Special Notice 12-SN-0003
Special Program Announcement for 2012 Office of Naval Research Research Opportunity: Basic Research Challenge: Carbon Molecular Electronics

I. INTRODUCTION:

This announcement describes a research thrust, entitled "Basic Research Challenge on Carbon Molecular Electronics" to be launched under the ONRBAA12-001, Long Range Broad Agency Announcement for Navy and Marine Corps Science and Technology which can be found at http://www.onr.navy.mil/Contracts-Grants/Funding-Opportunities/Broad-Agency-Announcements.aspx. The research opportunity described in this announcement specifically falls under numbered paragraph 2 of the "Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (Code 31)" sub-section. The submission of proposals, their evaluation and the placement of research grants will be carried out as described in that Broad Agency Announcement.

The purpose of this announcement is to focus attention of the scientific community on (1) the area to be studied, (2) for dialogue amongst those interested in this arena, and (3) the planned timetable for the submission of white papers and proposals.

II. TOPIC DESCRIPTION:

The proposed topic will explore and exploit the possibility of building electronic devices and circuits from the bottom up, using graphene as a platform, with atomic precision and Angstrom resolution. The program will pursue fundamental research toward building carbon based nanoelectronics from the molecular level up, using molecular synthesis, surface catalytic chemistry and other novel techniques.

Background:

The 2010 Nobel Prize for physics was awarded to Prof. Andre Geim and Prof. Kostya Novoselov for isolating and elucidating the peculiar physical properties of two-dimensional material graphene. The application potential of graphene for electronics was recognized early on, due to its record-breaking mobility, thermal conductivity and mechanical strength. However, despite the enormous progress that has been made in graphene research during the last few years, some of the more unusual and exotic properties unique to graphene, such as the predicted edge magnetism and the tunable intrinsic bandgap in graphene nanoribbons, remain poorly understood and awaiting to be exploited for device functionalities. Part of the challenges stem from our inability to control, assemble and synthesize atomically precise graphene nanostructures with desired shape and dimensions. Recent progress in chemical techniques using surface catalysis on metal substrate is highly encouraging. Using copper catalyzed chemical vapor deposition (CVD) technique, single atomic layer graphene sheets as large as 30 inches have been synthesized. On the other extreme, using surface-assisted polymerization of carbon-containing molecular precursors and their subsequent cyclodehydrogenation process, graphene nanoribbons that are 1-

2 nm wide with atomically precise edges, have been reported. These chemical and molecular synthesis techniques show great promise and could enable construction of carbon based electronics all the way from molecular scale building blocks to macroscale gadgets.

Objective:

The Office of Naval Research (ONR) is interested in receiving proposals on carbon-based molecular electronics.

The *objective* of this Basic Research Challenge (BRC) program is to encourage research and innovation in bottom-up chemical synthesis and assembly of carbon, particularly graphene, based electronic devices and circuits with atomic precision and Angstrom resolution.

The program will address the *challenges* and limitations in top-down fabricated graphene nanoelectronic devices, where structures are too large (limited by lithography) and intrinsic graphene properties are often masked by edge roughness and hard to measure.

The *long term vision* of the program is to enable a new kind of molecular electronics – a single giant molecule made of carbon or other related materials that functions as electronic, magnetic or optical devices or circuits. We envision a future when we will build large scale electronic systems in a hierarchical fashion, where nanoscale objects built with atomic precision and up to the size of , say ~ 1 μm, will seamlessly interface with microscale systems, built with top-down lithographic techniques (i.e., top-down meets bottom-up).

Program Focus and Scope:

The current BRC program will emphasize synthesis, characterization (both chemical and electrical) and atomic resolution imaging, of carbon nanostructures with increasing complexity. The initial focus of the program will be synthesis of graphene nanostructures with controllable predetermined shape and atomically sharp edges, e.g., graphene nanoribbons (GNR) a few nm wide and longer than 100nm, and ability to transfer them to non-metallic substrates. As the program progresses, the next levels of complexity will likely be synthesis of molecules that perform as graphene based circuit elements and eventually to rationally design and assemble them into "circuit molecules". In the long term, and possibly beyond this program, will be research on ways to interface the molecularly derived graphene circuit elements and circuits, and impedance match them, with top-down manufactured systems at μm scale. Also of interest to the BRC are opportunities to interface with other molecules, such as other carbon allotropes (CNT, C60, etc.), graphene derivatives (hydrogenated and/or fluorinated graphene) and other closely related non-carbon materials (hBN, Silicene, MoS2, etc.).

III. No workshop will be held for this Special Notice.

IV. WHITE PAPER SUBMISSION

White papers should not exceed 4 single-sided pages, exclusive of cover page and resume of the principal investigator, and should be in 12-point Times New Roman font with margins not less than one inch. The cover page should be labeled "White Paper for ONR 2012 Research Opportunity: Basic Research Challenge: Carbon Molecular Electronics" and include the following information: title of the proposed effort, technical point of contact, telephone number, fax number, and e-mail address. The 4-page body of the white paper should include the following information: (1) Principal Investigator(s); (2) Relevance of the proposed effort to the research areas described in Section II; (3) Technical objective of the proposed effort; (4) Technical approach that will be pursued to meet the objective; (5) A summary of recent relevant technical breakthroughs; and (6) A funding plan showing requested funding per fiscal year. A resume of the principal investigator(s), not to exceed 1 page per co-PI, should also be included after the 4-page body of the white paper.

Although not required, white papers are strongly encouraged for all offerors seeking funding. Each white paper will be evaluated by the Government to determine whether the technology advancement proposed appears to be of particular value to the Department of the Navy. Initial Government evaluations and feedback will be issued via e-mail notification from the Technical Point of Contact. The initial white paper appraisal is intended to give entities a sense of whether their concepts are likely to be funded.

Detailed Full Proposals (Technical and Cost volumes) will be subsequently encouraged from those Offerors whose proposed technologies have been identified through the above referenced e-mail as being of "particular value" to the Government. However, any such encouragement does not assure a subsequent award. Full Proposals may also be submitted by any offeror whose white paper was not identified as being of particular value to the Government or any offeror who did not submit a white paper.

For white papers that propose efforts that are considered of particular value to the Navy but either exceed available budgets or contain certain tasks or applications that are not desired by the Navy, ONR may suggest a full proposal with reduced effort to fit within expected available budgets or an effort that refocuses the tasks or application of the technology to maximize the benefit to the Navy.

White papers should be submitted electronically to the program technical points of contact, Drs. Chagaan Baatar (chagaan.baatar@navy.mil) and Paul Armistead (paul.armistead@navy.mil). These white papers shall be in Microsoft Word or Adobe PDF format.

NOTE: Do not send hardcopies of White Papers (including Facsimiles) as only electronic submissions will be accepted and reviewed; 2) Do not send .ZIP files;
3) Do not send password protected files.

To ensure full, timely consideration for funding, white papers should be submitted **no later than March 8, 2012**. White papers received after that date will be considered as time and availability of funding permit.

The planned date for completing the review of white papers is **March 30, 2012**.

V. FULL PROPOSAL SUBMISSION AND AWARD INFORMATION FOR GRANTS

Full proposals (including one technical volume and one cost volume) should be submitted under **ONRBAA12-001** by **May 1, 2012**. Full Proposals received after that date will be considered as time and availability of funding permit.

ONR anticipates only **grants** will be issued for this effort. All full proposals for grants must be submitted through www.grants.gov. The following information must be completed as follows in the SF 424 to ensure that the application is directed to the correct individual for review: Block 4a, Federal Identifier: Enter N00014; Block 4b, Agency Routing Number, Enter the three (3) digit Program Office Code (ONR Code 312 and ONR Code 332) and the Program Officer's name, last name first, in brackets (Baatar, Chagaan and Armistead, Paul). All attachments to the application should also include this identifier to ensure the proposal and its attachments are received by the appropriate Program Office.

ONR plans to fund two (2) to six (6) individual awards, consisting of both single investigator awards and team awards, using research funds. For single investigator awards, the target annual budget is $150,000 or less. For team awards, a team size of no more than four (4) members with an annual team budget not exceeding $600,000, are desired. However, lower and higher cost proposals will be considered. The period of performance for the projects will be three years, plus two additional years of option period.

Although ONR expects the above described program plan to be executed, ONR reserve the right to make changes.

Funding decisions should be made by **May 15, 2012**. Selected projects will have an estimated award date of **July 1, 2012**.

VI. SIGNIFICANT DATES

Event	**Date**
Recommended White Paper Submission Date	March 8,2012
Notification of White Paper Evaluation*	March 30,2012
Recommended Full Proposal Submission Date	May 1,2012
Notification of Selection: Full Proposals*	May 15, 2012
Awards*	July 1, 2012

Note: * These are approximate dates**.**

VII. POINTS OF CONTACT

In addition to the points of contact listed in ONRBAA12-001, the specific points of contact for this announcement are listed below:

Technical Points of Contact:
Dr. Chagaan Baatar, Program Officer, chagaan.baatar@navy.mil
Dr. Paul Armistead, Program Officer, paul.armistead@navy.mil

Business Point of Contact:
Jennifer Brown, Senior Contracting Officer, Jennifer.brown4@navy.mil

VIII. Submission of Questions

Any questions regarding this announcement must be provided to the Technical Points of Contact and/or the Business Point of Contact listed above. All questions shall be submitted in writing by electronic mail.

Answers to questions submitted in response to this Special Notice will be addressed in the form of an Amendment and will be posted to the following web pages:

- Federal Business Opportunities (FEDBIZOPPS) Webpage – https://www.fbo.gov/
- Grants.gov Webpage – http://www.grants.gov/
- ONR Special Notice Webpage - http://www.onr.navy.mil/Contracts-Grants/Funding-Opportunities/Special-Notices.aspx

Questions regarding **White Papers or Full Proposals** should be submitted NLT two weeks before the dates recommended for receipt of White Papers and Full Proposals.