

## Applied Graphene Materials

### Leading innovation with graphene dispersions

Applied Graphene Materials (AGM) specialises in providing graphene in the form of dispersions of nanoplatelets that can be readily incorporated by customers into their products. It is concentrating on the global protective coatings market, where the financial benefits of the performance enhancements achievable from incorporating graphene may be calculated, encouraging adoption. Revenues are still modest because although the number of customers that AGM is currently selling dispersions to is growing, they are all relatively small. This position could change if larger coatings companies decide to deploy AGM's dispersions or if the longer-term projects involving incorporation of graphene into composite materials or into thermal adhesives progress to commercialisation.

### Making it easier for customers to use graphene

Graphene has not lived up to its early hype because of the difficulty in incorporating graphene into materials so that its desirable properties, such as low permeability, high strength and thermal and electrical conductivity, are transferred. AGM stands out from competitors in supplying graphene formatted as additive dispersions of nanoplatelets. This makes it easier for its customers to incorporate graphene in their products in a repeatable, consistent fashion at volume, thus helping cut the time it takes for them to bring graphene-enhanced products to the market.

### Building customer pipeline

H122 revenues were £46k), the EBITDA loss was £1,723k and net cash (excluding IFRS 16 lease liabilities) reduced by £2.1m during H122 to £4.2m at the period end. Management estimates that this gives a cash runway beyond January 2023. It has recently confirmed its intention to investigate a possible fundraise, the quantum and timing of which have yet to be determined.

### Scenario analysis

AGM's pipeline at the end of H122, including revenues attributable to supplying dispersions for 24 products already launched by customers, represented £3.2m in annualised revenues on a probability-weighted basis. Our scenario analysis shows that this revenue level is not sufficient to take AGM to cash break-even, which is reached at annual revenues of around £11m. This is a very small proportion of the total global protective coatings market (US\$184bn in 2021).

#### Historical results and consensus estimates

Year end	Revenue (£m)	EBITDA (£m)	PBT* (£m)	EPS* (p)	DPS (p)	P/E (x)
07/19	0.1	(4.6)	(4.8)	(7.9)	0.0	N/A
07/20	0.1	(3.1)	(3.5)	(6.1)	0.0	N/A
07/21	0.1	(3.2)	(3.6)	(5.6)	0.0	N/A
07/22e	0.1	(3.7)	(4.1)	(5.8)	0.0	N/A

Source: Company accounts, Refinitiv. Note: \*PBT and EPS are normalised, excluding amortisation of acquired intangibles, exceptional items and share-based payments.

#### Tech hardware & equipment

18 August 2022

Price 18.8p  
Market cap £12m

#### Share price graph



#### Share details

Code	AGM
Listings	AIM, OTCQX
Shares in issue	64.3m
Net cash at end January 2022	£4.2m

#### Business description

Applied Graphene Materials develops graphene dispersions that are used by customers to enhance the properties of coatings, composites and functional materials. It also manufactures high-purity graphene nanoplatelets using readily available raw materials instead of graphite.

#### Bull

- Understanding of dispersion technology enables AGM to support customers developing commercial applications.
- Standardisation of some graphene dispersion products reduces length of sales cycle.
- Introduction of AGM's own anti-corrosion primers reduces dependence on customers incorporating dispersions in their own coatings and selling the end-products themselves.

#### Bear

- Revenue development dependent on success of individual customer product launches.
- Extensive testing required prior to customer acceptance.
- Supply chain challenges diverting customer attention from new product formulation.

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**Applied Graphene Materials is a research client of Edison Investment Research Limited**

## Company description: Enhancing materials' performance with easy-to-incorporate graphene

Graphene was quickly dubbed a 'wonder-material' when it was discovered by researchers at the University of Manchester in 2004 because of its unusual and desirable properties (Exhibit 1). But the material has failed to live up to its early hype because of the difficulty in incorporating graphene in materials so that these desirable properties are transferred. AGM is distinctive because it offers graphene dispersions that are simple and safe and easier for volume manufacturers to incorporate in their products. These dispersions are used by customers to enhance the properties of coatings, composites and functional materials. Significantly, AGM is working with customers on applications such as anti-corrosion coatings on flood-protection gates where the enhanced performance attributable to the incorporation of graphene nanoplatelets delivers quantifiable economics benefits, helping justify the price premium for graphene-enhanced materials.

**Exhibit 1: Properties of graphene**

Property	Graphene
Physical/mechanical	100x stronger than steel, harder than diamond. Highest surface area of all materials. Highly flexible, able to stretch to 120% of its length
Electrical conductivity	60x higher conductivity than copper
Thermal conductivity	5x conductivity of aluminium
Lubrication	Very low surface shear
Permeability	Vacuum tight even to helium gas
Transparency	Around 98% optical transmission

Source: AGM, Edison Investment Research

AGM's revenues are still modest because the customers in the coatings industry that it is selling dispersions to are all relatively small. This could change if one or more larger coatings companies decides to deploy AGM's dispersions so they also can offer graphene-enhanced products or if the longer-term projects involving incorporation of graphene into composite materials or into thermal adhesives progress to commercialisation. The pipeline at the end of H122, including revenues attributable to supplying dispersions for 24 products already launched by customers, represented £3.2m in annualised revenues on a probability-weighted basis. These products include a graphene-enhanced coating for roofing and cladding from Alltimes Coatings, a graphene-enhanced primer and top-coat from Blocksil and numerous car-care products. Alltimes' graphene-enhanced product has been used successfully in projects for P&O, the Severn Bridge trading estate, Royal Mail, Lidl and Bensons. In December 2021 AGM launched its own new Genable branded primers, which management hopes will accelerate adoption of its products in the protective coatings space. Management is scaling up production of dispersions from 10–20 tonnes annually to around 100 tonnes (depending on product mix), which it estimates will cost c £0.3m in capex and should be completed by the end of calendar 2022.

AGM was founded in 2010 by Professor Karl Coleman to commercialise the technology he initially developed at Durham University. It is located in Redcar in the north-east of England and currently employs around 30 people, including a direct sales team based in the United States and the UK. It has built up a global network of distributors, taking the number of people selling its products to around 100. The company listed on AIM in November 2013 and commenced trading on the US OTCQB Venture Market in August 2020, upgrading to OTCQX in July 2021.

## Graphene: The 21st century's new 'wonder-material'

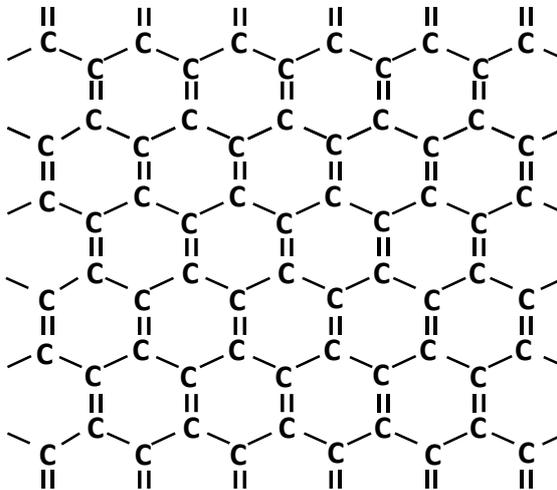
### Not delivered on early promise so far

Graphite is a naturally occurring mineral used in pencil 'leads' and electrodes and as a dry lubricant. It is formed from multiple sheets of graphene, each consisting of a one-atom-thick layer of

carbon atoms arranged in a honeycomb shaped lattice (Exhibit 2). Until the 21st century, most scientists believed that it would not be possible to split the graphite into graphene because the resultant monolayers would not be stable enough. However, in 2004 Professor Andre Geim and Professor Konstantin Novoselov, two researchers at the University of Manchester, became the first people to isolate graphene from graphite. The pair were awarded the Nobel Prize for Physics for their discovery in 2010.

Studies of the new material soon showed that its novel structure gave it exceptional properties (Exhibit 1), presenting the potential of incorporating small quantities of graphene into other materials such that the special properties of graphene would be retained, thus creating higher-value materials with enhanced characteristics. Consequently, graphene has been proposed as a solution for applications as various as performance-enhancing tennis racquets, targeted drug delivery, more fuel-efficient aircraft, faster computer chips, longer-lasting, faster-charging batteries, water filtration and keeping food fresh for longer. However, widespread adoption of graphene-enhanced products has not occurred yet.

**Exhibit 2: Structure of graphene**



Source: Edison Investment Research

In our opinion there are four reasons for the relatively low adoption of graphene so far:

1. While wealthy amateur sports people will pay extra for a graphene-enhanced golf club or tennis racquet in the hope that it will improve their game without carrying out a cost-benefit analysis, business customers using graphene-enhanced products expect to see quantifiable performance benefits before paying a premium.
2. It is difficult for companies manufacturing plastic mouldings, composite materials or any of the other diverse materials that could benefit from including graphene to incorporate pure graphene in their products in a repeatable fashion. One reason for this is because often the graphene itself is of inconsistent quality. In addition the graphene needs to be supplied in a form which is easier to mix with other materials.
3. It is time consuming and costly for a technology company manufacturing graphene alone to move up the supply chain and design, manufacture and sell products that contain graphene.
4. Given graphene's potential to enhance so many different products, it is tempting for a new company offering graphene to address multiple sectors, expending significant effort without return.

### **AGM's focus aids commercialisation**

AGM's commercialisation strategy addresses all of these issues. It is focusing initially primarily on the global protective coatings market, where graphene-enhanced products give clear economic and performance advantages. While the company has launched its own range of graphene-enhanced industrial anti-corrosion primers, it primarily sells customers graphene in the form of easy-to-use

dispersions of nanoplatelets. Customers use the dispersions to enhance the performance of their own products. AGM is also working on longer-term projects incorporating graphene into composite materials used in the aerospace industry and into thermal adhesives for space and other applications.

### Quantifiable benefits from graphene-enhanced coatings

Graphene in its pure form is impermeable even to helium gas so adding graphene nanoplatelets to protective coatings should reduce the permeability to water and gases, reducing corrosion. This is highly desirable for coatings and paints that need to withstand aggressive corrosion in automotive, heavy industry and harsh marine environments. AGM has formulated a range of dispersions of graphene in different solvents that clearly demonstrate a substantial reduction in corrosion in a range of coating scenarios. For example, AGM’s customer James Briggs has conducted trials that show that adding graphene to its automotive respray primers gives a threefold increase in corrosion resistance as well as eliminating the zinc present in conventional anti-corrosion primers. Reducing corrosion has economic benefits as well because the time between repainting can be extended. Alltimes Coatings has been able to extend the warranty on its liquid coating roofing system for industrial and commercial buildings from 20 years to 30 years because of the significantly enhanced anti-corrosion performance resulting from the inclusion of AGM’s graphene dispersions. Reducing the number of times that assets such as telecoms towers and ships need to be repainted over the lifetime of the asset gives a clear, quantifiable benefit that helps justify the price premium for graphene-enhanced products.

**Exhibit 3: Chemical resistance immersion testing – conventional glass-enhanced coating (left) versus graphene-enhanced coating (right)**



Source: AGM

**Exhibit 4: Graphene-enhanced anti-corrosive coating in use on flood-protection gates**



Source: AGM

### Environmental benefits of graphene-enhanced coatings

Since applying a graphene-enhanced coating extends the life of assets made from steel and aluminium, both of which are finite resources, the coatings confer environmental benefits. In addition, adoption of graphene-enhanced coatings potentially reduces the amount of zinc and chromates used in protective coatings for steel and aluminium. Since thinner coatings can be applied, the volume of volatile organic compounds used in each application is reduced. Moreover, since graphene-enhanced coatings last longer, the number of times old coatings need to be removed before recoating will be fewer over the lifetime of an asset. Scraping off old coatings typically releases small particles of polymer, so adopting graphene-enhanced coatings will potentially cut the amount of microplastic pollution.

We note that AGM has developed dispersions suitable for incorporation in water-based coatings, eliminating the use of volatile organic compounds entirely. In July 2021 it launched a range of eco-friendly graphene nanoplatelet dispersions that enable paints, coatings and composite materials customers to improve the sustainability of their product formulations, thus responding to increasing market pressures for environmentally friendly options.

## **Making it easy for customers to develop graphene-enhanced products**

AGM's route to market is primarily through supplying graphene that its customers use to enhance their own products. Most graphene manufacturers supply graphene as a powder. AGM sells customers graphene in the form of dispersions of nanoplatelets in a range of organic solvents, resins and water. The patented formulation keeps the platelets separated until the coating containing the dispersion is applied. The format is convenient for customers to use because the graphene dispersions can be added to the customers' products using standard equipment without needing to modify the manufacturing process. Importantly, adding dispersions containing nanoplatelets enables customers to distribute the graphene material in their products uniformly and repeatably in high volumes. It also helps them move from lab scale development to volume production easily, consistently and safely. A study published by The Graphene Council in January 2021 interviewing around 800 respondents showed that dispersibility was considered the most important challenge for successful use of graphene, with around 50% of people interviewed citing it as essential for graphene adoption.

AGM has created several ranges of standard dispersions under the Genable brand to speed up customer adoption. The dispersions are based on commonly used carrier solvents and resins including epoxy, butyl acetate, xylene, methyl ethyl ketone (MEK), ethyl acetate and water. Importantly, the Genable dispersions are supported by application guidelines, extended performance datasets and considerable formulation know-how from AGM's technical team. Having the extended performance datasets means that potential customers can predict in advance how the dispersions will behave, reducing the time that they need to conduct trials, which should, we believe, help accelerate AGM's revenue growth. The different Genable dispersions are suitable for incorporation in protective paints and coatings, composites and adhesive systems designed to be used for bonding, potting, sealing and encapsulation of electronics, space and automotive components. AGM also creates bespoke dispersions for customers.

## **Better quality dispersions from in-house graphene**

Graphene was initially manufactured by separating graphite into individual layers using mechanical or chemical exfoliation processes. Many graphene manufacturers continue to use this type of top-down technique. However, exfoliation processes typically create product of variable quality, depending on the source of the graphite. Moreover, it can be difficult to control the number of layers of graphene in a nanoplatelet when using exfoliation processes, giving considerable performance variability. In contrast, AGM synthesises graphene from hydrocarbon materials. The process outputs graphene nanoplatelets that are of consistently high quality for use in commercial dispersions that give repeatable performance enhancements in volume production environments.

## **Market size and growth**

Although AGM continues to work on projects with customers in the composites and aerospace industries, it is currently focused on the global protective coatings market. In June 2021 MarketsandMarkets predicted that the global market for coating resins would grow from US\$42.4bn in 2021 to US\$51.4bn by 2026, a CAGR of 4.0%. In January 2022 MarketsandMarkets predicted that the global paints and coatings market would grow from US\$184bn in 2021 to US\$212bn in

2026, a CAGR of 2.9%. In July 2022 IDTechEx published a report predicting that the global graphene market would grow from <\$100m in 2020 to more than \$1bn by 2032.

## Competitive environment

Our market analysis, which does not claim to be exhaustive, shows that AGM is unusual in focusing on protective coatings for architectural and industrial applications and in supplying the graphene in easy-to-use dispersions rather than selling graphene powder.

**Exhibit 5: Non-exhaustive selection of companies offering graphene**

Company	Ticker	Annual revenues	Gross margin	Product portfolio
Black Swan Graphene	SWAN.V	N/A	N/A	Bulk graphene for use in concrete, tyres, plastics, armour and batteries. 40 ton pilot plant production, planned capacity 10,000 tons.
Directa Plus	DCTA.L	£8.6m	N/A	Graphene-enhanced barriers for tackling oil spills and treating wastewater, textile treatments, graphene-enhanced garments including face masks, super-modifier for road surfaces, battery materials. Close to starting commercialisation of flame-retardant and anti-corrosion paints.
Elcora Advanced Materials	ERA.V	Not known*	N/A	Vertically integrated battery materials group that processes graphite into battery materials and graphene. Currently focused on developing vanadium opportunity.
First Graphene	FGR.AU	£0.3m	22.1%	100 tonnes/year production capacity. Graphene powder used as an additive for fibre-reinforced plastic composites, elastomers, plastics, coatings, energy storage and concrete, tailored additives for polyolefins, elastomers and bitumen. Pre-dispersed graphene paste for incorporation in paints, inks, latex, polymer and cement composites.
G6 Materials	GGG.V	£1.6m	26.7%	Graphene-enhanced air filtration materials as well as electrically conductive adhesives for replacing solder, composite formulations.
Global Graphene Group	N/A	N/A	N/A	Graphene powder, graphene thermal heat spreaders for electronic devices, graphene enabled silicon anodes, heat-dissipating coatings, conductive printable inks, anti-corrosion primers and mid-coatings, materials for use in conventional lithium-ion batteries, solid state batteries and lithium-sulphur or lithium-selenium batteries.
Graphenea	N/A	N/A	N/A	Manufacture of customised graphene-based electronic chips for bio-sensing, optoelectronic and photonic applications.
Graphenano	N/A	N/A	N/A	Graphene-enhanced materials for dental prosthetics, also concrete additives and materials for use in batteries, sensors and composite materials.
Graphene Manufacturing Group	GMG.V	£0.1m	N/A	Using graphene from its proprietary process involving decomposition of methane for heating, ventilating, and air conditioning (HVAC) coatings, lubricants and fluids. Working on development of graphene aluminium-ion batteries.
Haydale	HAYD.L	Not known*	N/A	Advanced materials portfolio includes graphene-enhanced carbon fibre composite, graphene impregnated fabric face masks, graphene inks for printed electronics, functionalised graphene for bicycle tyres. Also supplying carbon nanotubes and silicon carbide whiskers.
HeiQ	HEIQ.L	Not known*	N/A	Proprietary processes for the direct synthesis of porous graphene materials with demonstrated technical benefits for membrane-based applications in electronics, waterproof breathable textiles, water and industrial filtration and battery applications. This portfolio complements existing non-graphene textile treatment products.
Hydrograph Clean Power	HG.CN	N/A	N/A	Reactive shell graphene, which chemically combines with other products. Patented graphene-based nano-inks for flexible printed electronics and patented graphene-enhanced carbon fibre for additive manufacturing. Graphene manufacturing process produces hydrogen and syngas (hydrogen and carbon monoxide) as useful by-products.
Integrated Graphene	N/A	N/A	N/A	Manufacturer of 3D graphene foam, which it uses in bio-sensors and super-capacitors.
NanoXplore	GRA.T	£42.7m	11.4%	4,000 tonne/year capacity. Graphene powder, graphene-enhanced masterbatches and graphene-enhanced composites. Graphene primarily used in transportation, also in batteries, polymers, recyclable flooring, wind turbine blades and agriculture.
Ningbo Morsh Technology	N/A	N/A	N/A	Claim to have production capacity of 300 tons graphene annually and 2,000 tons graphene-enhanced composites or plastics.
Perpetuus Advanced Materials	N/A	N/A	N/A	Manufacturer of surface modified graphene primarily used in graphene-enhanced tyres.
Versarien	VRS.L	£1.9m	N/A	Graphene based inks for textiles with enhanced thermal transmission and moisture management, graphene-enhanced cement admixture, graphene enhanced elastomers for shoes, graphene-enhanced masks.
Vorbeck Materials	N/A	N/A	N/A	Communications and sensing devices for first responders, industrial workers and the military, many of which use graphene printed electronics made with its proprietary conductive graphene inks and coatings.
Zentek	ZEN.V	Not known*	N/A	Production of graphene-oxide/silver compound (Ag-GO) used in anti-microbial coatings for masks, other personal protection equipment and HVAC (heating, ventilation and air-conditioning) filters. Also exploring graphene-based applications in ice-phobic and fire-retardant (intumescent) coatings, fuel additives and graphene silicon anode battery technology.

Source: Edison Investment Research. Note: \*Attributable to graphene.

## Commercialising the technology

### Expanding the sales pipeline

An examination of AGM's sales pipeline shows that AGM is continuing to work with its customers to progress graphene enhanced products through to launch. Five projects were completed during H122 compared with nine in H221 and two in H121. The five projects completed in H122 included three car care products, Stanvac-Superon's conductive coating (see below) and a project with Infinite Composites. Products launched in H221 included a graphene-enhanced detailing spray for motorcycles from Tru-Tension and two graphene-enhanced sealants for the car care market from Constellation Chemicals. The rate of customer launches was slower in H221 than H222 because of the wider problems affecting the coatings market referred to in the financials section below.

The pipeline at the end of H122, including revenues attributable to supplying dispersions for 24 products already launched by customers, represented £3.2m in annualised revenues on a probability-weighted basis. The pipeline value at the end of H122 is lower than the value calculated at the end of FY21 (£3.7m) because several projects have been discontinued and the sales opportunity relating to completed projects has been revised downwards to reflect recent sales experience and the ongoing difficult trading environment. Around £0.5m of the pipeline is attributable to potential sales at full use rates associated with products already launched by customers.

**Exhibit 6: Pipeline development (number of projects)**

Date	Agreement on scope of sampling and engagement	Initial testing and interpretation of results	Repeat testing for consistency and review of results	Final product trials, formulation and specification	Final commercial agreement	Completed (cumulative)	Total no of projects	Value*
End H122	74	60	13	15	6	24	192	£3.2m*
End FY21	79	70	15	9	8	19	200	£3.7m
End H121	39	54	19	8	5	10	135	£3.7m
End FY20	19	57	18	12	3	8	115	£3.6m
End H120	12	45	14	13	8	5	92	£2.9m

Source: Applied Graphene Materials data. Note: \*Value of projects at development stages 1–5 is probability weighted. Value of completed projects is at full sales opportunity.

### Entry into chemical resistance segment

During FY20 and FY21, AGM was working primarily with smaller companies in the car care sub-sector of the protective coatings market. This had the advantage of working with companies with the ability to bring products to the market relatively quickly, but none of them had the market penetration to drive meaningful revenue growth. More recently, AGM has been working with a leading floor coatings manufacturer on protective barrier floor coatings for concrete which are resistant to chemicals used in industrial processes. The customer has successfully completed the test phase and is preparing to launch its coatings products during calendar Q422. In parallel AGM has created a performance data package which shows that the graphene technology performs extremely well compared with the glass flake and mica additives currently used to confer chemical resistance but at substantially lower loading levels. This gives coatings formulators greater flexibility with their products and application scope. AGM is using this data package to enter the chemical resistant coatings market. Applications include chemical tank linings, pipe linings, floor coatings and structural steelwork coatings, for example for off-shore wind-turbine towers.

### Opening a complementary route to market

AGM has incorporated its proprietary graphene nanoplatelets material in two new prototype paint systems of its own: one is a primer suitable for standard applications such as urban and industrial environments, the other a primer for harsh environments such as offshore and marine applications. These products, which were launched in December 2021, represent a significant step for AGM

because up to that point the company's route to market had been primarily through the sale of dispersions of graphene nanoplatelets to paint and coatings manufacturers. These manufacturers need to incorporate the dispersions in their paints and coatings before end-users can realise the benefit. The two new primers present a complementary route to market that enables end-users considering the adoption of graphene to test and evaluate its potential benefits quickly, by applying a ready-made formulation from AGM itself. Management expects that these new Genable primers will accelerate adoption of its products in the protective coatings space. AGM is working closely with the Environment Agency for England which is already using AGM's graphene-based primers on flood-gates in the north-east of England (Exhibit 4). Management expects that the Environment Agency will use its primers on other assets later this calendar year. AGM is currently working on a top coat to complement the primer product for the Environment Agency.

### Development of highly conductive coating

In February 2022 AGM announced that India-based Stanvac-Superon, which is a large manufacturer and exporter of welding consumables, protective coatings, aerosol sprays and stainless steel wires, had introduced a speciality conductive coating incorporating AGM's Genable dispersed graphene materials for use on industrial power transmission equipment. The inclusion of AGM's graphene dispersions means that the contact power loss in copper and aluminium electrical cable joints that are coated with Stanvac-Superon's new graphene-enhanced protective coating is 30–50% less. This offers significant energy savings over time. Stanvac-Superon has begun to offer the coating to its customers who will apply the product to assets at appropriate points in the maintenance cycle. Stanvac-Superon is advertising its new graphene enhanced "Nano Conductive Coating" as "ideal for power transmission, distribution, railways and high energy consumers such as steel mills, smelters, and refineries".

**Exhibit 7: Graphene-enhanced car detailing sealants**



Source: Constellation Chemicals

**Exhibit 8: Graphene-enhanced composite tanks**



Source: Infinite Composites Technology

### Composites and thermal adhesive markets a longer-term opportunity

Although the protective coatings market remains the short-term revenue driver, AGM continues to work with customers on graphene-enhanced composites. For example, Infinite Composites Technology is using graphene-enhanced material for linerless Type V carbon fibre pressure vessels used to store gas on spacecraft. Graphene enables composite materials, which are lighter than metals, to be used to store liquid gases at the very low temperatures found in outer space. Unmodified composites are too brittle at these temperatures. In addition, since graphene is impermeable to hydrogen and other gases, it can be used to replace the metal liners which are

otherwise required. In the longer term, graphene-enhanced composite tanks may be used to transport liquid hydrogen used to generate electricity in fuel cells for stationary power generation and transportation applications.

AGM has developed a thermal adhesive product that is currently tailored for space and defence applications and may be adapted for bonding, potting, sealing and encapsulation of industrial, electronic and automotive components. Management notes that an undisclosed customer trialling the thermal adhesive product is close to potentially approving it. Approval may lead to further opportunities within the aerospace sector. In the longer term, AGM intends to adapt the technology to prevent batteries from overheating by improving the heat conducted out of the battery stacks by the surrounding assembly. There is also potential for using graphene in coatings for silicon-based battery electrodes.

## Building out the sales network

Once AGM had developed a range of standard dispersions with well-documented properties, it was able to simplify the sales and support process enabling it to use distributors. Over the last three years AGM has expanded its distribution network, bringing the total number of salespeople acting for AGM to around 100, compared with 17 in H119. Given the relatively lengthy sales cycle and relatively recent addition of distributors, the proportion of revenues currently attributable to distributors is still very small.

**Exhibit 9: AGM's distribution network**

Announcement	Partner	Territory
April 2018	Inabata	Japan
May 2019	CAME	Italy
June 2019	Carst & Walker	South Africa
June 2020	Dichem Polymers	Greece
July 2020	Will & Co	Netherlands, Belgium and Luxemburg
August 2020	Barentz	United States and Canada
August 2020	Arpadis Benelux	United Kingdom, Germany, Spain, France, Portugal and Scandinavia
October 2020	GOBARR Kimya Ticaret ve Pazarlama	Turkey
December 2020	Manho Polymers	South Korea
March 2022	Rayoung Chemtech	Taiwan
May 2022	Imkemex	India

Source: Edison Investment Research

## Management

CEO Adrian Potts assumed his current role in August 2018 on the retirement of his predecessor. Prior to that he had been vice president for business development since January 2015, leading AGM's business development strategy in the United States. He previously worked at Cytec Process Materials in roles including global business development director, president of Cytec Process Materials (CA) and president of Umeco Structural Materials.

CFO David Blain joined AGM in October 2018 from Nanoco Group, where he was CFO and company secretary. Prior to that he spent seven years at Inspired Capital (formerly Renovo Group) where he played a significant role in the acquisition of Ultimate Finance Group. During this time the business increased its market capitalisation to £150m and employed 170 staff prior to its takeover by Tavistock in 2015.

## Sensitivities

### AGM's revenue growth depends on customer roll-out

AGM's revenue development is dependent on the success of individual customer product launches, so if a customer's product roll-out plans are held up, this has an adverse impact on AGM. We note

that AGM is currently engaged with many smaller innovative companies in the protective coatings sector to demonstrate the practicality and commercial benefits of its technology, so the risk associated with each customer is reduced, although the revenues associated with each customer are modest. The rate at which customers launch products is dependent on how quickly they can complete trials of graphene-enhanced variants and AGM's ability to support customer queries. Management's initiatives to create standard dispersions and to create a network of distributors are intended to help with both these effects. We believe that AGM's revenue growth will be significantly improved if one or more larger coatings company decides to deploy AGM's dispersions so they also can offer graphene-enhanced products or if the longer-term projects involving composites and thermal adhesives progress to commercialisation.

## **Economics of graphene-enhanced formulations**

End-user adoption of each individual customer product often depends on whether end-users are prepared to pay a premium for graphene-enhanced variants. Management has not provided any data on the premiums that AGM's end-users are charging, though it notes that the cost-benefit analysis for protective coatings is favourable given the reduction in maintenance costs. It is not as easy to quantify the benefit in the car care market. We believe that the ability for end-users in the protective coating market to quantify the benefits in economic terms should make it easier for AGM's customers to promote their products. In addition, for some formulations a low concentration of graphene provides similar protection to a high concentration of zinc or chromium, so the cost of manufacturing a graphene-enhanced coating is actually less than a conventional one.

## **IP protection**

In common with other IP-rich technology companies, AGM's success will depend on its ability to protect its IP and process know-how. The group patents IP where appropriate and currently has three patents granted across 15 regions and nine patents pending.

## **Graphene subject to legislation regulating use of new materials**

Graphene is a relatively new material so it needs to be extensively tested by regulatory bodies for toxicity. In January 2021 the European Chemical Agency (ECHA) raised the amount of graphene that can be manufactured annually by individual members of the Graphene REACH registration consortium from one to 10 tonnes of powder usage per annum of graphene products supplied. The permitted companies include AGM, which was a founder member of the consortium, as well as First Graphene, NanoXplore and Versarien's 2D-Tech Graphene. The REACH accreditation does not apply to the United States, where companies are permitted to supply graphene for product evaluation but then the product needs to be certified before it can be sold in commercial volumes. Other jurisdictions such as South Korea and Turkey have their own safety accreditation systems, which may require individual products containing graphene to be certified before use. The UK is in the process of creating an equivalent to the EU REACH legislation, which will require graphene to be re-certified. AGM is actively engaged in regulatory approvals to enable it to deal with local challenges to adoption.

## **Cash runway**

Management estimates that the funds raised in January 2021 extended the company's cash runway from October 2021 beyond the end of January 2023, enabling it to convert the current opportunity pipeline into meaningful annual revenues during the period. As will be discussed in the valuation section later in this note, we do not believe that AGM will have reached break-even by this point. On 8 July management announced that to raise general awareness across the investment community ahead of any future equity raise it had appointed Weild & Co, acting via its representative Crestmont, to introduce it to new potential investors in non-UK jurisdictions, particularly the US. While Weild & Co was instructed to effect these introductions on a general and

non-deal specific basis, disclosure was made to certain of the third parties approached, without AGM's authority or instruction, that AGM had engaged Crestmont in relation to an equity raise of up to US\$10m (c £8.3m). The Board has confirmed that in order to fund the company's operations and continued development of the business beyond January 2023 it is investigating a possible fund-raise, the quantum and timing of which have yet to be determined but are likely to be over the coming months.

## H122 performance affected by COVID-19 and supply chain issues

At £46k, H122 revenues were similar to H121 (£42k) but lower than H221 (£81k). The coronavirus related travel restrictions, which adversely affected H121 by preventing contractors from accessing sites and applying coatings to assets, eased during H221, resulting in an uptick in revenues. However, in H122 customers in the coatings industry struggled with a combination of COVID-19 related personnel absences and a lack of availability of basic raw materials including resins, solvents and additives such as titanium oxide. This meant that customers were focused on supply chain management, which pulled R&D resources from creating new products incorporating AGM's graphene dispersions to evaluating alternative source materials for established products. As a result, revenues from the supply of dispersions for evaluations were lower. In addition, the revenues relating to customer products launched in FY21 and early H122 were modest, reflecting the relatively small size of these customers. There were customer-specific issues as well. For example, Blocksil had expected to supply coatings for projects with Avanti, RTE and UK Network Rail. Funding for the Network Rail trackside enclosure refurbishment was substantially delayed and contractor issues for RTE and Avanti meant that these projects stalled.

### Exhibit 10: H121, H221 and H122 P&L summary

£000s	H121	H221	H122	Notes
Sales revenue	42	81	46	Production orders of graphene and evaluation quantities of graphene to commercial partners
Cost of sales	(146)	(217)	(278)	Including utility costs and some staff costs
Gross loss	(104)	(136)	(232)	Negative gross margin as very low levels of utilisation
Normalised operating expenses	(1,407)	(1,471)	(1,451)	
Share-based payments	(67)	35	(40)	
EBITDA	(1,578)	(1,572)	(1,723)	
Depreciation and amortisation	(214)	(195)	(183)	
Reported operating loss	(1,792)	(1,767)	(1,906)	
Finance costs (net)	(2)	(4)	0	
Reported loss before tax	(1,794)	(1,771)	(1,906)	
Tax	178	213	207	Accrued R&D tax credits.
Reported loss after tax	(1,616)	(1,558)	(1,699)	
Adjusted EPS (p)	(3.3)	(2.3)	(2.6)	Dilutive impact of funds raised in January 2021

Source: Applied Graphene Materials accounts

EBITDA losses widened by 9% compared to H121 to £1,723k and by 10% compared to H221. Operating expenses (adjusted for share-based payments) were similar to both H121 and H221. However, the cost of sales jumped by £132k compared to H121 to £278k, as a result of rising utility costs and a small increase in staffing numbers.

## Cash runway extends beyond January 2023

Net cash reduced by £2,094k during H122 to £4,214k at the period end. This excludes £7k IFRS 16 lease liabilities at end H122; there is no debt on the balance sheet. (We note that the property lease at AGM's site in Wilton was renewed post-period end, resulting in an additional £0.6m of lease liabilities and of right-of-use assets to accommodate an increase in dispersion production capacity.) Investment in tangible assets including the capital element of lease obligations was similar to H121 and H221 at £106k. £74k was invested in intangibles related to patents as all R&D is expensed.

The cash outflow included a £231k increase in working capital, primarily a reduction in payables, which were unusually high at the end of FY21.

Management is currently scaling up production of dispersions from 10–20 tonnes annually to around 100 tonnes. It estimates this will cost c £0.3m in capex and should be completed by the end of calendar 2022. Management notes that this volume output is sufficient to support the sales volumes expected from the existing qualified sales pipeline. AGM does not need to increase its in-house graphene manufacturing capacity to match the increase in volume of dispersions produced. AGM has recently completed the installation of a paint spraying booth (c £0.1m capex) to help with the formulation and test of its own coatings products and those of its customers.

## Scenario analysis

Exhibit 6 shows AGM's pipeline at the end of H122, which represents £3.2m in annualised revenues on a probability-weighted basis although management has not provided any guidance as to when AGM might achieve this revenue level. While we are not publishing formal forecasts for AGM at this stage, we have created a scenario analysis to assess how EBITDA and capex might track with revenue growth.

Our model makes the following assumptions:

- Average selling price of AGM's dispersions to customers of £50/kg (based on management guidance).
- Gross margin range of 35–45%. We have not based this on our sample of companies manufacturing graphene (Exhibit 5) because none of these focus on selling dispersions containing graphene and most are at an early stage of market development, so their current gross margins are not representative of potential gross margins when manufacturing graphene in high volumes. Instead, we are using a sample of established speciality chemicals and fragrance companies (Exhibit 11), which we consider a proxy for AGM because they typically produce substances that are added in relatively low proportions to enhance the performance of other materials. We have chosen a gross margin range that is towards the upper end of our sample, in line with informal management guidance.
- Incremental operating costs at 10% of additional sales, which will require good cost discipline, using H122 as the base level.
- We have set the upper bound of the revenue range at £25m. While higher revenues are possible, we are not presenting these at present because AGM has yet to engage with any of the larger players in the protective coatings market, which management notes are highly conservative and would probably need lengthy trial periods before adopting the material, and the projects for aerospace customers have not reached the commercial stage.

**Exhibit 11: Margins for speciality chemicals and fragrance companies**

Name	Sales last year (£m)	Gross margin last year (%)	EBITDA margin last year (%)	Note
Arkema	8,091	-	18.1	Speciality materials
Clariant	3,760	29.6	-	Speciality chemicals
Croda International	1,890	49.7	29.0	Speciality chemicals
Elementis	880	38.1	18.0	Speciality chemicals
Evonik Industries	14,955	26.9	15.9	Speciality chemicals
Givaudan	5,748	42.7	22.2	Flavours and fragrances
Holland Colours	96	52.2	15.4	Colourants and other additives for plastics
Johnson Matthey	3,940	26.8	18.4	Speciality chemicals
Robertet	606	41.6	19.4	Fragrances, flavours, natural raw materials
Symrise	3,826	38.7	21.3	Flavours and fragrances
Trealt	124	34.0	18.6	Flavours and fragrances
Wacker Chemie	6,208	26.9	24.8	Speciality chemicals

Source: Edison Investment Research, company data

Our analysis shows that the current pipeline is not sufficient to take AGM to cash break-even, which we estimate is reached at annual revenues of around £11m. Our table also shows the level of additional capital investment required, based on management guidance, with the caveat that investment will be required ahead of revenue generation. So, for example, the current capacity is sufficient to support c £2m of annual revenues, but by the time the company has hit that level of revenue generation it will have had to make £0.6m of investments to support the next stage of growth.

**Exhibit 12: Scenario analysis**

Volume of dispersion sold (kg)	40,000	72,000	100,000	220,000	500,000
Revenue (£m)	2.0	3.6	5.0	11.0	25.0
Gross profit at 35% gross margin (£m)	0.7	1.3	1.8	3.9	8.8
Gross profit at 40% gross margin (£m)	0.8	1.4	2.0	4.4	10.0
Gross profit at 45% gross margin (£m)	0.9	1.6	2.3	5.0	11.3
Operating costs (£m)	(3.5)	(3.7)	(3.8)	(4.4)	(5.8)
EBITDA at 35% gross margin (£m)	(2.8)	(2.4)	(2.1)	(0.6)	2.9
EBITDA at 40% gross margin (£m)	(2.7)	(2.3)	(1.8)	0.0	4.2
EBITDA at 45% gross margin (£m)	(2.6)	(2.1)	(1.6)	0.5	5.4
Cumulative capital investment (£m)	0.6	0.9	1.2	2.7	5.6

Source: Edison Investment Research

Even at the upper bound of revenues presented in our analysis, AGM's sales are a tiny percentage of the total global paints and coatings market (US\$184bn in 2021, see above) or the sales of one of the major paints and coatings companies. For example, Sherwin-Williams' Performance Coatings division reported sales of US\$6.0bn in FY21.

**Exhibit 13: Financial summary**

	£'000s	2018	2019	2020	2021
Year end 31 July		IFRS	IFRS	IFRS	IFRS
<b>INCOME STATEMENT</b>					
Revenue		77	50	83	123
Cost of Sales		(250)	(472)	(215)	(363)
Gross Profit		(173)	(422)	(132)	(240)
EBITDA		(3,984)	(4,559)	(3,084)	(3,150)
Normalised operating profit		(4,295)	(4,902)	(3,530)	(3,559)
Amortisation of acquired intangibles		0	0	0	0
Exceptionals		(307)	0	(168)	0
Share-based payments		0	0	0	0
Reported operating profit		(4,602)	(4,902)	(3,698)	(3,559)
Net Interest		57	67	33	(6)
Profit Before Tax (norm)		(4,238)	(4,835)	(3,497)	(3,565)
Profit Before Tax (reported)		(4,545)	(4,835)	(3,665)	(3,565)
Reported tax		1,046	908	476	391
Profit After Tax (norm)		(3,192)	(3,927)	(3,021)	(3,174)
Profit After Tax (reported)		(3,499)	(3,927)	(3,189)	(3,174)
Minority interests		0	0	0	0
Net income (normalised)		(3,192)	(3,927)	(3,021)	(3,174)
Net income (reported)		(3,499)	(3,927)	(3,189)	(3,174)
Basic average number of shares outstanding (m)		42.7	49.4	49.4	56.4
EPS - normalised (p)		(7.5)	(7.9)	(6.1)	(5.6)
EPS - normalised fully diluted (p)		(7.5)	(7.9)	(6.1)	(5.6)
EPS - basic reported (p)		(8.2)	(7.9)	(6.4)	(5.6)
Dividend (p)		0.00	0.00	0.00	0.00
Revenue growth (%)		N/A	(35.1)	66.0	48.2
Gross Margin (%)		N/A	N/A	N/A	N/A
EBITDA Margin (%)		N/A	N/A	N/A	N/A
Normalised Operating Margin		N/A	N/A	N/A	N/A
<b>BALANCE SHEET</b>					
Fixed Assets		1,959	1,800	1,696	1,702
Intangible Assets		78	155	276	427
Tangible Assets		1,881	1,645	1,420	1,275
Investments & other		0	0	0	0
Current Assets		11,111	7,681	4,522	7,090
Stocks		56	52	74	93
Debtors		197	171	281	276
Cash & cash equivalents		10,443	6,135	3,685	6,308
Other		415	1,323	482	413
Current Liabilities		(949)	(993)	(929)	(1,097)
Creditors		(949)	(993)	(908)	(1,023)
Short term borrowings		0	0	0	0
Finance leases		0	0	(21)	(74)
Long Term Liabilities		0	0	(4)	0
Long term borrowings		0	0	0	0
Lease liabilities		0	0	(4)	0
Other long term liabilities		0	0	0	0
Net Assets		12,121	8,488	5,285	7,695
Minority interests		0	0	0	0
Shareholders' equity		12,121	8,488	5,285	7,695
<b>CASH FLOW</b>					
Op Cash Flow before WC and tax		(3,984)	(4,559)	(3,084)	(3,150)
Working capital		(12)	68	(199)	99
Exceptional & other		44	376	(182)	32
Tax		631	0	1,316	461
Net operating cash flow		(3,321)	(4,115)	(2,149)	(2,558)
Capex		(319)	(193)	(342)	(218)
Acquisitions/disposals		0	0	0	0
Net interest		0	0	41	(6)
Equity financing		9,375	0	0	5,552
Dividends		0	0	0	0
Net Cash Flow		5,735	(4,308)	(2,450)	2,770
Opening net debt/(cash) - excluding lease liabilities		(4,708)	(10,443)	(6,135)	(3,685)
FX		0	0	0	0
Other non-cash movements		0	0	0	(147)
Closing net debt/(cash) - excluding lease liabilities		(10,443)	(6,135)	(3,685)	(6,308)
Source: Company accounts					

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