DEFENSE MICROELECTRONICS ACTIVITY (DMEA)
STTR 13.B PROPOSAL SUBMISSION INSTRUCTIONS

INTRODUCTION

The Defense Microelectronics Activity (DMEA) Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) Programs are implemented, administrated, and managed by the DMEA Management Operations and Support Division. If you have any questions regarding the administration of the DMEA SBIR/STTR Program, please contact the DMEA SBIR/STTR Program Manager (PM), Mr. Kevin Rankin, kevin.rankin@dmea.osd.mil.

For general inquiries or problems with electronic submission, contact the DoD SBIR/STTR Help Desk at 1-866-724-7457 (1-866-SBIRHLP) between 8:00 am to 5:00 pm ET. For questions about the topic during the pre-solicitation period (26 July 2013 through 25 August 2013), contact the Topic Authors listed under each topic on the http://www.dodsbir.net Web site prior to the solicitation. Information regarding the DMEA mission and programs can be found at http://www.dmea.osd.mil.

PHASE I GUIDELINES

DMEA intends for Phase I to be only an examination of the merit of the concept or technology that still involves technical risk, with a cost not exceeding $150,000.

A list of the topics currently eligible for proposal submission is included in this section followed by full topic descriptions. These are the only topics for which proposals will be accepted at this time. The topics are directly linked to DMEA's core research and development requirements.

<u>Please assure that your e-mail address listed in your proposal is current and accurate. DMEA cannot be responsible for notification to companies that change their mailing address, e-mail address, or company official after proposal submission.</u>

PHASE I PROPOSAL SUBMISSION

<u>Read the DoD front section of this solicitation for detailed instructions on proposal format and program requirements.</u> When you prepare your proposal submission, keep in mind that Phase I should address the feasibility of a solution to the topic. Only UNCLASSIFIED proposals will be entertained. DMEA accepts Phase I proposals not exceeding $150,000. The technical period of performance for the Phase I should be no more than 6 months. DMEA will evaluate and select Phase I proposals using the evaluation criteria contained in paragraph 6.0 of the DoD Solicitation 13.B preface. Due to limited funding, DMEA reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded.

If you plan to employ NON-U.S. citizens in the performance of a DMEA STTR contract, please identify these individuals in your proposal as specified in Section 5.4.c(8) of the program solicitation.

It is mandatory that the <u>ENTIRE</u> Technical Volume, DoD Proposal Cover Sheet, Cost Volume and the Company Commercialization Report are submitted electronically through the DoD SBIR/STTR Web site at http://www.dodsbir.net/submission. If you have any questions or problems with the electronic proposal submission contact the DoD SBIR/STTR Helpdesk at 1-866-724-7457.

This COMPLETE electronic proposal submission includes the submission of the Cover Sheets, Cost Volume, Company Commercialization Report, the ENTIRE Technical Volume and any appendices via the DoD Submission site. The DoD proposal submission site http://www.dodsbir.net/submission will lead you through the process for submitting your technical proposal and all of the section electronically. Each of these documents is submitted separately through the Web site. Your proposal submission must be submitted via the submission site on or before the 6:00 am deadline on 25 September 2013. Proposal submissions received after the closing date and time will not be considered.

PHASE II GUIDELINES

Phase II is the prototype/demonstration of the technology that was found feasible in Phase I. DMEA encourages, but does not require, partnership and outside investment as part of discussions with DMEA sponsors for potential Phase II efforts.

Phase II proposals may be submitted for an amount not to exceed $1,000,000.

PHASE II PROPOSAL SUBMISSION

The Reauthorization of the SBIR/STTR Program has resulted in significant changes to the Phase II proposal submission process. On December 31, 2011, the President of the United States signed into law the National Defense Authorization Act for Fiscal Year 2012 (Defense Reauthorization Act), Public Law 112–81. Section 5001, Division E, of the Defense Reauthorization Act contains the SBIR/STTR Reauthorization Act of 2011 (SBIR/STTR Reauthorization Act), which extends both the SBIR and STTR Programs through September 30, 2017.

Phase I awardees may submit a Phase II proposal without invitation not later than thirty (30) calendar days following the end of the Phase I contract. The DMEA SBIR/STTR Contracting Officer will provide additional instructions to each of the Phase I awardees before the end of their respective Phase I contract completion dates.

All Phase II proposals must have a complete electronic submission. Complete electronic submission includes the submission of cover sheets, cost volume, company commercialization report, the entire technical volume, and any appendices via the DoD submission site (http://www.dodsbir.net/submission). The DoD proposal submission site will lead you through the process for submitting your technical volume and all of the sections electronically. Each of these documents is submitted separately through the Web site. Your proposal must be submitted via the submission site on or before the DMEA-specified deadline or it will not be considered.

DMEA will evaluate Phase II proposals based on the Phase II evaluation criteria listed in paragraph 8.0 of the solicitation preface.

COST VOLUME GUIDELINES

The on-line cost volume for Phase I and Phase II proposal submissions must be at a level of detail that would enable DMEA personnel to determine the purpose, necessity, and reasonability of each cost element. Provide sufficient information (a through i below) on how funds will be used if the contract is awarded. Include the itemized cost volume information (a through i below) as an appendix in your technical proposal. The itemized cost volume information (a through i below) will not count against the 20-page limit.

a. Special Tooling and Test Equipment and Material: The inclusion of equipment and materials will be carefully reviewed relative to need and appropriateness of the work proposed. The purchase of special tooling and test equipment must, in the opinion of the Contracting Officer, be advantageous to the government and relate directly to the specific effort. They may include such items as innovative instrumentation and / or automatic test equipment. Title to property furnished by the Government or acquired with Government funds will be vested with the DoD Component, unless it is determined that transfer of the title to the contractor would be more cost effective than recovery of the equipment by the DoD Component.

b. Direct Cost Materials: Justify costs for materials, parts, and supplies with an itemized list containing types, quantities, price, and where appropriate, purposes.
c. Other Direct Costs: This category of costs includes specialized services such as machining or milling, special testing or analysis, costs incurred in obtaining temporary use of specialized equipment. Proposals, which include teased hardware, must provide an adequate lease *versus* purchase justification or rationale.
d. Direct Labor: Identify key personnel by name if possible or by labor category if specific names are not available. The number of hours, labor overhead and / or fringe benefits and actual hourly rates for each individual are also necessary.
e. Travel: Travel costs must relate to the needs of the project. Break out travel cost by trip, with the number of travelers, airfare, and per diem. Indicate the destination, duration, and purpose of each trip.
f. Cost Sharing: Cost sharing is permitted. However, cost sharing is not required, nor will it be an evaluation factor in the consideration of a proposal.
g. Subcontracts: Involvement of university or other consultants in the planning and /or research stages of the project may be appropriate. If the offeror intends such involvement, describe the involvement in detail and include information in the cost proposal. The proposed total of all consultant fees, facility leases, or usage fees and other subcontract or purchase agreements may not exceed 30% of the total contract price or cost, unless otherwise approved in writing by the Contracting Officer. Support subcontract costs with copies of the subcontract agreements. The supporting agreement documents must adequately describe the work to be performed (i.e., cost volume). At the very least, a statement of work with a corresponding detailed cost volume for each planned subcontract must be provided.
h. Consultants: Provide a separate agreement letter for each consultant. The letter should briefly state what service or assistance will be provided, the number of hours required, and the hourly rate.

DMEA STTR PHASE II ENHANCEMENT PROGRAM

To encourage transition of STTR into DoD systems, DMEA has a Phase II Enhancement policy. DMEA's Phase II Enhancement program requirements include: up to one year extension of existing Phase II, and up to $500,000 matching SBIR/STTR funds. Applications are subject to review of the statement of work, the transition plan, and the availability of funding. DMEA will generally provide the additional Phase II Enhancement funds by modifying the Phase II contract.

PHASE I PROPOSAL SUBMISSION CHECKLIST:

All of the following criteria <u>must be met</u> or your proposal will be REJECTED.

_____1. Your Technical Volume, the DoD Cover Sheet, the DoD Company Commercialization Report (required even if your firm has no prior STTRs), and the Cost Volume have been submitted electronically through the DoD submission site by 6:00 am ET on 25 September 2013.

_____2. The Phase I proposal does not exceed $150,000.

DMEA STTR 13.B Topic Index

DMEA STTR 13.B Topic Descriptions

DMEA13B-001 TITLE: Electrochemical Micro-Capacitors Utilizing Carbon Nanostructures

TECHNOLOGY AREAS: Materials/Processes, Electronics

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.4 of the solicitation.

OBJECTIVE: Development of a non-Faradic, thin film, electrochemical capacitor-based energy storage system utilizing a nano-structured carbon/ ionic liquid material system with a gravimetric energy density greater than 100 Wh/kg. Novel device architectures such as 3-dimensional or interdigitated arrays are primary areas of interest. Process compatibility with lithographic techniques common to commercial semiconductor processes and printable circuit technology are areas of further interest.

DESCRIPTION: Electrochemical capacitors, informally known as ultracapacitors, are energy storage devices that combine the high energy storage capability of batteries with the high power delivery capability of capacitors. Ultracapacitors have a demonstrated superiority over conventional batteries, in terms of higher power delivery and longer cycle life. The materials utilized in such a device play a prominent role in determining the achievable energy and power densities. High-surface area activated carbon is currently the predominate material used to form the electrodes in macro scale ultracapacitors.

Charge storage in ultracapacitors is generally evaluated by capacitance, which in turn is dependent on the electrode/solution interface. Typical carbon electrodes exhibit poor electrolyte accessibility (low mesoporosity) as a consequence of small pore size in the carbon compared to the larger size of the solvated ions in the aqueous electrolyte. However, recent developments have shown that utilization of carbon allotropes, such as carbon nanotubes (CNTs) and graphene, will result in an electrode with much higher mesoporsity. The manifestation of increased mesoporosity is increased capacitance which results in higher energy density and specific energy. Additionally, carbon allotropes can be chemically modified to increase pseudocapcitance. Graphene monolayers are extremely flexible; thus, micro ultracapacitor arrays created with graphene can be readily incorporated into flexible electronic structures.

A limiting factor in the miniaturization of carbon nanostructure-based ultracapacitior arrays is a relatively low volumetric energy density (Wh/L) due to the rather poor packing density of structures such as tangled CNTs. Typically, the volumetric energy density of current generation CNT-based ultracapacitors is many orders of magnitude lower than mainstream energy storage devices. Thus opportunities for miniaturization of macro-scale ultracapacitors exist with novel designs that strive to minimize intrinsic components such as current collectors and separators that do not directly contribute to the cell energy storage.

The successful solution will meet the following performance metrics:
- Utilize a material system that delivers gravimetric energy densities greater than 100 Wh/kg
- A sustained output voltage of 3 V.
- Minimal performance degradation over a temperature range of -55oC to 125oC
- A minimum volumetric energy density of 400 Wh/L
- Demonstrate no discernible performance degradation to output power and voltage after undergoing a minimum 2,000 and a maximum of 100,000 full charge/discharge cycles.
- A minimum useable lifetime of 5 years

If any of the goals listed above cannot be met, the contractor will present relevant research and establish parameters that are attainable.

PHASE I: The goal of Phase I is to demonstrate, by simulation and direct measurement, a carbon nanostructure/ ionic solution material system that has a gravimetric energy density greater than 100 Wh/kg and an associated volumetric energy density of at least 400 Wh/L. A high level of consideration will be given to achieving the maximum volumetric energy density. The results of a rigorous, analytical simulation methodology shall be substantiated by direct measure of material samples. The simulated and measured data results shall constitute a deliverable item.

PHASE II: Phase II will result in the creation of prototype micro ultra-capacitor cell arrays. Rigorous analytical simulations utilizing both the material system's physical and electrical parameters will be substantiated by direct measure of the prototype cells to demonstrate that the designed ultra-capacitor cells are capable of meeting the performance criteria listed in the description section for the final energy storage device design. Consideration will be given to designs that enhance miniaturization by minimizing intrinsic components that do not directly contribute to energy storage. Production techniques utilized will be compatible with the lithographic techniques found in commercial integrated circuit fabrication processes. The simulated and measured data that prove prototype conformance shall constitute a deliverable item.

PHASE III: Phase III will conclude with the delivery of fully developed and verified pre-production miniaturized energy storage devices capable of meeting all of the performance and process integration metrics described in the preceding sections of this document. Additionally, documentation shall be provided from a certified testing facility that the pre-production devices have undergone and passed environmental testing in conformance with Mil-Std 883. Additional government and commercial customers and applications for the devices will be identified.

REFERENCES:
1. Beidaghi, M. and Wang, C. "Micro-Supercapacitors Based on Interdigital Electrodes of Reduced Graphene Oxide and Carbon Nanotube Composites with UltraHigh Power Handling Performance. Advanced Functional Materials. vol. 22, pp 4501-4510. 2012.

2. Ramesha, G.K. and Sampath, S. "Graphene: Synthesis, Properties, and Phenomena". Wiley-VCH Verlag GmbH & Co. Weinheim, DE. ch 9: "Graphene and Graphene-Oxide-Based-Materials for Electrochemical Energy Systems". 2012.

3. Matte, H.S.S.R et al. "One Dimensional Nanostuctures: Principles and Applications". John Wiley & Sons, Inc, Hoboken, N.J., USA. ch6: "Selected Properties of Graphene and Carbon Nanotubes". 2012

4. An, K.H. et al. Electrochemical Properties of High-Power Supercapacitors Using Single-Walled Carbon Nanotube Electrodes". Advanced Functional Materials, 11 (5) 387-392. 2001

5. Simon P. & Gogotsi, Y. "Materials for Electrochemical Capacitors". Nature Materials, Vol 7. pp 845-854. 2008

KEYWORDS: Energy Storage, Ultracapacitor, Energy Density