HIGH-RATE PRODUCTION OF ISOTROPIC DARC COMPOSITES FOR ATTRITABLE SYSTEMS

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ORIGIN: BGS ENGINEERING, LLC | ALBUQUERQUE, NM
SUBJECT: ENABLING THE $2,300 UNIT COST FOR THE DRONE DOMINANCE PROGRAM (DDP) VIA NOVEL MATERIALS

I. EXECUTIVE SUMMARY

The Department of War’s “Drone Dominance” initiative demands a radical shift in aerostructures: the transition from low-volume, high-touch manufacturing to **high-rate, attritable production**. Current airframe solutions, primarily machined aluminum and autoclave-dependent woven composites, cannot meet the dual requirements of a **$2,300 unit cost and scalable US-based output**.

BGS Engineering introduces **DARC (Discontinuous Advanced Resin Composite)**, a proprietary material platform designed specifically for the next generation of loitering munitions and attritable systems. With a density of **1.37 g/cm³** and **isotropic** mechanical properties, DARC allows engineers to utilize high-pressure compression molding to replace complex machined components with a 40%-50% density reduction compared to aluminum and significantly reduced waste from both machined aluminum and cut carbon plate.

Validated through ongoing collaboration with **Sandia National Laboratories (SNL) and New Mexico State University (NMSU)**, DARC provides a sovereign, high-throughput solution that eliminates the autoclave bottleneck. By integrating intrinsic UV resistance, conductivity, potential EMI shielding, and potential signature management directly into the matrix, BGS delivers a true **multifunctional material platform** that simplifies the supply chain and enhances survivability.

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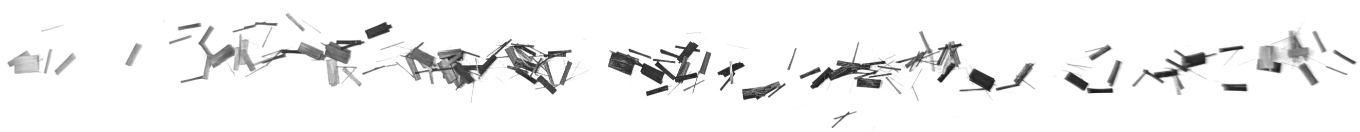
II. THE CAPABILITY GAP: THE COMPOSITE BOTTLENECK

To achieve the scale required for modern loitering munitions, the U.S. industrial base must produce hundreds of thousands of units capable of 10km+ sorties. Traditional manufacturing presents three critical points of friction:

The Anisotropic Constraint: Traditional carbon fiber is strong primarily along the fiber axis (anisotropic). This forces engineers to use overly complex ply-layups or revert to heavier machined aluminum for structural junctions, manifolds, and gimbals.

The Autoclave Lifecycle: Woven pre-preg composites require massive energy expenditure and 8–12 hour autoclave cycles. This “batch processing” is a primary barrier to reaching the high-velocity production rates demanded by the Drone Dominance Program and the Replicator Initiative.

Environmental & Signature Vulnerability: Standard composites require secondary coatings for UV stability and specialized treatments for EMI/RCS management. In tactical scenarios, these coatings are vectors for failure, adding weight, cost, and maintenance requirements that attritable systems cannot afford.



III. MATERIAL SCIENCE & MANUFACTURING VELOCITY

DARC is engineered for **isotropic performance** and **net-shape precision**. By utilizing a high-pressure compression molding process, the material behaves predictably under load from any direction. This liberates engineers from the “drape limitations” of woven cloth, offering the **geometric design freedom** of die-cast aluminum at a composite weight, coupled with a manufacturing workflow designed for massive parallelization.

Geometric Freedom & Aerodynamic Optimization: Traditional pre-preg laminates are constrained by fiber orientation and drape limits, often forcing compromises in aerodynamic shape. DARC flows hydrostatically during consolidation, enabling the production of highly complex, compound-curvature airframes with variable wall thicknesses. Engineers can utilize topology optimization to place mass only where structural loads demand, reducing parasitic drag and eliminating the weight penalties of over-engineered laminate sections.

Distributed Manufacturing Architecture: To eliminate the autoclave bottleneck, we utilize a decoupled curing process. The high-tonnage press is used only for the initial consolidation and mold-bolting phase. Once secured, molds are transferred to standardized industrial convection systems for the cure cycle. This allows a single press to feed a battery of ovens, enabling a manufacturing model that can **scale capacity in days or weeks**, rather than the months required to commission new autoclave facilities.

III. MATERIAL SCIENCE & MANUFACTURING VELOCITY (CONTINUED)

Assembly Velocity (Molded-In Hardware): The DARC process allows for the direct integration of **threaded interfaces** and **structural metallic hardware** during the primary molding cycle. This eliminates the “drill-and-bond” phase, reducing total airframe assembly man-hours.

Modular Logistics & Field Repair: Unlike permanently bonded composite structures, DARC components with integrated hardware enable **bolted assembly architectures**. This allows airframes to be shipped in “flat-pack” configurations for high-density transport and rapidly assembled or repaired in the field using standard hand tools.

Superior Specific Strength: While 6061-T6 Aluminum (2.70 g/cm^3) imposes a rigid “weight floor,” DARC (1.37 g/cm^3) provides nearly **double the specific strength** (strength-to-weight ratio). Our current conservative baseline is 280 MPa, with process optimization in the upcoming Q1 2026 series targeted to yield further increases.

TECHNICAL NOTE: GEOMETRY VALIDATION (PATHFINDER UNIT)
STATUS: DEPLOYED JAN 1, 2026

To demonstrate immediate production readiness, BGS Engineering recently deployed a “Pathfinder” component utilizing the DARC platform to test high-precision molding and hardware integration.

Complex Geometry: The unit features ergonomic, non-uniform surfacing that validates the material’s “Net-Shape” flow during high-pressure consolidation.

Hardware Integration: The component successfully utilizes a molded-in threaded insert, proving the mechanical interlock between the DARC matrix and metal hardware is viable without secondary bonding.

Real-World Evaluation: This unit is currently in active use to monitor surface durability, resin stability, and insert retention under cyclic mechanical loading.

IV. INTRINSIC SURVIVABILITY & SIGNATURE MANAGEMENT

In the tactical environment of the Drone Dominance Program, airframes must survive “rough handling” and hostile detection without relying on fragile secondary coatings. DARC integrates these capabilities directly into the material matrix.

Integrated UV Resilience (Sustainment): Our proprietary UV-stabilizing chemistry is integrated throughout the DARC matrix. Unlike traditional paints that can chip and lead to rapid structural degradation, DARC remains protected even if the surface is scratched or abraded in the field, significantly extending the service life of stored munitions and assets in the field.

Intrinsic Conductivity & EMI Shielding (Pending Quantification): Qualitative analysis in September 2025 confirmed the material possesses intrinsic bulk conductivity, providing a platform for EMI shielding and ESD protection without heavy metallic liners. While the physical mechanism is validated, **quantitative ASTM D4935** (Shielding Effectiveness) and **ASTM D257** (DC Resistance) data is currently scheduled for testing and validation in the upcoming Q1 2026 test series at NMSU/SNL to finalize the technical datasheet.

Structural Health Monitoring (SHM) Readiness: The validated conductivity of the DARC matrix enables resistance-based damage detection. By integrating simple voltage-drop electronics, the airframe itself can function as a distributed sensor. This allows the flight computer to detect impedance shifts caused by cracks or fatigue in real-time, providing “damage awareness” to the operator without the weight of added strain gauges.

Radar Signature Management (Theoretical Capability): Following the identification of intrinsic radio-opacity and bulk conductivity in September 2025, a theoretical review was conducted with subject matter experts in Radar Absorbent Materials (RAM) at Sandia National Laboratories. While empirical RCS testing is pending, expert review confirms that the DARC conductive fiber matrix possesses the requisite theoretical properties for **Low-Observable (LO) signature management**. If validated in the upcoming Q2 2026 test series, this would offer a structural alternative to radar-reflective aluminum without the weight of parasitic coating systems.

V. OPERATIONAL SOVEREIGNTY & PROGRAM VELOCITY

BGS Engineering operates as a streamlined, vertically integrated entity, structured to bypass the inertia of legacy supply chains. By retaining full control over internal tooling design and mold fabrication, we execute rapid **“Design-to-Hardware” sprints**, capable of moving from digital CAD to physical testing in **4–6 weeks**. This velocity allows us to align strictly with Department of War requirements, executing the rapid iteration cycles necessary for the Replicator Initiative.

Projected TRL Progression & Milestone History: BGS Engineering has maintained an aggressive validation cadence, securing Tier 1 institutional partnerships and non-dilutive state funding to accelerate the transition from TRL 4 to TRL 6.

Dec 2024: Initial experimental validation of Discontinuous Carbon Fiber potential.
Apr–May 2025: BGS Engineering founded; initiated SNL partnership for integrated UV-resistance chemistry.
Aug–Sep 2025: Discovery and qualitative validation of material conductivity and structural novelty.
Dec 2025: Awarded NM EDD Science & Technology Start-Up Grant; initiated NMSU partnership and patent filing.
Jan 2026: Radar absorption theory validated with SNL; deployment of DARC Pathfinder Unit.
Feb 2026 (Scheduled): Quantitative Conductivity and ASTM D30 Structural Series at NMSU.
Mar 2026 (Scheduled): Full-scale DARC Airframe Flight Campaign at NMSU/FAA UAS Flight Test Center.
Summer 2026 (Projected): Final SNL/NMSU quantification of UV, EMI, and Radar Signature Management.

VI. CONCLUSION: A CALL FOR INTEGRATION

BGS Engineering is transitioning from TRL 4 laboratory validation to a **TRL 5/6 validation** series scheduled for Q1 2026. This upcoming campaign, conducted in coordination with the NMSU/FAA UAS Flight Test Center, will benchmark a BGS DARC airframe directly against a legacy material clone to quantify flight performance deltas.

All ongoing structural validation and testing protocols are aligned with **ASTM D30 standards**, ensuring our data is immediately actionable for Tier 1 aerospace integration. While surface finish optimization is ongoing, our core manufacturing process is **locked for structural repeatability**, ensuring that the data gathered in this next phase is representative of high-rate production units.

BGS Engineering is currently selecting lead integration partners for the FY26 production ramp. We invite distinct Department of War partners and Tier 1 Prime contractors to discuss strategic allocation and review the upcoming round of SNL/NMSU high-precision test data.

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