Topic: N172-128

Composite Technology Development, Inc.

Manufacturing Process Development for High Temperature Polymer or Nanocomposite Films for Dielectric Capacitors

This effort delivers a polymer film and film capacitor production process. The capacitors exhibit sustained performance at elevated temperatures with high-power density and fast recovery. CTD specializes in developing state-of-the-art composites for extreme conditions and demanding applications including superconducting magnets, defense, and industrial markets. The targets for these capacitors are ONR's Railgun and Electromagnetic Aircraft Launch System (EMALS). The solution involves a novel film capacitor that enables continuous, sustained operation and performance at elevated temperatures supporting pulsed power applications, while exhibiting characteristics that support affordable and scalable manufacturing. Current work is towards pilot scale film processing techniques that retain the high performance of lab produced films. On success our goal is to secure a scaling partner for manufacturing the capacitors to address the market demands aligned with existing capacitor production processes and application requirements.

Technology Category Alignment:

Energy storage
Power Control and Distribution
Power and Energy
Propulsion and Extreme Environments

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SYSCOM: ONR
Contract: N68335-19-C-0178
Corporate Brochure: https://navystp.com/vtm/open_file?type=brochure&id=N68335-19-C-0178

Department of the Navy SBIR/STTR Transition Program

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Topic # N172-128
Manufacturing Process Development for High Temperature Polymer or Nanocomposite Films for Dielectric Capacitors
Composite Technology Development, Inc.

WHO

SYSCOM: ONR

Sponsoring Program:

Transition Target: Railgun - NSWC Dahlgren

TPOC:
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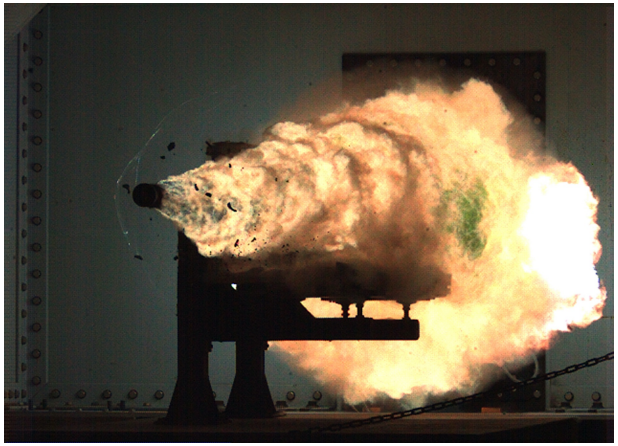
Other transition opportunities: Electromagnetic Aircraft Launch System (EMALS), pulsed power and power handling applications, Directed-Energy Weapons



080131-N-0000X-001 DAHLGREN, Va. (Jan. 31, 2008) Photograph taken from a high-speed video camera during a record-setting firing of an electromagnetic railgun (EMRG) at Naval Surface Warfare Center, Dahlgren, Va., on January 31, 2008

WHAT

Operational Need and Improvement: This effort will deliver a polymer film and film capacitor production process, which will lead to the delivery of capacitors that will enable enhanced mission effectiveness for pulsed power devices. The capacitors will exhibit sustained performance at elevated temperatures with high-power density and fast recovery, which will enable increased operational tempo in terms of firing rates, sorties, or power generation and recovery.

Specifications Required: Minimum performance temperature for 90% efficiency is 125°C as stated in the Navy solicitation
Goal Charge-discharge efficiency >= 95% to 400 V/micron at 125°C
Uniform film thickness in large rolls (10 microns thick or less, free standing, not on substrate)

Technology Developed: Thin film dielectric films with uniform properties (e.g. particle dispersion) that are used as a feed-stock for the manufactures of thin-film capacitors at lower cost than existing commercial dielectric-thin films.
Development of a roll-to-roll process for manufacturing and production of long rolls of film.
Capacitor prototypes for evaluation.

Warfighter Value: The warfighter will benefit from this technology as capacitor recovery times are reduced, which leads to an increase in operational cadence. For the railgun application, it will enable sustained firing rates enabling operational effectiveness of the weapon with reduced downtime. For EMALS, the ability launch additional aircraft over a short duration will enable mission effectiveness as more assets are available to complete mission objectives.

WHEN

Contract Number: N68335-19-C-0178 **Ending on:** November 8, 2020

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Facility demonstration production of film	Low	Production of film sufficient for thermal, mechanical, and electrical characterization	4	3rd QTR FY20
Demonstration of capacitor meeting Navy Requirements	Med	Dielectric breakdown strength, Equivalent Series Resistance (ESR), Equivalent Series Inductance (ESL), leakage current at different temperatures, and lifetime using a high voltage capacitor charge-discharge setup	4	1st QTR FY21

HOW

Projected Business Model: CTD will target a defense contractor as a partner to integrate the technology into the system solution(s) to enhance the likelihood of end-customer adoption. CTD plans to partner with capacitor manufacturer(s) for commercial applications, licensing the roll-to-roll film production process as necessary to ensure quality of films produced. In both cases, CTD plans to manufacture the thin film rolls in-house leveraging CTD materials and process. As the technology is adopted at scale, CTD may transition to a material supplier to the capacitor market, licensing the filming process as appropriate to ensure performance and uniformity as a feed-stock for reel-to-reel film production and to enable the volume potential that may be limited as a small bsuiness.

Company Objectives: CTD aspires to develop a material based solution that creates a long-term sales channel for CTD products to third parties as a feed-stock for the capacitor production process. Coupled with the roll-to-roll manufacturing process that CTD envisions offering to a partner, CTD will leverage the future sales to continue to deliver material innovations that further enhance this capability and lead to market growth in other commercial applications.

Potential Commercial Applications: High temperature capacitors have utility in the following markets: oil and gas downhole exploration technology, power conditioning, automotive (electric vehicle (EV) motors), and the very high-speed transit sector. In each case, these high temperature films can create film capacitors that are capable of operating in high temperature environments with high energy demands. Especially int he oil and gas downhole market, directional drilling tool failure can be costly and time-consuming to troubleshoot. The capacitors developed by CTD can alleviate this downtime, enabling more efficient completions.In automotive and high-speed transit, the resulting benefits include higher power density electric motors and magnetic drive systems that are currently limiting range and performance (acceleration rates).

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