THE MARKET FOR NANODIAMONDS
Analysis of applications, markets, producers, and competitive landscape for nanodiamonds.

LATEST NEWS ON COATINGS
Recent nanocoating products to repel and inactivate microbes and viruses.

LATEST NEWS
All the latest nanotech research and product developments to address COVID-19.

Nanotech Magazine is published by Future Markets, the world’s leading publisher of market information on advanced materials and nanotechnology.
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NOTE FROM EDITOR

Issue 62 of Nanotech magazine continues our analysis of recent nanotech based responses to COVID-19 mitigation. We cover commercial activity in filters, face masks, diagnostics, anti-viral coatings, mask validation tech, biosensors and vaccines.

Also covered is the growing market for nanodiamonds, which find application in personal care products (sunscreens, anti-aging products), biomedicine (drug delivery and therapeutics, anti-virals and anti-bacterials), coatings, composites, electronics, energy storage, lubricants and sensors.

We analyse nanodiamonds types, applications and producers.

Also in this month’s issue, latest nanotech products and graphene commercial activities.

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Detonation nanodiamonds (DND) are the most widely produced due to their inexpensive synthesis.
**Figure 1: Structure of a single nanodiamond particle.**

*Source: Nature.*

DNDs are the most widely produced due to their inexpensive synthesis. The smallest NDs (typically< 10 nm) are produced using this process. Larger NDs are produced by either a high pressure-high temperature (HPHT) process or via chemical vapor deposition (CVD), followed by a ball-milling process to crush the micron sized diamonds into NDs, and finally washed in strong acids to remove surface impurities.

**Figure 2: Nanodiamond powder.**

To make fluorescent nanodiamonds (FNDs), high-energy sources (e.g. electrons, He+, or H+ ions) are used to bombard the HPHT or CVD diamonds to create colour vacancy centers within the diamond lattice. Extremely small amounts of nanodiamond additives can modify a variety of thermal and mechanical properties in various parent materials. Properties include:

- Diamond core: highest hardness (167 Gpa) and wear resistance
- Highest thermal conductivity (2300 W/mK)
- High electrical resistivity ($10^{13}$ Ωcm)
- Low thermal expansion (1.0×10⁻⁶ K⁻¹)
- Wide band gap (5.47 eV (300 K))
- High refractive index (2.417)
- Low specific gravity (3.52)
- Chemical/radiation resistance
- Biocompatibility
- Large surface area (250- 450 m²/g)
- High & controllable chemical activity of the surface.

### Table 1: Markets, benefits and applications of nanodiamonds.

<table>
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<tr>
<th>Nanomaterials</th>
<th>Properties</th>
<th>Applications</th>
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| **Personal care products** | • Biocompatibility  
• Nontoxicity  
• Excellent adsorption properties.
• Stable UV absorbers. Will not photo degrade unlike typical chemical sunscreens.
• NDs attenuate UV radiation through absorption and scattering (for applications in UV protective skin care).
• Potent antioxidants (radical scavengers) and do not photodegrade like Vitamin C. | Protective sunscreens, anti-aging skin care products (serum, cream, lotion, dermal strips, skin cleansers) |
| **Biomedicine**      | • Inherent photoluminescence.  
• Chemical stability  
• Large specific surface area and high adsorption potential  
• Optical and physical properties can be tuned.  
• Photostable.  
• Biocompatibility.  
• Inherently low cytotoxicity and genotoxicity | • Drug and gene delivery.  
• Cancer therapy.  
• MRI contrast agents/biomarkers.  
• Cell imaging.  
• Protein separation and purification. |
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<th>Biomedicine</th>
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<th>Composites</th>
<th>Electronics &amp; semiconductors</th>
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| - Rapid transmembrane transport.  
- High drug loading capacity based on high surface to volume ratio  
- The presence of nitrogen vacancy (NV) centres in nanodiamonds results in the absorption of the visible spectra and emission in red at room temperature with great temporal stability and almost no photobleaching. A single nanodiamond crystal can produce luminescence brighter than standard fluorescent protein.  
- Filler material for implants.  
- Anti-virals and anti-bacterials. | - Increase in the microhardness (2-3 times)  
- Decrease in the porosity of a coating layer.  
- Improvement in coating quality.  
- Increase in wear resistance: 2-12 times.  
- Increase in elasticity.  
- Improved corrosion resistance.  
- Precursors in CVD coatings  
- Thermal diffusion coatings  
- PVD Coatings  
- Electronic devices  
- Gears, shafts and pistons. Metal cutting tools  
- Food processing equipment  
- Petrochemical processing equipment  
- Medical implants. | - Improved strength and elasticity  
- Wear resistance  
- Adhesive strength with metals  
- Thermal conductivity without compromise to other properties. Thermal conductivity increased 25-100% with 0.1wt% ND.  
- Increasing heat conductivity while retaining the absolute dielectric properties.  
- Can be used as radical trapping stabilizers in thermal processing of polymers.  
- Aging, radiation, scratch and corrosion resistance  
- Increase in refractive index in thin polymer films  
- Fluoroelastomers  
- Rubbers  
- Polyurethanes.  
- Polyamide and fluoroplastics.  
- Coolants.  
- Membranes.  
- PEEK composites.  
- Thermoplastic heat sinks.  
- Silicone and epoxy thermal interface materials.  
- Abrasion resistant resins. | - Surface roughness can be greatly reduced when NDs are used in the lapping of magnetic heads. NDs can significantly increase lapping endurance and reduce the friction effect.  
- High thermal resistance and high particle distribution.  
- Precise polishing in angstrom units is possible  
- Surface defects, crystal dislocations, and surface stress are low  
- UDD suspension is chemically stable, so chemically active additives can be used  
- Thermal paste for heat management (heat dissipation).  
- Nanoabrasives in polishing pads for CMP.  
- Insulation materials.  
- CVD seeding.  
- Thermoplastic heat sinks. |
### Electronics & Semiconductors
- No toxicity to liquids, pastes and powders
- Thickness of the layer removed from the surface is small
- Cryptography
- Quantum computing.

### Energy
- High thermal conductivity.
- Hydrogen accumulators.
- Electrodes.
- High voltage, high energy density, high temperature capacitors.
- High efficiency catalysts.
- Battery additives.

### Lubricants
- Carbon chemistry biodegradability
- Non-toxicity.
- Reduced friction coefficient (10-60%)
- High energy savings (~10%)
- Solubility in both mineral oil and others
- Improved wear resistance
- Reduced contact temperature
- Reduced viscosity
- Increased thermal stability (efficient at higher temperatures)
- Improved performance and durability (e.g. engine components)
- Decrease in noise
- Lubricating oils and greases for reduction of wear and friction.

### Sensors
- Excellent biocompatibility
- Composite Noncytotoxic nature
- Narrow size
- Possess several oxygenated functional groups on its surface, including hydroxyl and carboxyl groups, which facilitate the immobilization of biomolecules.
- Biosensors.
- Single-spin sensors in nanomagnetometry.

### 3D printing
- Faster 3D printing and improved mechanical durability of the printouts
- Lubricants in 3D printers.
- 3D printing filaments.

Overall, adding nanodiamonds can change most of the currently existing materials. Successful laboratory results and patents have been obtained in respect of many applications. The launch of nanodiamonds commercial production has made it possible to introduce laboratory results into industrial technologies and has enabled the manufacture of mass products. As the production volume of NDs increases and their price decreases, their scope of application will expand.

### Applications
Main current applications of Nanodiamonds in terms of volume demand are:
- Fine polishing abrasives
- Coatings additives (galvanic and electroless)
- Lubricant additives (oils and grease)
- Reinforcing polymer fillers

There are also a wide range of secondary, niche applications. The list of mentioned nanodiamonds applications below is not exhaustive.
Nanodiamonds producers

Currently, there are 10 main nanodiamond companies in the world in total. There are also a number of other companies and suppliers. Most are small to medium-sized companies who sell internationally but generally have a localized regional presence. Daicel is the largest company producing Nanodiamonds.

The key players’ position on the market is determined by price and production capabilities, which are closely related to the target applications. Most companies are targeting high-volume market such as lubricants, polishing additives, electroplating coatings etc. which require low price and potentially high volumes of NDs.

None of the producers sell ND based market solutions to industry globally. The market players mainly sell regionally, with sales outside their regions undertaken mainly by distributors or the regional offices of the mother-company. Many China based producers have multi-kilogram/month production capabilities for detonation nanodiamond powder.

Adamas Nanotechnologies, Inc.
USA
www.adamasnano.com

The company produces nanodiamond suspensions, powders, additives for lubricants and fluorescent nanodiamonds. 16 patents have been issued to Adámas or licensed from parent company. The 20-40 nm size range provides the smallest and brightest currently commercially available fluorescent diamond particles on the market. These sizes are suitable for intracellular imaging and single molecule tracking. The brightness of particles depends on the particle size. The larger the particle, the higher the brightness due to the larger number of colour centres that can be accommodated by larger particle volumes.

Carbodeon Ltd. Oy
Finland
http://www.carbodeon.net

Carbodeon's patented technologies are used as additives in applications including thermal management materials, metal plating and selected polymer coating applications. The company has several global distributors for its nanodiamond products. Carbodeon's uDiamond® contains diamond nanoparticles with a diameter of 4-6 nm. Carbodeon's nanodiamonds are non-toxic materials suitable for a variety of applications according to REACH and EPA assessments. Although they are used in the materials at very low concentrations, they can significantly improve material performance at a low cost. Carbodeon has extensive patent coverage for the nanodiamond materials it manufactures, and refined products enhanced with nanodiamonds.

Figure 3: Nanodiamond detonation chamber.

Figure 4: Carbodeon NanoDiamond Powders And
Dispersions.

**Daicel Corporation**  
**Japan**  
www.daicel.com

The company produces DINNOVARE™ nanodiamonds. The product is available as a powder and aqueous dispersion. The DINNOVARE range has cluster NDs and seven different types of solvent dispersions such as, Water-soluble modified NDs in water, and 4 organic solvent dispersions (THF, IPA, MIBK, toluene). The company provide samples of DINNOVARE™ free of charge to researchers at universities and research institutions.

![DINNOVARE](image)

**Ray Techniques Ltd.**  
**Israel**  
www.nanodiamond.co.il

The company is producing nanodiamonds based on proprietary technology for the laser treating of specially prepared targets containing carbon soot mixed within hydrocarbon media. This technology is in contrast to the traditional technology of nanodiamond synthesis by detonation of explosives in metal reactors. Laser treating of specially prepared targets containing carbon soot mixed within hydrocarbon media (e.g. wax) to obtain diamond nanocrystals (4-5 nm size). The Ray method is more controllable, environmentally friendly, and less hazardous than detonation synthesis. It provides high purity and homogeneity of ND without graphite and metal impurities. RAY has developed an industrial technology (know-how) for introducing ND within various media. Special mechanical, thermal and chemical ND surface modification results in:

- Covalent bonding with matrix' molecules (no surfactants)
- ND disaggregation in diverse solvents
- Uniform distribution in water, solvents and oils
- High efficiency of ND in the improving performance of basic material

The company also design novel ND-based composite materials with desired properties. Applications are in Anti-friction additives (Lubricants), Pastes and slurries for fine polishes, Protective coatings, Additives to galvanic electrolytes, Precursors for CVD diamond coatings, Additives to polymers and Thermal management.

**Further information**  
**The Global Market for Nanodiamonds**  
Published July 2020  
https://www.futuremarketsinc.com/the-global-market-for-nanodiamonds-2/
COVID-19 NEWS

RECENT NANOTECH DEVELOPMENTS

Researchers at the Indian Institute of Technology Madras have developed a filter that can be used to protect healthcare workers treating COVID-19 patients. The nylon-based nano-coated filter uses polymer coating on cellulose paper and was developed using electro-spinning process.

The coating properties are optimised to efficiently remove sub-micron sized dust particles in the air. The filter media is currently being field-tested and once validated through field trials it will be recommended for bulk manufacturing. K. Arul Prakash, Department of Applied Mechanics, said: “The nano-coating fabricated through the electro-spinning process has fiber diameter less than one micron and can be positioned according to the need to enhance surface/depth filtration for healthcare workers or public responders. This novel filter with multiple nano-coating can filter particles of the order of one micron size.”

Nano Air Mask has produced PURE-MSK respiratory masks that are available for general purchase at NanoAirMask.com. PURE-MSK is an FDA-cleared respirator mask made from nanofiber. Lighter than a sheet of paper, PURE-MSK’s nanofiber material filters out more than 95% of particulate matter that are the size of 0.3 microns or larger. One nanofiber strand (0.1
microns) is 1,000 times smaller than a strand of human hair (100 microns), enabling PURE-MSK’s mask to block out harmful contaminants such as pollutants, smoke, allergens, aerosols, bacteria, and even water, while allowing for relatively unobstructed airflow through the mask.

**Surfix B.V.**, together with its shareholders Qurin Diagnostics B.V. and LioniX International B.V. have developed bio-photonic nanochips for cancer detection and other applications. The company has also initiated an accelerated development plan to allow mass-scale COVID-19 diagnosis and immunity detection with the financial support and in close collaboration with PhotonDelta.

The desktop testing device will yield reliable test results within 5 minutes and is scheduled to be available for commercial exploitation within 6-9 months. The device will be built around a photonic biochip using LioniX’ mature and proven silicon nitride based integrated optics technology (TriPleX™), a key technology within the PhotonDelta ecosystem.

**Directa-Plus** is using graphene in face masks to enhance personal protective equipment. The graphene-enhanced facemasks are designed for use by commuters and in the workplace, as well as during a wide range of leisure activities.

The dermatologically tested and hypoallergenic G+ mask will confer a wide-range of benefits to consumers looking to protect themselves and others against COVID-19. This includes, but is not limited to, a naturally bacteriostatic quality which helps prevent bacteria growing and reproducing on the mask, a high filtration level, and improved respiratory performance allowing users to breathe easier, both literally and figuratively.

**ZEN Graphene Solutions Ltd.** has received a report on the first batch of samples that were submitted to Western University’s ImPaKT Facility Biosafety Level 3 lab (UWO) for virucidal efficacy testing. The batch-testing program’s focus is to confirm and measure virucidal potency of the graphene oxide-based silver nanoparticle composite inks that were produced at ZEN’s Guelph lab. The company prepared five different formulations with varying oxygen contents and silver nanoparticle loadings for testing at a concentration of 4g/L. All five variations with concentrations diluted to as low as 0.16g/L reduced viral replication. These formulations slowed growth of the COVID-19 Coronavirus in a media designed to replicate human cells.

ZEN has also signed an international collaboration with UK-based **Graphene Composites Ltd (GC)** to fight COVID-19 by developing a potential virucidal graphene-based composite ink that can be applied to fabrics including N95 face masks and other personal protective equipment (PPE) for significantly increased protection. Once the development, testing, and confirmation of the graphene ink’s virucidal ability have been completed, the ink will then be incorporated into fabrics used for PPE.

**Dotz Nano** has entered into a $1.53 million agreement
with Hong Kong’s Universal Exports Group to supply its ValiDotz security markers to medical face masks required for government stockpiles and national health services. The markers will be applied to a total 100 million masks to ensure quality and authenticity. Universal will initially apply the ValiDotz to 30 million masks, with a follow-up order of up to 70 million masks subject to customer demand.

As part of the two-year agreement, Universal will also become the sole and exclusive distributor for Dotz in South Africa and China for face masks, medical gowns and gloves, and other medical protective gear. In return, Dotz will grant Universal three million unquoted options with an exercise price of $0.048 vesting on a pro-rata quarterly basis with a term of three years.

Chitra Magna, a RNA extraction kit, has been developed by Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), India, as a tool for isolating RNA from swabs for COVID 19 tests. The protocol for the kit uses magnetic nanoparticles to capture and concentrate the RNA from the patient sample. This is of significant advantage because even if some viral RNA disintegrates during storage and transportation of the patient samples, all of it is captured by the magnetic bead-based extraction technology. The magnetic nanoparticle beads bind to the viral RNA and, when exposed to a magnetic field, give a highly purified and concentrated level of RNA. As the yield of PCR or LAMP test is dependent on getting an adequate quantity of viral RNA, this innovation enhances the chances of identifying positive cases. The Institute has filed for a patent for this technology, which is simpler than in imported kits. The technology of Chitra Magna has been transferred to the Agappe Diagnostics Ltd Ernakulam. The company has already taken the Chitra GeneLAMP-N technology, which uses RT-LAMP for identification of the N gene of SARS-COV-2.

Sona Nanotech Inc., a developer of rapid, point-of-care diagnostic tests, has announced that its rapid detection, COVID-19 antigen test’s laboratory validation studies of performance levels have resulted in a test sensitivity of 96%, test specificity of 96% and a Limit of Detection (‘LOD’) of 2.1 x 102 TCID50. Sales of the tests will now be permitted under a ‘research use only’ label until full regulatory authority is granted, in relevant territories, at which time the ‘research use only’ label requirement would be lifted.

Avalon GloboCare Corp., a clinical-stage global developer
of cell-based technologies and therapeutics, has signed a strategic partnership with the **University of Natural Resources and Life Sciences (BOKU)** in Vienna, Austria to develop an S-layer vaccine that can be administered by an intranasal or oral route against SARS-CoV-2, the novel coronavirus that causes COVID-19 disease. The principal investigator of the co-development project is BOKU’s Professor Uwe B. Sleytr, an eminent member of the Austrian Academy of Sciences.

Professor Sleytr is a pioneer of applied surface layer ("S-layer") nanotechnology, based on the repetitive protein structures that make up the outer surface of microbial cells. Dr. Eva-Kathrin Ehmoser, Professor and Head of the Institute for Synthetic Bioarchitectures at BOKU, serves as the co-principal investigator of the COVID-19 vaccine program. Avalon and Professor Sleytr have jointly filed a provisional patent application with the U.S. Patent and Trademark Office (USPTO) pertaining to the nanoparticle S-layer based vaccine against SARS-CoV-2.

The research is part of an ongoing and broader collaboration between Avalon and BOKU that will utilize S-layer technology to accelerate additional vaccine programs for other respiratory infections including different strains of the flu (influenza A/B), respiratory syncytial virus (RSV), and other viruses. As part of the partnership, Avalon is also actively exploring other practical uses of S-layer technology including targeted drug delivery, diagnostic devices, and therapeutic applications.

**Nicoya** will receive advisory services and up to $299,190 in research and development funding from the National Research Council of Canada Industrial Research Assistance Program (NRC IRAP) to develop a portable COVID-19 diagnostic test called **Atlas**.

This funding comes as part of a joint challenge issued by the Public Health Agency of Canada (PHAC) and the National Research Council of Canada (NRC) through the Innovative Solutions Canada (ISC) program. The saliva-based test will be able to detect COVID-19 infection in less than 20 minutes, with an easy-to-use device that can be employed in a variety of settings. The company has developed a nano-structured sensor surface uses localized SPR (LSPR) to deliver repeatable, highly sensitive kinetic data.

**Further information**

**Nanotechnology and nanomaterials solutions for COVID-19**

Published May 24 2020, available at [https://www.futuremarketsinc.com](https://www.futuremarketsinc.com)
Low-cost, high volume production and ease of integration is crucial for the development of widespread application of nanotech-enabled products. Recent nanotech products on the market May-July 2020.

**SunHydrogen Inc.** is a US-based company that develops solar-powered nanoparticle systems that separate hydrogen from water by mimicking photosynthesis. They have extended their research agreement with the University of Iowa for the development and commercialization of the company's GEN 2 nanoparticle hydrogen production panels, with a much higher solar-to-hydrogen efficiency and lower production costs compared to their GEN 1 hydrogen panels.

"As we move closer to building a full demonstration pilot plant with our first-generation technology, our efforts are focused on replicating the success we have had in the University of Iowa Labs with commercial entities that will integrate the essential components of the solar hydrogen generation device including protective coatings, catalysts and membranes," said Tim Young, CEO of HyperSolar.

The agreement also covers the extensive development work to complete and commercialize the company's GEN 2 nanoparticle hydrogen production panels that will deploy a much higher solar-to-hydrogen efficiency than GEN 1 at lower manufacturing cost. The work will continue to be led by University of Iowa Assistant Professor Dr. Syed Mubeen and HyperSolar CTO Dr. Joun Lee.

A research proposal submitted by the Center for Functional Nanomaterials (CFN) and Nuclear Science and Technology (NST) Department at the U.S. Department of Energy's (DOE) Brookhaven National Laboratory, with the startup Forge Nano as a partner, has been selected as a 2020 Technology Commercialization Fund (TCF) project. The project that Brookhaven Lab and Forge Nano scientists will partner on is "Maturation of Technology for Trapping Xenon and Krypton." Brookhaven will partner with Forge Nano to scale up the manufacture of the lab-demonstrated nanocages to maximize the surface area for trapping Kr and Xe atoms.

**Exir Royan Tabiat Inc.** is an Iran-based company, has succeeded in developing a oil-in-water nanoemulsion technology that enables the production of flavored omega-infused bottled water. The company designed the technology of producing oil-in-water nanoemulsion
CENS develops a proprietary, industrial process, that significantly increases the battery's energy capacity and cuts the charging time. Both are critical elements for electric vehicles (EV), drones, and other devices powered by batteries. CENS' solution is based on carbon nanotubes (CNT). CENS process efficiently disperses CNT on Li-Ion battery cathode and anode powder. The process generates highly dispersed 3-D conductive network of CNT which drives Li ions along the nano tubes. This mechanism sharply increases battery capacity under high power mode. CENS solution is a powder in/powder out process, therefore it does not affect the existing production line and does not require infrastructure modifications.
kinds with an L/C ratio of 75/25. The company Creative Diagnostics now offers new PLGA nanoparticles for researchers focusing on study fields like cell labeling, coating materials for drugs, drug carriers, and drug delivery.

**Nissan Chemical America Corporation** has partnered with industrial gas supplier, **Messer Americas**, to improve oil and gas production. Their collaborative treatment, nanoActiv HnP—an energized, fast turnaround style “Huff ‘n Puff”—incorporates nanoActiv with a carbon dioxide (CO₂) or nitrogen (N₂) gas application method to enhance oil and gas recovery.

**Taopatch** is a quantum dot based wearable patch for improving posture, reducing chronic pain and helping with emotional and physical well-being. Early bird pledges are available at Indiegogo from $149 (£119) and worldwide deliveries are expected August 2020.

**NANO-OPTICS FOR SECURITY**

**Nanotech Security Corp.**, a developer of nano-optic security features used in the government and banknote and brand protection markets, has launched LumaChrome™, a colour-shifting film into the brand protection market. Nanotech has designed several unique colour combinations with multiple application formats exclusively for the brand protection marketplace. LumaChrome colour-shifting film can be customized with brand names, logos or taglines and is available in multiple widths and formats or can be converted into pressure sensitive adhesive (PSA) labels, patches, or stripes for direct application.

Quantum dot company **UbiQD, Inc.** and the **Solvay Group** are partnering on the development of luminescent greenhouse technology under UbiQD’s UbiGro® family of specialty agricultural products. UbiGro® is a layer of light that helps plants get more from the sun. Powered by UbiQD’s safe and bright quantum dots, UbiGro® uses fluorescence to create a more optimal light spectrum for crops. UbiQD’s dots convert underutilized colors of light from the sun, such as blue and UV, to more photosynthetically active colors of light.

**Nano colour-shifting film can be customized with brand names.**
Low-cost, high volume production and ease of integration is crucial for the development of widespread application of graphene-enabled products. This month we look at recent developments and breakthroughs.

**LAB TO PRODUCT**

Aircraft engine maker Rolls-Royce is to work with the University of Manchester’s Graphene Engineering Innovation Centre (GEIC) and its partner Versarien on the use of graphene and other 2D materials used in wiring for next-generation aerospace engine systems. The programme aims to present potential economic benefits, through the possibility of significant cost reductions, and global environmental benefits, through the reduction of energy use and lower emissions from electrification.

ZEN Graphene Solutions and Evercloak have been awarded CAD$125,000 (USD$92,000) each as part of a Next Generation Manufacturing Canada (NGen) Project. The project entitled “Advancing Large-Scale Graphene and Thin-Film Membrane Manufacturing” will support the scale up of graphene oxide (GO) production by ZEN to supply GO to Evercloak for their scale up and optimizing activities. NGen supports collaborative technology projects that enable the development of world-leading advanced manufacturing capabilities in Canada.

NanoXplore has completed the commissioning of its state-of-the-art 4,000 metric tons/year commercial graphene capacity facility in Montreal, Province of Quebec. NanoXplore’s new graphene facility is a fully automated production plant that enables a connected, flexible and continuous manufacturing system. NanoXplore will gradually ramp-up commercial production of its GrapheneBlack powders over the next six months, in alignment with the Corporation’s sales visibility.

Following a successful Phase 1 collaboration agreement with IRPC Public Company (IRPC), UK-based graphene producer Haydale has now signed a Phase 2 agreement. The Agreement will see IRPC developing transparent graphene and functionalized acetylene black conductive inks for RFID, NFC and related applications. Haydale is to functionalize IRPC’s acetylene black product to create the organic RFID ink. The success of this collaboration is expected to pave the way to numerous opportunities in printed electronic
UK-based Graphene producer Thomas Swan has signed an exclusive agency agreement with Concrene to develop graphene for concrete products.

Thomas Swan’s Graphene Nano Platelet (GNP) products have been tested in a number of concrete dispersions by Concrene and have shown compressive strength improvements of greater than 20% with loading of less than 1% by weight. Michael Edwards at Thomas Swan said “We are delighted to be working with Concrene in this exciting partnership. With 8% of the World’s carbon emissions emanating from concrete production, this demonstrates a tangible commitment to our internal goal of achieving Carbon Net Zero by 2030, in addition to carefully expanding our focused application base. The team at Concrene will drive our GNP dispersion options in multiple regions, consolidating our position as a global volume manufacturer of graphene.”

Highways contractor Amey and its client Kent County Council will be testing Gipave, a graphene-based asphalt supermodifier said to extend pavement life. The trial is taking place as part of the Association of Directors of Environment, Economy, Planning & Transport (ADEPT) Smart Places Live Labs programme funded by the Department for Transport of the UK. Gipave is a polymeric supermodifier containing graphene and a selected type of hard plastic. It has been used in trials of asphalt resurfacing at many sites in Italy including a number of roads and airport runways. Gipave, developed by Iterchimica, is the result of a three-year research program in collaboration with Directa Plus, G.Eco and the University of Milano Bicocca. The graphene used in the new supermodifier is produced by Italy-based Directa Plus.

Alé Cycling has unveiled a graphene-enhanced cycling shirt, the Velocity G+ jersey. The new jersey sells for around £230 and uses a graphene-based fabric that allows an active interaction between the body and the fabric. UK-based cycling brand AbsoluteBlack applications and be more environmentally friendly than existing inks.
has added a new graphene chain lube product to its portfolio. The hydrocarbon lubricant has outstanding durability per application, delivering reduced friction for prolonged periods of use. The graphene lube blend is free of toxic solvents, using a wax-based water emulsion with an inherently superior resistance to moisture to mitigate chain friction.

First Graphene (FGR) has entered an agreement with Aquatic Leisure Technologies (ALT) to supply PureGRAPH products over the next two years. Incorporating First Graphene’s PureGRAPH graphene powders into the new range of pools will enable a brand new construction process to provide the next generation of fibreglass pool technology.

UK-based start-up Payper Technologies is using graphene to provide the restaurant industry with a new pay-at-table technology. Graphene antennas are printed on paper to enable customers to pay their bill by tapping their smartphone on the receipt.

**GRAPHENE MOTORBIKE SEATS**

U.S.-based motorcycle maker Indian Motorcycle has launched a new graphene-based technology Called ClimaCommand Classic Seat, which aims to deliver both heating and cooling to riders and passengers. The thermo-electric technology reportedly raises the bar on cooling, providing a much more effective solution than HVAC convection systems. A performance benefit of the ClimaCommand technology is that it actually produces a surface that’s cold to the touch, rather than merely pushing cool air through perforations in the surface in the manner that HVAC system offerings operate.

Graphene supplier and product manufacturer Nano Graphene (d/b/a GrapheneCA) antibacterial products have shown to be 99.9% effective in making various surfaces bacteria proof according to ASTM E2180 testing protocol for determining antimicrobial activity of polymeric materials. This follows GrapheneCA’s April 2020 launch of its online store to sell these new “Dr. Nano” antibacterial coatings. GrapheneCA’s Dr. Nano Flooring and Dr. Metal product lines have been shown in an independent laboratory test to provide exceptional antimicrobial protection of different surfaces.