Department of the Navy SBIR/STTR Transition Program

DISTRIBUTION STATEMENT A. Approved for public release. Distribution is unlimited.
NAVAIR 2020-836

Topic # N162-092
All Solid-State Batteries for Navy Applications
NanoCoatings, Inc.

WHO

SYSCOM: NAVAIR

Sponsoring Program: NAWCAD Chief Technology Office (CTO)

Transition Target: Navy F/A-18

TPOC:
(301)342-5788

Other transition opportunities: Navy Flight and Attack aircraft batteries for engine-start, electrical systems back-up power, and in-flight emergency power. For the F/A-18 only a 28 V battery would be applicable. Army Next Generation Combat Vehicle (NGCV), advanced communication devices, and warfighter power needs. Air Force reserve batteries with fast electrolyte introduction and good cathode wetting after long dormant storage periods, and long shelf-lives.

Prototype Pouch-Cell Battery; NCI Image, 2020

WHAT

Operational Need and Improvement: U.S. Navy requires aircraft batteries with higher performance, lighter weight, and more reliable operation without the thermal runaway, fire, and explosive hazards associated with current Li-salt organic-liquid electrolyte batteries.

Specifications Required: Target application for advanced fighter aircraft includes replacement of 270V Li-ion battery for engine-start and in-flight emergencies and the 28V Li-ion battery for back-up power to electrical systems. Operational requirements include greater than 200Wh/kg energy density and 1.5 kW/kg power density, -40 to +85 degrees centrigrade temperature-use range, and survivability to carrier-based environments.

Technology Developed: Reproducible coin-cells with solid-state cathode and Li-glass/ceramic electrolyte have been fabricated using Physical Vapor Deposition (PVD). The Li-glass/ceramic electrolyte has the highest ionic-conductance of candidate solid electrolytes. Preliminary testing gave an open-circuit-voltage of about 2V, a capacity of 0.2 mAh, and a specific capacity of about 400 mAh/g (0.4C rate) for cells with a thin (<0.025 mm (<0.001 in.)) solid cathode-electrolyte layer. These values exceed performance for commercial solid-electrolyte cells by at least 2X.

Warfighter Value: Application of solid-state batteries into warfighter systems will significantly improve the operational safety, assured performance, and lifetime of power systems. With the smaller thickness and weight of the PVD-fabricated solid materials, higher specific capacity and specific energy output will result. Fabrication onto flexible substrates will increase installation options and result in a conformable wearable battery.

WHEN

Contract Number: N68335-18-C-0221 **Ending on:** March 26, 2021

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Reliable PVD sputter-targets from precursors	High	Mechanical survival during application of RF power in PVD process	4	August 2019
PVD co-deposition of cathode and electrolyte	High	Electrochemical performance measurements	4	August 2020
Fabrication of multiple, reproducible coin-cells	Med	Cell impedance, charge/discharge performance	4	September 2020
Cells in battery enclosure, integrate battery management system (BMS)	Med	Total voltage output and charge/discharge behavior and control by BMS	4	December 2020

HOW

Projected Business Model: Protection of intellectual property (IP) by obtaining utility patent(s) for materials and processing used to fabricate the all-solid-state battery. Revenue model consists of licensing IP for reduction to practice by battery manufacturer and/or larger electronics-PVD vendor. Cost-reduction by roll-to-roll deposition technology will enable continuous fabrication of solid-state materials onto flexible cathode substrates.

Company Objectives: Manufacture prototype battery with integrated battery management system (BMS) to demonstrate operational performance. Obtain utility patent(s) and license agreements with commercial battery manufacturers and/or larger PVD service vendors.

Potential Commercial Applications: Near-term: Biomedical devices, smart cards, RF-ID tags. Growth to higher power applications; computer laptops / tablets, phones, power-tools, and electric-vehicles. Market growth for conventional Li-ion batteries projected to increase from $44B/yr (2020) to $94B/yr (2025). Replacement solid-state battery market projected to increase from $62M/yr (2020) to $483M/yr (2027).

Contact: Frank Kustas, Chief Technical Officer
fmkustas.nci@gmail.com (303) 910-8463