



CARBON RIVERS

**ADVANCED TECHNOLOGIES CREATING A
SUSTAINABLE PRESENT**



Advanced Materials for a Sustainable Present

rGF TECHNOLOGY

Carbon Rivers G2G+ has commercialized a novel **glass fiber and resin oil recovery process for post-industrial and post-consumer waste streams**

- **Processes and recovery thermosets and thermoplastics**
- **Recovers various resins** to monomers such as elium, epoxy, polyurethane, etc
- Is **carbon negative** scope II for the LCA model
- **Provides a mechanical, thermal, and chemical step**
- Has syngas, glass fiber fines, carbon black, crude oil, and recovered glass fiber
- **Successfully recycled 1,000 blades** in 2023 and has 3,000+ for 2024 project forecast

PGN TECHNOLOGY

Carbon Rivers Nano has commercialized a top-down **mechanical exfoliation of the critical mineral graphite to pristine graphene**

- **Efficient and economic process whereby 1mT of graphite yields 1mT of pristine graphene**
- Evaluated **high-quality graphite** mines throughout the world
- **Three grades** for electrical, bulk, and recovered nanoflakes
- **1-3 layers with no defects** or functional groups and **up to 99.9% carbon**
- Commercialized PGNs for textiles, coatings, concrete, lubricants, composites, elastomers, foams, ballistics, etc



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G2G+

rGF intermediates and applications

G2G provides an **ESG circular economy for the composite industry**

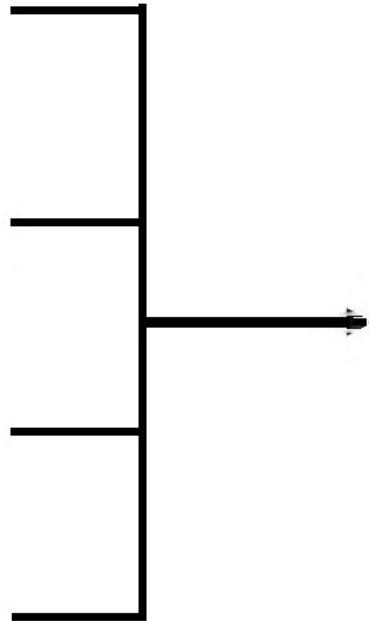
- rGF that is mechanically intact and clean for next life cycle manufacturing
- Non-woven mats with various GSM (20-600) for various industries
- rSMC for automotive, marine, and building material markets
- Thermoplastic pellets with various polymer chemistries
- AM filament with rGF for diverse applications

PPAP for automotive, marine, wind, and global composite market

G2G+ is currently in **PPAP with over two dozen OEMs** in various composite industries

- Automotive has mandate for 25% recovered material by 2030
- EU has composite landfill restrictions by 2025
- rGF intermediates meet product specs set forth by OEM / Tier supplier product validation
- Companies receive various GHG, IRA, PTC, Carbon Credit, and other incentives and credits for incorporating rGF material

STATUS QUO: WHAT HAPPENS AT END-OF-LIFE? EITHER BURY OR BURN...



Landfill

OR



Cement kiln incineration

**No current market option offers true, sustainable recycling for composites.*

~100,000 tons/year
by 2030

THE G2G SOLUTION: THERMOLYSIS RECYCLING



**End-of-Life Waste &
Production Scrap**



**Composites
Recycling**



Reclaimed Fiberglass

**Return to
Composites
Supply Chain**



**Recovered resin and
heavy hydrocarbons**

**Return to Oil
& Gas / Resin
Supply Chain**

EXAMPLE REINFORCED PLASTIC PRODUCTS WE ALREADY RECYCLE



**AUTOMOTIVE
PARTS**



**WIND TURBINE
BLADES**

rGF INTERMEDIATE PRODUCTS FOR OFFTAKE SUPPLY CHAIN



RAW STAPLE FIBER



- Est. Market Size: \$13.2 Billion USD
- Fiber can be sold as-is with lengths +2" to 1/2" for fabric/textile applications
- Glass can also be milled for thermoplastic compounding or remelt

NONWOVEN FABRICS

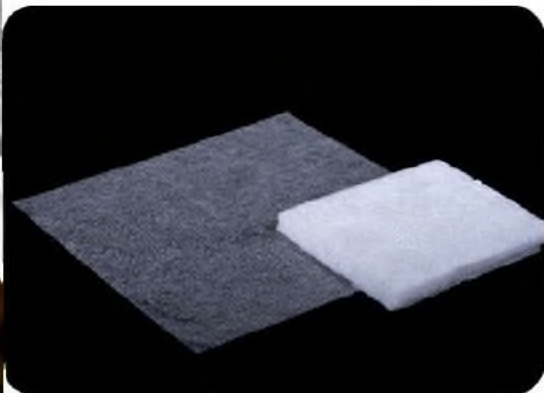


- Est. Market Size: \$1.3 Billion USD
- Can be pure fiberglass or comingled with thermoplastic (or other) fibers for automotive, marine, wind, etc. applications
- Can do heavier mats at 100-400gsm or veils ~30-50gsm

COMPOUNDED PLASTICS



- Est. Market Size: \$24.1 Billion USD
- Able to compound fiber with common plastics such as polypropylene and nylon for AM or injection molding
- Currently able to compound up to 30wt% fiber loadings with existing equipment



CR G2G PROVIDES A SUSTAINABLE PRODUCT FOR A GLOBAL MARKET

- Global glass fiber **CAGR is 8.4%** and climbing
- The G2G+ solution can **process over 55,000mT per year**, per facility.
- The UK and EU markets need over 40 G2G facilities to keep all **post-industrial and post-consumer** composite out of landfill and supply a genuine manufacturing circular economy.
- rGF intermediates are **comparable to virgin price** with an ESG label and credits / incentives.
- In addition, the other natural gas, carbon black, glass fiber fines, and sulfur-free crude are valuable **ESG by-products**.
- Composite material responsibility is finally achievable with **perpetual composite life cycles**.

SUSTAINABLE PRISTINE GRAPHENE:
PG MUST BE HIGH QUALITY, LOW COST, AND
HIGH VOLUME



Carbon Rivers Nano has completed the trifecta for **1-3 layer** PGNs at a low cost at monthly tonnage scale for global concrete, asphalt, coatings, ballistics, foam, elastomer, metal, lubricant, composites, filtration, energy storage, fuel cell, and other industries.

CR NANO GRAPHENE GLOBAL TECHNOLOGIES

ENHANCED CONCRETE AND BUILDING MATERIALS

- CR Nano has formulated a PG solution for enhanced concrete, asphalt, composites, and building materials in general.
- PG provides at least **50% increase** in mechanical properties such as compression, shear, and flexural values.
- PG is **hydrophobic and UV resistant** so the nanoflakes decrease a freeze-thaw cycle and reflect UV light.
- Increased **anti-corrosion and anti-abrasion** in building materials for increased fatigue and structural performance.
- **Can cure in salt water** for specialized projects, and less materials, water, and additives are needed for decreased material costs and therefore a tremendous decrease of global emissions.
- **Thermal dissipation and electrical conductivity** values increase.

ANTI-FOULING AND ANTI-MICROBIAL COATINGS

- CR Nano has formulated a PG solution for **enhanced marine and anti-microbial coatings**.
- The PG lowers surface energy so marine vessels have **decreased drag and increased fuel efficiency**.
- **No metals or biocides** so no sloughing or toxicity into the oceans for coral reef and marine life damage.
- Lowered surface energy means **not having to dry dock to clean vessels** from barnacles and marine growth.
- Tremendous **decrease of global marine emissions** due to superior efficiencies and lack of marine growth.
- Multi-industry **solution to mold, fungus, and other bacterial and viral growth** on surfaces in schools, hospitals, factories, distilleries, and other industries.

LIGHTWEIGHT FLEXIBLE ARMOR SYSTEMS

- **Soft, lightweight body armor** for various threat levels including rifle.
- **Lightweight systems** for vehicles and aviation to increase capability, reduce fuel consumption, and protect lives in growing hostile geopolitics.
- **Grid enhancement and protection** for renewable and traditional oil / gas assets to keep energy and fuel available to rural and urban energy consumers.
- **Ballistic building materials** for government buildings, schools, and hospitals to protect non-combatants, children, and physicians / nurses.
- **Defensive ballistic materials** for emergency and first responder personnel and vehicles in crisis environments.

CR NANO GRAPHENE GLOBAL TECHNOLOGIES

UPGRADE TO ENERGY AND ELECTRICAL GRID

- **The current grid cannot take renewable and EV load** that is going online this decade.
- **Graphene creates nucleation sites** for smaller grain and applies stress relief against brittleness.
- **Thermally and electrically conductive.**
- **EMI and EMF shielding** when drawn into wire.
- **Increases fatigue cycle,** compression strength, and modulus.
- **Graphene tensile strength at 130 GPa,** about 200 times stronger than steel.
- **For 6061 just as-cast there is an ~8.8% IACS increase and a ~3.9% IACS increase in 1350** just as-cast. Further alignment will see greater increase in IACS.

CARBON BASED EV BATTERY DESIGNS

- Current EV battery designs employ rare earth elements and supply chain material challenges, so PG provides pristine graphene for a **carbon-based solid state battery system.**
- PG is used for the anode and polyethylene film separator for **thermal dissipation.**
- **Augmented corrosion resistance,** higher surface area and higher conductivity.
- **Increased cycle time** and power and energy density for EV.
- **Prevents dendrite growth** in battery chemistries.
- **Increased thermal dissipation and electrical conductivity** along with **gas / liquid impermeability.**
- CR developed an EV.MMS that is a **mobile, modular supercharger** that runs on single phase.
- CR has capability for **EOL battery recycling** with tremendously increasing market.

PERFORMANCE TIRES AND ELASTOMERS

- ~1b tires need to be recycled each year. PG tires for EV and petrol vehicles can last **at least 3x longer life** with extended abrasion and fatigue properties.
- The toxic agent **6PPD can be decreased** in tire chemistry as PG is UV resistant and retards elastomer decay.
- **Decreasing tire landfill** is a necessity for improving social and environmental conditions.
- **26% increase in peel adhesion,** and **50% decrease in gas permeation**
- **Abrasion resistance:** 28% decrease in volume loss, **and increased static and thermal energy dissipation**
- CR has capability for **EOL tire recycling.**



CR NANO PG NANOFILAKES FOR SUSTAINABLE MATERIALS FOR A GLOBAL MARKET

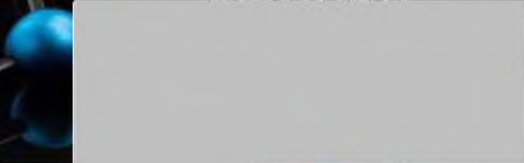
- PG **lubricant** in the gearbox to increase **thermal resistance**, increased **fatigue**, reduce **friction of coefficient**, and minimize oil leaks from gaskets and o-rings
- PG **elastomers** for thermal and corrosion resistant gaskets and o-rings along with increase in abrasion resistance and gas / liquid impermeability
- PG UHMWPE **ballistic fabric** for energy grid protection from EMI and threats
- PG for **additive manufacturing** in concrete, composites, and other material matrices for increased compression and tensile as well as hydrophobic and fatigue resistance
- PG polyethylene **film** for leading edge erosion, along with resistance to corrosion, UV, and freeze-thaw cycle. Also reduces challenges from bird migration.
- PG **metal** transmission cables provide increased thermal and electrical conductivity as well as EMI shielding.



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**ADVANCED DISRUPTIVE TECHNOLOGIES FOR A
BETTER HUMANITY CREATING A BETTER WORLD**

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