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Technology Description

Additively Manufactured 3D Textile Reinforced Structures and Composites

Business Opportunity: Response Technologies' (RT) expects to reduce the cost and weight of 3D textile reinforced structures and composites to include carbon fiber, P-aramids, UHMWPEs and other high performance fibers. RT uses a proprietary additive manufacturing process and materials science that it anticipates will result in:

1) Seamless constructions that can extend service life by eliminating seam failure
2) Weight reductions of 20% through additive manufacturing - overlap elimination and strength where needed
3) Increased chemistry coating options to include dissimilar chemistries on inside and outside
4) Component cost reductions through reduced materials, utilities, labor, and costly tooling
5) Reduced development and prototyping times and costs

RT is seeking customers in need of RT's value proposition for 3D textile reinforced composites.

Company Background: Response Technologies, a certified small business, was founded in 2015 as a product development company utilizing material science and advanced manufacturing processes to deliver breakthrough product and process solutions. The company, which is in Riverside RI, has its own: engineering, product design, prototype manufacturing, testing, and development facilities.

Industry Problem: The current subtractive processes employed for manufacturing textile reinforced composite structures are suboptimal for cost and performance as shown in the figure.

Current Methods	Process	Product Examples	Problems
Sacrificial Form: Build Layers atop 3D Form, Break and Remove Forms			Form Cost Form Removal Cost Master Form Storage Labor – Building Layers Overlap Added **Weight**
Split – Molding: Build Layers atop Partial Forms, Peel Composite from Form, and Connect Parts			Seams – Cost & **Weight** Seam Strength Forms Storage Labor Building Layers Defects at Form Interface

Technology: RT's patent-pending innovation offers three disruptive advantages. The first advantage is the elimination of processes. For example: cutting, seaming, hand laying-up, joining and sacrificial mold processes through additive manufacturing. This eliminates variation in workmanship and contamination between the layers and flanges. The additive manufacturing process also greatly decreases costs by reducing: labor, materials, and scrap levels. Finally, the agile nature of the additive manufacturing process, translates to significantly reduced development and manufacturing lead times.

The second advantage is the ability to utilize superior coating chemistries. For example, thermoplastic fluorinated polymers that are highly chemical resistant, and/or, high-energy absorbing polymeric coatings. Since there is no seaming required in the formation of the structure, RT's process can utilize dissimilar chemistries to best suit the unique operational environments of the final product. For example, the outside of a part could be optimized for its performance and longevity against severe weather climates and conditions, while the inside of the product can be highly resistant to harsh chemicals.

Finally, the third disruptive advantage that RT's additively manufactured 3D textile process allows, is the incorporation of dissimilar yarns or quantities of yarn to be placed in specific areas requiring greater strength. Corners and the areas around fittings are the primary failure locations during impacts. RT's technology can strengthen these areas without having to add weight nor cost across all other areas of the structure. This flexibility gives design engineers the tools necessary to approach theoretical minimum weight for parts.

Advantages: RT's seamless process affords a significant expected advantage over incumbent technologies, by reducing: processing steps, lead times, cycle time, and the materials, labor, and utilities required. The resulting value proposition is a lighter, less expensive and longer lasting parts.

Stage of Development: RT has manufactured an 8-gallon working prototype flexible reinforced fuel tank and is in the process of phase I qualification a 30"x27"x27" test tank to MIL-DTL-27422F Class B Semi-Rigid and Type 1 Self-Sealing. RT has additively manufactured 8" rigid, semi-rigid, and flexible spheres of carbon fiber as well as Carbon+P-Aramid+PBO blended constructions. These products were produced without expensive nor sacrificial tooling.

Process Capabilities: RT's current process capabilities are:

Dimensions: Combined 180 inches in X and Y and effectively infinite in the Z direction
Fiber types: Singular fiber or mixed constructions using: Basalt, Kevlar – P-Aramids, Carbon Fiber, Zylon - PBOs, Ballistic Nylon, Nomex, Polyester, Vectran, Spectra – Dyneema - UHMWPEs
Yarn Size Range: 10 to 350 Tex
Pre-Fabric Density Range: 20.0 to 500 g/m^2
Coating Types: Rigid or semi-flexible to include: Urethane – Ester or Ether, PVDF, Polyester, Nylon, PTFE, Urea, CNT/PE Blends, Metallics, and Metallic Blends.