RQ16-3

AFRL CALL FOR RESEARCH

1. **Research Title:** *Advanced Integrated Smart Cell Onboard Printed Electronics Development*
2. **Individual Sponsor:** Nathaniel R. Smith

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3. **Academic Area/Field and Education Level:** Chemical and Materials Engineering / electrochemistry, Electrical and Electronics Engineering, printed electronics, metal/ceramic processing, interface and colloidal science, modeling/simulation (MS or Ph.D. level)
4. **Objectives:** Next generation aircraft contain a host of system-level power and thermal challenges to enable capabilities such as low-observable electronic attack and electrically-driven directed energy-based self-defense. Energy storage is among the critical technology challenges supporting aircraft power and directed energy weapons (DEWs). Within these operational environments, it is critical to monitor cell telemetry within a battery to ensure efficient and safe operation. State-of-the-art aerospace batteries typically employ custom monitoring electronics which may or may not provide a level or fidelity of data and control detail needed by the Air Force. Battery monitoring system implementations also do not have a standard to follow, causing unnecessary complications and compromised reliability when attempting safe battery integration into an aerospace system. This effort will focus on designing and depositing printed electronics integrated directly onto the packaged cell surface to provide in-situ cell monitoring of temperature, voltage, as well as simple, standardized communication..
5. **Description:** The goal of this 3-year DAGSI project is to investigate methods for designing and printing integrated electronic circuitry to enable safe, self-monitoring power devices. This approach would be scalable into a broad array of components, enhancing the safety, utility, and reliability of aerospace power systems and subsystems. As volumetric and gravimetric power and energy densities of components increase, monitoring electronics are either sacrificed or added as an afterthought. This effort will introduce the integrated monitoring capability much earlier in the design process. DAGSI researchers will assist AFRL in exploring proper materials selection and ink development for use in an aerosol jet printer; optimization and integration of low profile passive electrical components, such as resistors, capacitors, inductors, and thermocouples; and integration of low profile active components (MOSFETs) and communication ICs. Printable, flexible electronics research has been ongoing for a number of years, further reducing risk of successful application to cell substrates. While this technology will specifically impact aerospace battery systems, it may potentially apply to a multitude of industrial and commercial applications.
6. **Reference:** Chang, Joseph, and Zhang, Xi, and Ge, Tong, and Zhou, Jia. "Fully printed electronics on flexible substrates: High gain amplifiers and DAC." *Organic Electronics* 15 (2014): 701-710. ScienceDirect. Web. 10 July 2015.
7. **Eligible Research Institutions:** Indicate to what organizations this topic should be provided

☒ **DAGSI** (Wright State University, AFIT, Ohio State University, University of Dayton, Miami University, Ohio University, University of Cincinnati) NOTE: Topics submitted to DAGSI must be approved for public release. Need PA Approval #88ABW-2015-3697

☒ **AFIT (only)**

☐ **USAFA (only)**

If you are submitting a topic for the USAFA, indicate if you are also interested in sponsoring a USAF Cadet in summer 2015 (Average cost for USAF Cadet for 33 days is $5000)

☐ Yes ☐ No

Public Release Pending