

## 6. Staffing and Corporate

### Appointment of Dr Andy Goodwin

It was announced on 18 September, that FGR had significantly added to its graphene credentials with the appointment of Dr Andy Goodwin as a Senior Consultant to the Company. For the last five years Dr Goodwin has been Business Director, Advanced Materials Division, at Thomas Swan & Co Limited in Consett UK. Thomas is a private company and one of the leading graphene organisations based in the UK. Dr Goodwin has been primarily responsible for development and commercialisation of graphene products. Not only will Dr Goodwin be of great assistance to First Graphite as it prepares to take its products to the market, but his location in the UK will give the Company a valuable presence and capability in the important, expanding market for graphene in Europe.

Prior to joining Thomas Swan Dr Goodwin was the Global Science & Technology Manager – Solar, for Dow Corning Corporation, in the USA. Dr Goodwin has a Ph.D. in Polymer Chemistry and an MTE Diploma from the International Institute for Management Development Business School in Lausanne, Switzerland.

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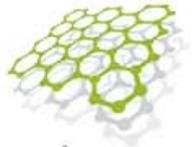
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In recent weeks Dr Goodwin has been visiting the Australian operations and interfacing with the scientists at the universities with which FGR is dealing. We are already benefitting from his intense understanding and expertise in this business, particularly the high standards of professional competence and integrity to which he adheres.

### **New York Investor Base**

FGR personnel have recently completed a visit to New York where they presented the company to a range of investors for the first time. This is part of the strategy to build a shareholder base that understands technology considerations and the enormous growth potential well beyond anything that mining ventures may present. Very encouraging responses were received at the time with the expectation that the USA will be an important source of interest and support as the Company continues to expand into the graphene business.

### **IDTechEx Conference**

FGR will have a strong presence at this conference in November 2017 taking with it scientists from the universities with which it is dealing in Australia. The purpose will be to strongly cement the credibility of the projects and products being advanced by FGR amongst the international scientific community. More importantly though, as this is one of the major advanced technical conferences world there will be an opportunity to interface with many potential customers in the North American market.

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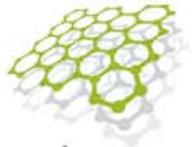
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### *About First Graphite Ltd (ASX: FGR)*

*First Graphite produces high quality graphene from high grade Sri Lankan vein graphite.*

*First Graphite seeks to develop graphene production methods and acquire graphene related intellectual property which can provide further revenue related opportunities.*

### *About Graphene*

*Graphene, the well-publicised and now famous two-dimensional carbon allotrope, is as versatile a material as any discovered on Earth. Its amazing properties as the lightest and strongest material, compared with its ability to conduct heat and electricity better than anything else, mean it can be integrated into a huge number of applications. Initially this will mean graphene is used to help improve the performance and efficiency of current materials and substances, but in the future, it will also be developed in conjunction with other two-dimensional (2D) crystals to create some even more amazing compounds to suit an even wider range of applications.*

*One area of research which is being very highly studied is energy storage. Currently, scientists are working on enhancing the capabilities of lithium ion batteries (by incorporating graphene as an anode) to offer much higher storage capacities with much better longevity and charge rate. Also, graphene is being studied and developed to be used in the manufacture of supercapacitors which are able to be charged very quickly, yet also be able to store a large amount of electricity.*

*For further information, please contact*

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