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ASX ANNOUNCEMENT

30 October 2020

# September Quarterly Activities Review

## HIGHLIGHTS

- **Appointment of Dr Andy Goodwin as non-executive director and Paul Ladislaus as Chief Technology Officer**
- **Commenced project with the University of Warwick (UK) to focus on applications of graphene in polymer systems of plastics and rubbers**
- **Significant progress shown in incorporation of PureGRAPH® in High Density Polyethylene (HDPE)**
- **Concrete tests in cement-based mortars improve compressive strength 34.3% and flexural strength 26.9%**
- **PureGRAPH® significantly improves rubber polymers used in the mining sector**
- **Continued validation of PureGRAPH® Product Quality through NPL collaboration**
- **Ascent Shipwrights confirmed PureGRAPH® significantly improves FRP Boats**

Advanced materials company, First Graphene Limited (ASX: FGR or "the Company") is pleased to provide this update on its financial and operational performance for the quarter ended 30 September 2020.

Appendix 4C quarterly cash flow report follows this update.

### Leadership Appointments

In July 2020 it was announced Dr Andy Goodwin had been appointed a Non-Executive Director and was transitioning to Senior Scientific Advisor, while Mr Paul Ladislaus had been appointed as Chief Technology Officer (CTO). Dr Goodwin had become CTO in September 2018. He led the launch of the Company's PureGRAPH® products, established the UK R&D and marketing capabilities and has supported multiple customer engagements. Mr Paul Ladislaus (MA MEng CEng MIChemE VR) assumed the role of CTO. He had joined the Company in November 2018 as Senior Process Engineer and had since led manufacturing process upgrades, product quality programmes and R&D projects in rubber, plastics, and supercapacitor technologies.

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**Warwick Manufacturing Group**

The Company commenced a PhD Project under the Warwick Collaborative Post Graduate Research Scholarship Scheme, in conjunction with the Warwick Manufacturing Group (WMG). The research collaboration with world-leading experts at the University of Warwick will work to enhance the understanding of graphene in a range of polymer systems such as plastic and rubber. First Graphene will collaborate with the University's Professor Tony McNally, who has an established capability in incorporating nanomaterials, including carbon nanotubes and graphene into bulk polymer systems.

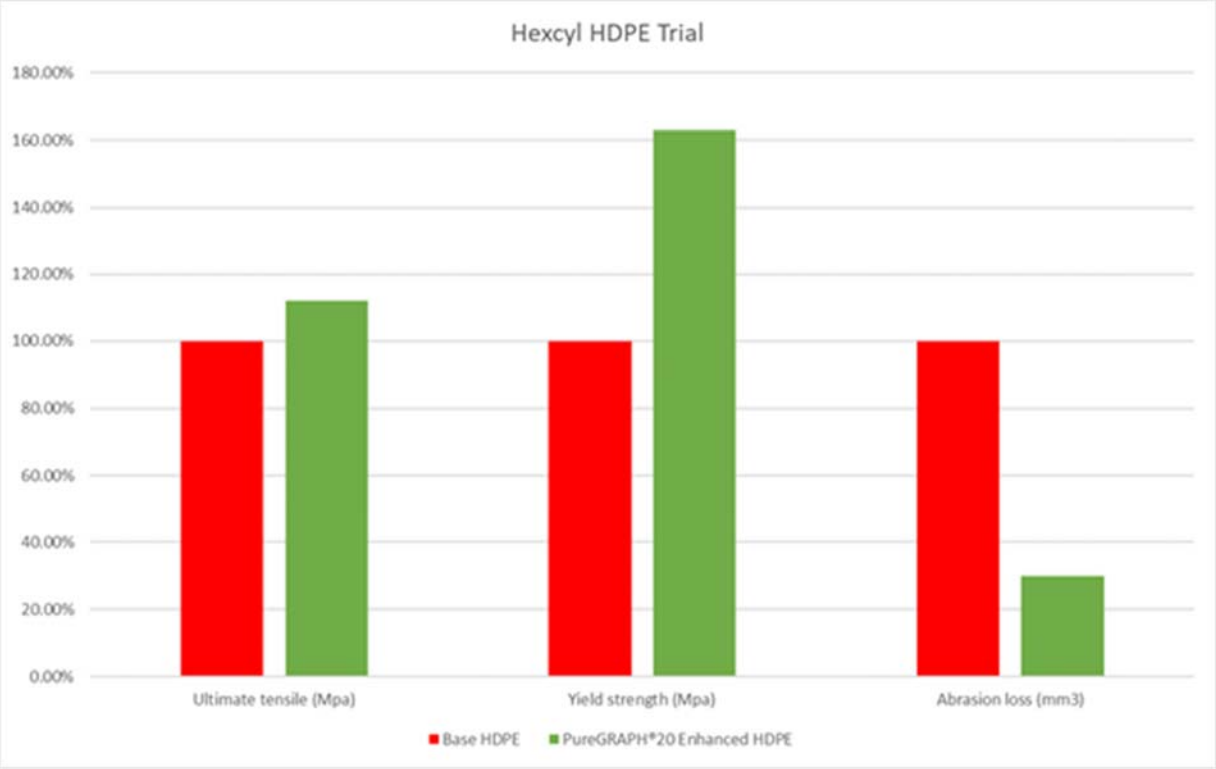
Using graphene as an additive in thermoplastic materials provides an improvement in properties such as mechanical, electrical, thermal, fire retardancy, chemical resistance and gas barrier. This provides the potential to move lower cost polymers such as polyolefins and polyamides up the "plastics performance pyramid," creating new value for plastic manufacturers. Potential uses for these enhanced engineering plastics are light-weighting in automotive and aerospace as well as the delivery of a new generation of high-performing fire-retardant plastics in mass transport, construction, mining, and oil & gas.

This project will combine WMG's capability and First Graphene's operational experience of graphene production and processing to investigate and optimise the impact of surface chemistry, the use of additives and optimising the mixing process technology to deliver further improvements in the properties of graphene-enhanced polymers. Existing First Graphene customers will benefit from this research, which will also enable a new range of PureGRAPH® enhanced polymer and rubber systems.

**PureGRAPH® in HDPE**

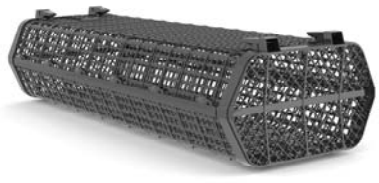
FGR's PureGRAPH® products were used in High-Density Polyethylene (HDPE) and showed improvements in strength, wear resistance and longevity. The trial confirmed that PureGRAPH® graphene products successfully enhanced the performance of HDPE materials in industrial applications. This was an important milestone in our strategy to develop additives for various thermoplastic materials. Low dosages of less than one per cent of PureGRAPH® have generated an increase in yield strength of more than 60 per cent, when compared to the base HDPE product.

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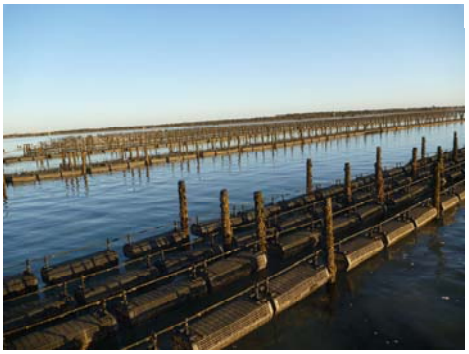



Test Results showing ultimate tensile improvements (>10%), defined as the stress (Mpa) at Moment of rupture and calculated using standard test method for tensile properties of plastics (ASTM D638-14). Yield strength improvements (>60%), defined as the stress (Mpa) limit of elastic behaviour and calculated using standard test method for tensile properties of plastics (ASTM D638-14).
Abrasion loss reduction (>50%), defined as a volume loss (mm3) under abrasion and calculated using an internal method designed to simulate an accelerated abrasive environment

The HDPE masterbatch has been provided to Hexcyl's injection moulding provider to manufacture test baskets and accessories. These will then be field trialled in South Australian waters.



Typical Hexcyl Oyster Basket



Typical Hexcyl Oyster Farm

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**planarTECH Graphene Enhanced Face Masks:**

Our customer planarTECH continues to ship 2AM™ to global customers, the masks are also now available in Australia. planarTECH continue to validate the effectiveness of graphene coating in protective face masks.

Independent test laboratories prove the 2AM™ graphene face mask from planarTECH, which uses PureGRAPH® in the novel textile coating retains its performance after 100 domestic wash cycles. The product is a truly reusable mask, maintaining its bacteria resisting performance and appearance after 100 washes.

The 2AM™ flexible graphene coated polyester fabric used in the masks has been tested by the THTI (Thailand Textile Institute) to the specification Antibacterial Finishes on Textile Materials AATCCTM 100: 2012. Staphylococcus aureus ATCC 6538 was used as the challenge bacteria.

The fabric test specimens were sterilised before testing using an autoclave at 121°C, 15 psi for 15 minutes. Microorganism samples were introduced to the test specimen swatches and left for 24 hours and the number of bacteria remaining on the fabric is subsequently measured. The coated fabrics were tested after 30, 50, 80 and 100 wash cycles in all cases a reduction in the level of bacteria of over 99.94% was recorded. The tests confirm the cutting-edge bacteria resisting properties of the PureGRAPH® coating developed by planarTECH.

The company continues to ship PureGRAPH® raw materials for the manufacture of the 2AM™ masks.

**Improved strength in cement mortar with PureGRAPH®**

In August 2020 FGR released a technical update on the application of its proprietary PureGRAPH® graphene as an additive in cement grouts and concrete. The study showed that graphene admixtures increase strength, reduce materials usage (reducing carbon footprint), and potentially increase longevity of products. This analysis is noteworthy since cement is estimated to amount to 6% of all CO2 emissions from human activity. Cement is the most manufactured and traded product globally after water, which is causing enormous climate change challenges to reduce its carbon footprint.

The Company's PureGRAPH® graphene products were successfully investigated by the ARC Graphene Research Hub at the University of Adelaide. The study, led by Professor Dusan Losic, assessed the influence of dosages and particle (platelets) size of PureGRAPH® graphene on physicochemical, microstructural, and mechanical performance of Ordinary Portland Cement (OPC) cement mortars.

The results show the compressive strength increased by 34.3% and tensile strength by 26.9% when PureGRAPH® is added to cement mortar at very low levels of 0.07%w/w in the cement paste (equivalent to ca. 0.01%w/w in concrete), further validating earlier studies by Professor Losic.

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**Reduced Water Permeability**

Further studies have been completed by Dr. Meini Su at the School of Mechanical, Aerospace and Civil Engineering, of the University of Manchester. She investigated the impact of PureGRAPH® graphene additives on the performance of concrete systems. The cement was prepared and tested in accordance with industry standards (BS 1881-108:1983 method for making test cubes from fresh concrete) and the water permeability assessed by a soaking methodology.

A 0.2%w/w loading of PureGRAPH® in cement reduced water permeability by approximately 40%. The reduction in permeability is derived from the enhanced formation of nucleation sites for the C-S-H hydration crystals and the high surface area of graphene, forming a denser network of interlocked cement crystals.

Furthermore, the School of Mechanical, Aerospace and Civil Engineering, of the University of Manchester, also examined the impact of PureGRAPH® concrete additives on the electric conductivity of cement materials.

Sample blocks of 60 mm x 25 mm x 18 mm were cured for 28 days prior to measurement. The inner two electrodes act as a voltage measuring unit and the outer two are used for inducing current. A significant increase in the electrical conductivity of the cement is observed when the graphene dopant level exceeds ca. 0.05 w/w.

**PureGRAPH® concrete additives for recycled aggregate concrete**

The production and use of cement-based products, as well as the recycling and effective re-use of demolished concrete aggregate, represent significant environmental and construction challenges for the global industry. In the United Kingdom alone, more than 50 million tonnes of concrete aggregate are reclaimed every year. Effective re-use of this material as an aggregate in new concrete is limited by the reduced performance (compressive strength, tensile strength, and Young's modulus) of the composite.

An additional study by the School of Mechanical, Aerospace and Civil Engineering, University of Manchester, investigated the impact of graphene additives upon the performance of Recycled Aggregate Concrete (RAC).

PureGRAPH® graphene concrete additives were dispersed with plasticiser in water to prepare a cement mortar and then RAC concrete prepared. Researchers identified enhancements in the RAC performance achieved by washing the recycled aggregate and doping the cement mortar with 0.01%w/w of PureGRAPH® graphene additives.

The compressive and tensile strengths of the resulting RAC were enhanced by 43.9% and 24.1% respectively to reach values of 39.14MPa and 3.76MPa which are similar to those of C40 New Aggregate Concrete (NAC) a standard concrete manufactured with fresh materials.

A short summary of these studies is available at https://bit.ly/2Cq5tNN.

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### Concrete Industry Involvement

To increase its involvement with the concrete industry First Graphene joined the Concrete Institute of Australia (www.concreteinstitute.com.au) and the Concrete Society UK (http://www.concrete.org.uk/). The Company has commenced discussions with several potential Australian and overseas parties for industry relevant development work.

The use of graphene admixtures is showing improvements in strength, reduction in materials usage and durability of products. However, further studies are required to fully understand the mechanisms behind these results. Additionally, engagement with the construction industry is needed to ensure graphene can be used as a viable, cost effective industry enhancement.

### Developments in Rubber

As previously reported FGR has commenced work on the incorporation of PureGRAPH® powders into long-chain rubber polymers.

To leverage customer interest, FGR has concentrated on the compound most commonly used in the mining screen media market, which has the potential to adapt the findings into other sacrificial wear-liner rubber materials across the industry.

The work has been conducted in conjunction with an experienced rubber consultant in Perth and an established rubber processor in Ipoh, Malaysia.

### Initial Science

Rubber compounds vary considerably depending on their use. Screening tests were completed on 35 compounds using formulation variations and compounded on a laboratory scale two-roll mill.

The two-roll mill allowed for multiple small batches of rubber to be produced with adjusted PureGRAPH® concentration and rubber chemistry. A range of mechanical testing could then be carried out on each batch to evaluate performance and produce the following data displayed in Figure 1.

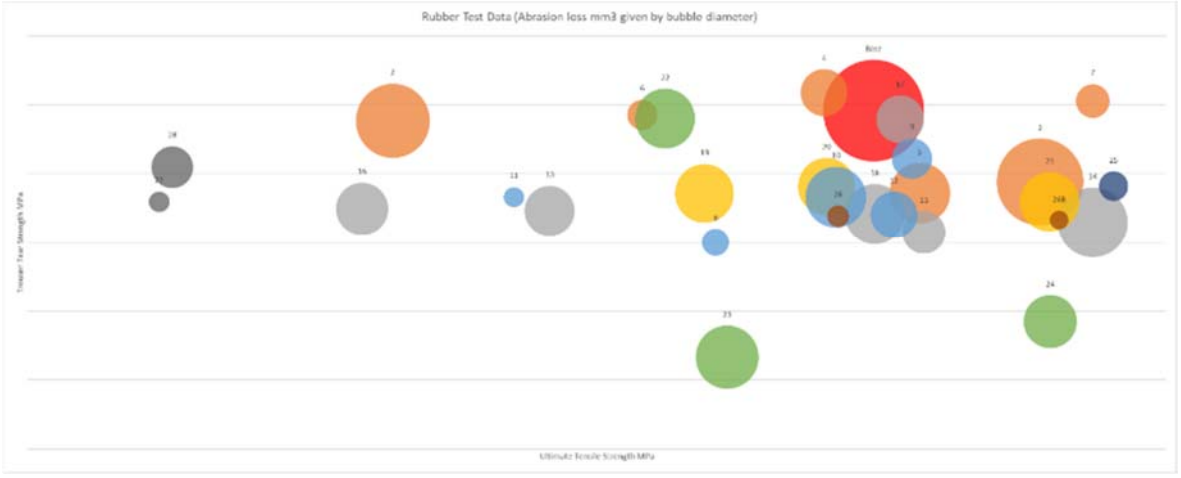



*Figure 1: Bubble chart demonstrating mechanical performance of various graphene enhanced rubber formulations. Y axis represents tear strength, X axis represents tensile strength and the bubble diameter shows abrasion loss.*

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This figure demonstrates multiple mechanical improvements can be achieved through low addition rates of graphene using a two-roll mill. This has meant FGR has a better understanding of how certain mechanical properties can be tailored for specific applications through adjustments to the graphene concentration and rubber chemistry.

Laboratory testing demonstrated the benefits for numerous graphene enhanced rubber compounds using a two-roll mill.

However, laboratory scale equipment does not fully resemble the processing conditions present in full scale commercial rubber compounding, typically carried out in large internal mixers followed by industrial two-roll mills, and so it was important to upscale the laboratory testing to better simulate commercial rubber compounding and demonstrate the benefits of graphene under this environment.

For the commercial scale tests, a control rubber was selected based on industry compounding experience, demonstrating the desired mechanical properties of a typical hard rock screen or wear liner application. A production scale run of this material was then compounded using the Malaysian partner's commercial production process line, both with and without the addition of PureGRAPH®. The compounded rubber was then moulded into large prototype parts and test sheets for mechanical testing.

**Results from PureGRAPH® enhanced rubber**

The following table outlines the improvements achieved from the incorporation of PureGRAPH®20 in the base material used for mining screen or wear media compounds.

| Ultimate Tensile Strength, AS1683 | Die C tear resistance, ASTM D624 | Trouser tear, ASTM D624 | Abrasion Loss (FGR test), Internal Method | Abrasion Loss – taber, ASTM D4060 |
|---|---|---|---|---|
| +20.3% ↑ | +25.8% ↑ | +12.1% ↑ | -5.3% ↓ | -66.0% ↓ |

*Table 1 – PureGRAPH enhanced rubber compared to base compound.*

The improvement in abrasion resistance (i.e. decrease in abrasion wear over the base material) and tear strength is of particular importance for improved performance and longevity of screen media.

As detailed in Table 1, both abrasion resistance and tear strength can be significantly improved through a low addition rate of PureGRAPH® into the rubber compound.

Several client compounded PureGRAPH® enhanced rubber screens are currently in field trials in the mining industry in Western Australia.

Further laboratory test work is underway on additional rubber compounds and processing techniques focussing on improved compound dispersion and fire-retardant applications. Updates will be provided as this work is completed.

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## National Physical Laboratory (NPL) Collaboration

The Company was awarded UK government funding through the National Physical Laboratory (NPL) UK to refine test methods for PureGRAPH® graphene products.

The assurance of product quality and consistency is vital for the successful adoption of graphene additives by downstream customers. FGR has always maintained a strong focus on product quality with its PureGRAPH® graphene product range. Implementing state of the art analytical methods, participating in establishing international standards (ISO/TC229) and use of 6-sigma approaches to control manufacturing processes have all contributed to establishing PureGRAPH® as the leading brand for quality in the industry[1].

World-leading measurement solutions are critical to business and government, accelerating research and innovation, improving quality of life, and enabling trade. Following the COVID-19 crisis the NPL with the support of National Measurement Laboratory partners launched the Measurement for Recovery (M4R)[2] programme, to support UK companies. First Graphene has successfully secured a place on the programme to study the Specific Surface Area of PureGRAPH® products.

Specific Surface Area is an important parameter of graphene platelets, which may impact dispersion and polymer wetting, and a critical parameter for regulatory authorities to enable them to categorise new substances and compare toxicology and environmental fate profiles. Specific Surface Area of powders is typically characterised by the BET (Brunauer-Emmett-Teller) method which uses nitrogen gas adsorption to characterise the surface area. In recent work by NPL[3], researchers investigated factors impacting upon BET measurements including the pristine nature of the graphene platelets.

In the collaborative M4R project, NPL researchers will determine the BET specific surface area of a range of PureGRAPH® products and intermediates, to determine the factors that affect the results of BET measurements. The project commenced late in the quarter.

## Ascent Shipwrights (Ascent)

Ascent and FGR worked on the development of PureGRAPH® enhanced composite construction materials used in fiberglass boat building applications.

Composite boats are fabricated using a composite core material sandwiched between layers of fibre reinforced polymer (FRP) to create a strong and lightweight structure.

The incorporation of PureGRAPH® into the FRP laminate aimed to improve the mechanical properties of the overall composite system, whilst also providing an additional barrier to moisture intake and hydrolysis attack.

[1] https://firstgraphene.net/leading-the-industry-in-graphene-product-quality/
[2] https://www.npl.co.uk/measurement-for-recovery
[3] Sofia Marchesini, Piers Turner, Keith R. Paton, Benjamen P. Reed, Barry Brennan, Krzysztof Koziol, Andrew J. Pollard, Carbon 167 (2020) 585-595

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The Company was pleased to report the initial test work was completed using a conventional high strength core material to evaluate the performance of increasing PureGRAPH® 20 concentrations compared to a control system being used at present. This success has now led to Ascent receiving orders to build four graphene enhanced boats.

The composite materials were produced using existing production methods at Ascent Shipwrights to generate the results displayed in Figure 2.

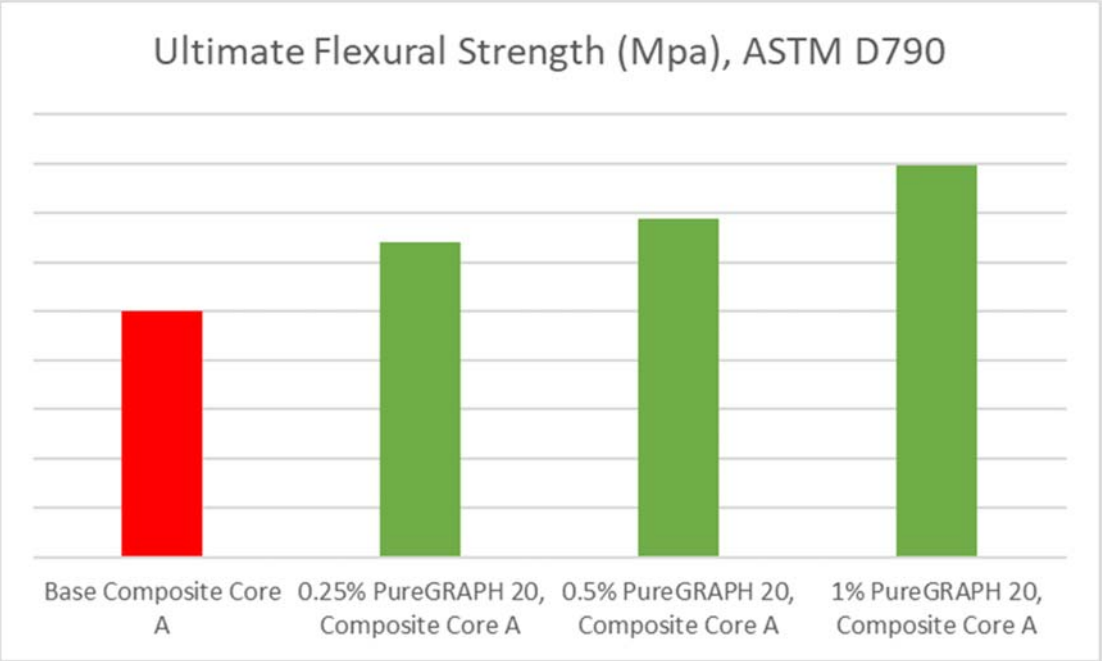



*Figure 2: Ultimate flexural stress for increased PureGRAPH® concentrations in FRP laminate compered to control composite.*

Figure 2 details the significant increase of 59.4% in ultimate flexural stress for a 1% addition rate of PureGRAPH® 20 within the FRP laminate. This result demonstrates the enormous potential for PureGRAPH® enhanced composite structures within the boat building industry and how the material can easily be incorporated within an existing production process. These results have also led to increased enquiry from Australian and overseas boat builders.

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| Significant September Quarter Announcements | | |
|---|---|---|
| **Date** | **Subject Matter** | **URL Link** |
| 1 July 2020 | FGR Strengthens Leadership | https://firstgraphene.net/wp-content/uploads/austocks/fgr/2020_07_01_FGR_f15be423ce78984b2f06a9916b4b5f24.pdf |
| 26 July 2020 | Research Partnership with University of Warwick (UK) | https://firstgraphene.net/wp-content/uploads/austocks/fgr/2020_07_27_FGR_116ac421021fdfe7c3cae2ee9488d97b.pdf |
| 2 August 2020 | Successful trials with HDPE for oceanic farming | https://firstgraphene.net/wp-content/uploads/austocks/fgr/2020_08_03_FGR_cb6804d691396d54bf53e4f73bf2a10b.pdf |
| 16 August 2020 | Study Shows Concrete is Enhanced with Graphene | https://firstgraphene.net/wp-content/uploads/austocks/fgr/2020_08_17_FGR_c4e4c989deb10d3afe464504ee531055.pdf |
| 1 September 2020 | PureGRAPH significantly improves rubber polymers | https://firstgraphene.net/wp-content/uploads/austocks/fgr/2020_09_01_FGR_ed9e8655eb71be9c5a293db938dfa071.pdf |
| 22 September 2020 | Test work with boat builder confirms significant improvements | https://firstgraphene.net/wp-content/uploads/austocks/fgr/2020_09_22_FGR_161e5c995d66dd78dbf78834b871153b.pdf |

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# ASX ANNOUNCEMENT


## Investors

**Craig McGuckin**
Managing Director

First Graphene Limited
craig.mcguckin@firstgraphene.net
+ 61 1300 660 448

## Media

**Luke Derbyshire**
Managing Director

Spoke Corporate
luke@spokecorporate.com
+ 61 488 66 42 46


## About First Graphene Ltd (ASX: FGR)

*First Graphene Ltd. is the leading supplier of high-performing, graphene products. The company has a robust manufacturing platform based upon captive supply of high-purity raw materials and an established 100 tonne/year graphene production capacity. Commercial applications are now being progressed in composites, elastomers, fire retardancy, construction and energy storage.*

*First Graphene Ltd. is publicly listed in Australia (ASX:FGR) and has a primary manufacturing base in Henderson, near Perth, WA. The company is incorporated in the UK as First Graphene (UK) Ltd. and is a Tier 1 partner at the Graphene Engineering and Innovation Centre (GEIC), Manchester, UK.*

## PureGRAPH® Range of Products

***PureGRAPH®*** *graphene powders are available in tonnage volumes with lateral platelet sizes of 20µm, 10µm and 5µm. The products are high performing additives, characterised by their high quality and ease of use.*

## First Graphene Limited

ABN 50 007 870 760

1 Sepia Close
Henderson WA 6166
T: +61 1300 660 448
E: info@firstgraphene.net
W: firstgraphene.net

## Directors:

Warwick Grigor
Craig McGuckin
Peter Youd
Dr Andy Goodwin

## ASX Symbol

FGR
FGROC
Frankfurt
FSE:M11

*With authority of the board, this announcement has been authorised for release, by Peter R. Youd Director, Chief Financial Officer and Company Secretary.*