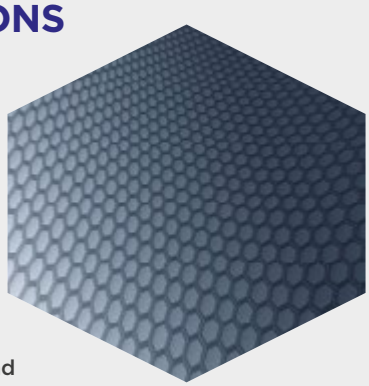
News

OCTOBER 2018

Applied Graphene Materials

TOMORROW'S MATERIAL. **TODAY**

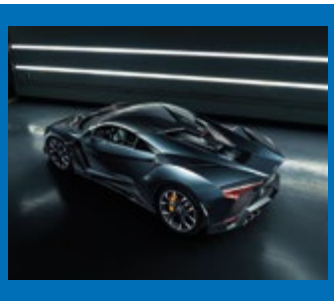
Genable® GRAPHENE DISPERSION TECHNOLOGY DELIVERING OUTSTANDING PERFORMANCE GAINS INTO EARLY COMMERCIAL APPLICATIONS



AGM's latest newsletter is filled with articles demonstrating the exciting progress being made introducing graphene technology across numerous industry sectors. It should be noted however, that all the applications have two critical factors in common. Firstly, all products are based on AGM's graphene nanoplatelets, and secondly, successful application has been achieved through a combination of G*enable*® dispersion technology and close collaboration with our industry partners, working to ensure the full benefits of graphene are realised in the end product. Please contact us using the details on the back page if you have an application in mind...

MAGNA EXTERIORS, AGM AND SHD COLLABORATE ON THE FENYR SUPERSPORT TAILGATE

Read the full story on page 2 ▷



GRAPHENE ANTI-CORROSION PRIMER FROM JAMES BRIGGS

Following two years of development work with AGM, James Briggs Ltd (Oldham, UK) are bringing to market a new range of aerosol graphene anti-corrosion paint primers, initially under their own Hycote primer banner. AGM and JBL have agreed commercial heads of terms for this initial product launch and to support the broader adoption of AGM G*enable*® dispersions into other product lines within the JBL paint range over future months.

(See JBL case Study on page 4)

AIRBUS DEFENCE AND SPACE QUALIFICATION OF AGM THERMAL PASTE ADHESIVES

Working with Airbus Defence and Space (Stevenage, UK), the qualification of two thermal paste adhesive materials for space use was completed at the end of Quarter 3 2018... the products are AGM TP300 and AGM TP400.

Following on from this, Airbus D&S are carrying out application-specific space flight qualifications on AGM TP300, which offers significant thermal and mechanical benefits over the currently specified materials.

These flight qualification programmes are scheduled to be completed during Quarter 4 2018.

It is Airbus' intention to specify this product on to their next-generation satellite platform, with first flight application and production sales anticipated in early 2019.

INDUSTRY LEADING ANTI-CORROSION PERFORMANCE. G*enable*® 3000 SERIES, GRAPHENE BASED, ACTIVE NON-METALLIC, ADDITIVES

AGM has launched their latest, ground-breaking, dispersion range – the G*enable*® 3000 series, graphene based, active non-metallic, anti-corrosion additives that have been proven capable of delivering outstanding anti-corrosion performance.

Over 5 times extension to the primer coating lifetime ▶ under cyclic salt spray (ASTM G-85-94 Prohesion) with the use of G*enable*® 3000, AGM's formulation ready active corrosion inhibitor, in place of zinc phosphate:

*Control is an in-house primer typical of a standard industrial C3 ZnPO4 based system

CONTINUED.....

Incorporated into the formulation of an industry standard C3 epoxy primer system, and tested under representative cyclical salt spray testing (ASTM G-85-94 Prohesion), **G***enable*® 3000 series materials have been shown to deliver a 5-fold extension in coating lifetime, based on a single 60 micron dry film thickness (see images overleaf). These exciting results are supported by a detailed mechanical dataset and studies incorporating combination with a PU topcoat and exploring intercoat adhesion and overcoating intervals.

Further investigating **G***enable*® 3000 series potential for applications in harsher C4/C5/CX environments, AGM has embarked on another extensive test programme looking at the performance of a higher-build primer system. The thickness of this high-build primer is around 110 microns, and is therefore typically thinner than some comparative industry standard systems in the C4/C5/CX category (ISO12944).

The properties of the **G***enable*® 3000 series make it an ideal tool-box additive for formulators seeking to significantly enhance coating performance in a range of environments. As an additive capable of offering metal-free systems with extended durability it is anticipated that the **G***enable*® 3000 should find multiple applications in industrial areas subject to high humidity and aggressive atmosphere, including inshore areas of medium to high salinity.

Extended durability and thinner flexible coatings are directly equatable to significant cost savings in both initial coating system application, as well as maintenance and repair for commercial end users. **G***enable*® 3000 series dispersions are available initially in epoxy resins, but with a range of solvent and water-based dispersions under near-term development.

All AGM's **G***enable*® dispersions are formulated for long-term stability and engineered to aid easy incorporation into existing manufacturing processes. The new range follows on the heels of the recent launches of the **G***enable*® 1000 series (for enhancing existing anti-corrosive additive performance) and the **G***enable*®2000 series (specifically for corrosion inhibition on aluminium substrates).

DEVELOPMENT WITH HMG PAINTS MOVING TO COMMERCIALISATION AND "REAL WORLD" SUCCESS WITH BRIT TIPP TRUCKS

AGM continue to work with HMG Paints (Manchester, UK) in the development and commercialisation of graphene containing anti-corrosion coatings. Initial formulation development focused on representative laboratory testing and then, working exclusively with an innovative commercial vehicle company, Brit Tipp (Warrington, UK), this then extended to field testing through a number of commercial tipper truck contracts.

These "real world" trials have progressed very well and Brit Tipp are currently bidding on several larger contracts based on customer feedback around this enhanced coating system. In parallel HMG and AGM have continued to expand their understanding of how to further optimise graphene performance and their combined focus is now on bringing a new product to the broader market within the first half of 2019.

"HMG are delighted to have partnered with AGM in developing graphene enhanced coatings" said Jonathan Falder, Head Technician of the HMG Graphene Project. "We've found AGM's graphene based **G***enable*® *dispersions to integrate well using our conventional processes and they have demonstrated some exciting results. We are now working closely with AGM's product development team to fully commercialise a new product range, which we anticipate will be offered to the market within the first half of 2019."*

*G**enable***® GRAPHENE DISPERSION QUALIFIED FOR USE IN APPLIED NANO SURFACES TRICOLIT®-GO

AGM has qualified its A-GNP nanoplatelets, applied through a bespoke G*enable*® **dispersion for Applied Nano Surfaces (Uppsala, Sweden) highly innovative graphene-fortified low friction coating Tricolit®-GO. Tricolit® GO coating features low friction and high abrasion resistance, and can be supplied in bulk for professional use and in easy-to-use spray cans for DIY enthusiasts.**

ANS Tricolit® is a series of thermoset surface coatings serving to reduce friction and wear. Tricolit coatings can be applied by spraying, dipping or brushing and are suitable for treatment of non-ferrous materials which cannot be triboconditioned. The coating gives the component great tribological performance at a competitive price.

How is it done ... visit ANS website **www.appliednanosurfaces.com** for more information.

AGM COLLABORATES WITH MAGNA EXTERIORS AND SHD ON THE W MOTORS FENYR SUPERSPORT CAR

This exciting collaboration has seen Magna Exteriors enhance the tailgate of W Motors' performance-focused supercar using a graphene-enhanced epoxy prepreg, supplied by an AGM technology partner SHD Composites.

This development follows the launch of SHD's industry-leading graphene enhanced epoxy prepreg system - MTC9810.

MTC9810 is a tangible demonstration of the ease by which AGM's "process-ready" **G***enable*® dispersions can be adopted by the composites industry, with minimal disruption to existing manufacturing routes, and deliver cost effective performance

gains. MTC9810 is supported by a strong mechanical database that exhibits significant increases in fracture toughness, interlaminar shear strength and fatigue life.

Included into Magna's design, the MTC9810 prepreg aims to mechanically enhance the W Motors Fenyr SuperSport tailgate by offering increased torsional stiffness, interlaminar shear strength and laminate fracture toughness, in addition to improved surface finish, in-service fatigue life and enhanced properties under hot and wet conditioning.

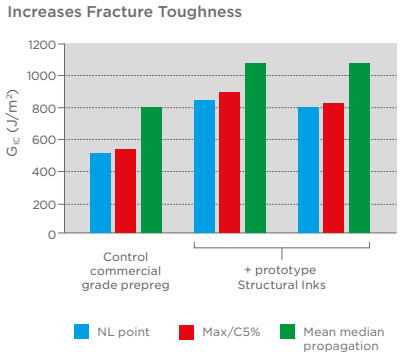
This first successful collaboration project has enabled the team to develop a strong baseline knowledge to take graphene technology even further. The long-term aim of the collaboration team is to build on the delivered baseline mechanical enhancements and ultimately move towards designing in many of graphene's multifunctional capabilities on future joint development programs, to offer other additional benefits such as extended life moisture barrier performance, conductivities and even energy storage.

Dr. Joseph J. Laux, Global Director of Material Science – Exteriors, Magna Exteriors, said: *"Graphene represents an exciting new technology and early application successes require strong and open collaboration. Our Global Materials Science Group selected working with AGM, and adopting SHD's prepreg material, because of their early innovation lead and undoubted commitment to support on-going materials developments and technology optimisation."*

STRUCTURAL INK® - DEVELOPMENT OF AGM'S STEP-CHANGE TECHNOLOGY ACCELERATES

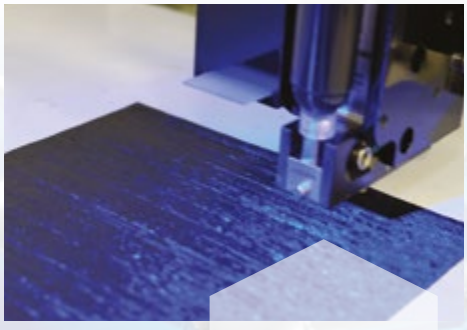
Structural Ink® (patent pending) is a novel technology that enables the selective targeting of performance gains, by printing graphene into composite materials and structures where it will be most design and cost efficient.

By adopting Structural Ink®, end users across the composites industry will have the ability to increase mechanical toughness through the addition of graphene and, most significantly, to target critical areas within a structure. Through the optimisation of materials performance and structural design, Structural Ink® will ultimately enable reductions in weight and also total manufacturing costs.



Following the conclusion of a NATEP project (UK NATIONAL AEROSPACE TECHNOLOGY PROGRAMME) which proved the initial feasibility of Structural Ink®, AGM has embarked on an ambitious programme looking not only to optimise the basic materials technology but in parallel to realise scalable printing technologies to underpin wider exploitation.

AGM recently expanded their in-house capability to two Structural Ink® printers, adding a maximum print bed coverage of 600mm x 600mm, and is actively involved in several technology development programmes with industry innovators across several key sectors.



GRAPHENICS® - GRAPHENE ENHANCED, SUSTAINABLE HIGH PERFORMANCE BASE OILS

AGM continues to work with technology partner PURAGLOBE on the exploitation of their graphene enhanced sustainable base oils range which was formally launched under the GRAPHENICS® banner in early 2018. GRAPHENICS® oils, enhanced by formulation with AGM's graphene products, are supported by an extensive (and jointly generated) performance dataset, and the technology is currently part of product development programmes being undertaken by several European finished lubricant manufacturers. Ultimately, all these manufacturers are seeking to access the combined benefits of material sustainability, greater protection and extended part life, that are achievable through GRAPHENICS®. Development of new lubricants is not a quick process, but PURAGLOBE report excellent progress with their customers and anticipate increasing sales through 2019.

To help raise the profile of their technology, PURAGLOBE has recently become the sponsor of the successful German racing cyclist Daniel Harnisch. Using GRAPHENICS®, PURAGLOBE has formulated an advanced, high-performance cycle chain lubricant and internal hub grease. It provides outstanding lubrication and protection against friction and wear, which means racing professionals like Harnisch can spend less time on maintenance, and more time focusing on winning.

As Dr. Soenke Moehr, the Director Global Sales & Marketing at PURAGLOBE explained:

"Bicycle racing is a fine-tuned, high-performance, endurance sport. The slightest calibrations, and slightest details can make an enormous impact when it comes to taking the victory lap. And since many races involve distances of 150km or more, it's a perfect real-world application for us to precisely formulate GRAPHENICS® lubricants and greases and put them to the test."

WORKING WITH JAMES BRIGGS TO BRING A GRAPHENE ENHANCED ANTI-CORROSION PRIMER TO THE AUTOMOTIVE MARKET

James Briggs Limited (JBL) is a leading independent chemicals business based in the UK. From their base they have the capacity to manufacture and distribute up to 150 million aerosols and 30 million litres of high performance product, every year.

What was the challenge?
As a British manufacturer committed to innovation within their product range they were looking to explore what potential benefits graphene could offer to enhance their automotive paints range.

What did the programme involve?
Over the course of development the technical teams of JBL and AGM worked hand in hand producing and analysing data from a variety of experiments to assess the impact graphene can have in delaying the onset of corrosion within certain coatings.

These tests incorporated many different tests including:

- salt spray testing, used to accelerate the aging process;
- a variety of product combinations to access how graphene interacted with other products within the coatings;
- ladder testing, where different levels of graphene are introduced to access the optimum loading; and
- stability testing, to ensure the various products do not separate.

What was the end result?

Standard primer

VS

AGM G*enable*® graphene enhanced primer

Results after extended representative salt spray corrosion testing.

It is probably best explained by Jim Miller, JBL's Commercial Director who noted,

"The two year development collaboration between JBL and AGM has resulted in our first products coming to fruition. The programme has encompassed both processing and formulation optimisation studies and ultimately demonstrated that AGM's graphene, applied using **G***enable*® *dispersion technology, can deliver a significant extension to coating life against environmental corrosion effects while remaining cost viable to JBL and our customer base".*

SIT-SKI PROJECT - GRAPHENE PREPREG DEMONSTRATES ITS VALUE

The Sit-Ski project was run as a technology demonstrator by the UK's High Value Manufacturing Catapult, High Tech sports project with components being manufactured by the AMRC, the MTC and the NCC. The project applies the latest in UK R&D know-how to make the Sit-Ski faster, lighter and, more crucially, maximise performance.

"This novel Graphene prepreg provided the optimum performance characteristics for the High Value Manufacturing Catapult, High Tech sports project" Garry Scott (NCC)

AGM LAUNCHES G*enable*® THERMAL PASTE ADHESIVES RANGE

AGM has recently announced the launch of two new high-performance thermal paste adhesive materials - G*enable*® 4400 and G*enable*® 4300.

The new products are supplied to customers as easy-to-process two part epoxy systems and are designed for use in thermal management applications, either directly as a paste adhesive and gap filler, or as potential base additives to enhance other formulated systems.

The two products have been formulated to deliver different level of processing viscosity to suit specific application requirements and will provide in-situ thermal conductivity in the region of 3-6 W/(m·K), combined with good levels of lap shear strength.

AGM anticipates applications within formulations for bonding, potting, sealing and encapsulation for Space, Electronics and Automotive components.

ABOUT AGM

AGM was admitted to AIM stock exchange in November 2013 and has its operations based at the Wilton Centre, Redcar, UK.

AGM has developed proprietary bottom-up manufacturing technologies which are capable of producing high volumes of graphene nanoplatelets using continuous, repeatable and robust processes. These manufacturing processes are based on sustainable, readily available raw materials and do not rely on the supply of graphite.

AGM works in close partnership with its customers to provide custom graphene dispersions and material formats to deliver enhancements and benefits over a wide range of application in three core markets: coatings, composites & polymers and functional fluids.

For enquiries please contact AGM Sales Office on:
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