Final Report

Grant: DE-SC0013773

Date: January 18, 2016

Title: Student Support for EIPBN 2015 Conference - Final Report

New Jersey Institute of Technology
323 Dr. Martin Luther King, Jr. Blvd
Newark, NJ 07102-1982

Principal Investigator:

Reginald C. Farrow, Ph.D.
Department of Physics, New Jersey Institute of Technology
323 Dr. Martin Luther King, Jr. Blvd, Newark, NJ 07102-1982
Tele (973) 596-2473, Fax (973) 596-5794
reginald.farrow@njit.edu

Submitted to:

Department of Energy,
Basic Energy Sciences, Physical Behavior of Materials

Program Manager:

Refik Kortan, Ph.D.
DOE/Basic Energy Sciences, Physical Behavior of Materials
SC-22/Germantown Building
U.S. Department of Energy
1000 Independence Avenue,
SW Washington, DC 20585-1290
Phone: 301/903-3308
Fax: 301/903-9513
Email: refik.kortan@science.doe.gov

I. Introduction

The 59th International Conference on Electron, Ion, and Photon Beam Technology and Nanofabrication (EIPBN) was held in San Diego, CA from May 26 to May 29, 2015. The conference received technical co-sponsorship from the AVS in cooperation with the IEEE Electron Device Society, the Optical Society of America, and the American Physical Society. EIPBN, commonly known as "three beams," is the premier conference for emerging nanoscale lithography and fabrication research, with a particular emphasis on electron, ion and photon-beam technologies (the 3 beams). The conference continued its history of success by bringing together over 500 engineers and scientists in industry, academia, and government from twenty-five countries to discuss 152 oral and 128 poster presentations.

The plenary session featured far-reaching talks from Julia R. Greer (Caltech) concerning 3D meta- materials with remarkable thermomechanical properties, Kevin Gunderson (illumina) about the impact of nanofabrication on scaling genomic assays, and Lynn Rothschild (NASA Ames) regarding 3D printing of biocomposites with an emphasis on doing so away from earth. The conference also featured numerous topics that have become staples at EIPBN including strong sessions on electron beam, ion beam and optical lithography. Directed self assembly-based patterning and nanoimprint lithography continued to produce innovative results, and this year we expanded the content on beam induced deposition and etching. This field has grown steadily in the past decade and has become a vital technique for academic researchers with direct industrial application. Metrology techniques have been presented at EIPBN for several decades; however, 2015 was the first year where developments in high throughput, parallel beam or multiple beam scanning electron microscopy warranted its own session.

Application areas such as nanophotonics, nanobiotechnology and nanoelectronics remain core areas of interest. In 2015 we also introduced a focus session on nanofabrication for quantum computing devices. While experimental quantum computing is certainly not a new field, recent advances have ushered in a resurgence in research on this topic that can greatly benefit from innovations in nanofabrication. Atomic layer deposition (ALD) has become a standard technique in production CMOS and memory device technologies. We included a session this year that focuses on novel patterning and nanofabrication applications of ALD. The conference hosted an especially well attended short-course on state-of-the-art nanofabrication with five instructors from national laboratories and instrument developers. Lastly, the nanoscience user centers sponsored by the U.S. Department of Energy and the U.S. Department of Commerce have long been supporters of EIPBN. A session featuring these centers and results from their users was included to highlight the resources available to researchers in our field.

The 2015 Conference Chairman is Dr. J. Todd Hastings of the University of Kentucky and the Program Chairman is Dr. Michael Guillorn of IBM. The Conference is organized and managed by a Steering Committee, which is incorporated in the state of New Jersey, and fully protected by liability insurance. In addition to the Conference Chair and Program Chair the members of the Steering Committee at the time of the conference were:

Lawrence Muray, Keysight Technology
Stefano Cabrini, Lawrence Berkeley National Laboratory

John Hartley, College of Nanoscale Science and Engineering, Albany
G. Patrick Watson, Princeton University
Theodore Fedynyshyn, MIT Lincoln Labs
Karl K. Berggren, MIT
Leonidas E. Ocola, Argonne National Laboratory
Rebecca Cheung, University of Edinburgh

Students are the lifeblood of the EIPBN conference, in that they both provide a fresh and exciting perspective, and also become the future scientists attending the conference in the future on a regular basis. Financial support provided for their travel came from a mixture of government agencies and corporate donors. The Department of Energy Office of Basic Energy Sciences provided $5,000 to support student travel from US universities to participate at EIPBN 2015 through grant DE-SC0013773.

II. EIPBN 2015 Student Participation

Student presentations are a vital part of the EIPBN Conference. They contain new, innovative approaches to the topics of the conference that are of great interest to the technical community at large. Furthermore, once the students graduate and launch their careers in the field, they become the regular attendees of the conference for years to come. If they become professors, they advise students in turn on projects that address future problems in the field of the conference, and the cycle continues. In this regard, maintaining strong student participation is a requirement for the long-term viability of the conference. Thanks to travel support from EIPBN in combination with a reasonable reduced hotel rate and conference registration rate for students, 106 students attended EIPBN 2015. Students were 21% of the conference attendance, which a healthy participation. Of those students that attended 50 received travel support from EIPBN through sponsors such as the DOE Office of Science. Students were presenting authors on either an oral or poster presentation. This is not surprising, since the time and expense for a student to attend the conference is usually justified only if a paper is to be presented.

This year, as in previous years, the students were offered discounted registration for the conference. The advance student registration rate was set to $275, with the on-site student registration set to $325 (compared to $700 and $750 for regular attendees). EIPBN negotiated an arrangement with the Manchester Grand Hyatt Hotel for a limited number of room nights (50) at the reduced rate of $169 per night for students (compared to the $189 regular conference rate).

Student Financial Support

As in years past, financial support for student travel was provided. The amount funded was chosen to approximately offset air travel. Each supported student receives $500. As part of the conditions for receiving funds, students were:

1) Required to register for the conference, and
2) Asked to volunteer for various tasks that may be available for students.

The tasks we usually ask students to perform at the conference are assisting the session chairs in managing their room, usually helping questioners be heard by running microphones to them.

Students are also asked to help at the set up time the physical posters, putting banners on the poster boards to identify the locations where individual posters are to be placed.

III. Awarding Student Funds

A detailed process was used to decide which student should receive financial support. These steps were listed in detail on the conference website.

Acceptance of Abstract: First, it was required that students have their name on an *accepted abstract* to be considered for travel reimbursement. The decisions about student support were therefore made after the Program Chair had prepared the initial Program.

Request by Professor: Second, the student's *Professor* needed to send a request for financial support to either the Conference Chair or the Program Chair. Requests from students themselves were returned and the students asked to have their professor provide a request. All requests were forwarded to the Conference Chair for final disposition.

Granting: At a predetermined cutoff date all requests for support received for students who were the presenting authors on papers were granted. For EIPBN 2015, awards were offered to 52 students. 50 students accepted the awards and attended the conference.

A variety of universities, countries, and topics were represented among the students receiving support. Students from 8 countries (including the US) and 27 universities were among the recipients of student travel financial support. The students receiving EIPBN 2015 financial support are listed in Table I.

First Name	Last Name	Institution
Arooj	Aslam	New Jersey Institute of Technology
Ferhat	Aydinoglu*	University of Waterloo
Abhijeet	Bagal	North Carolina State University
Jingxuan	Cai	University of Hong Kong
Haogang	Cai	Columbia University
Lingqian	Chang*	Ohio State University
Mikai	Chen*	University of Michigan
Xi	Chen	University of Michigan
Celal	Con*	University of Waterloo
Anarup	Datta	Purdue University
Junjun	Ding	Stevens Institute of Technology
Hyung-Wan	Do	Massachusetts Institute of Technology
Samaneh	Esfandiarpour	University of Kentucky
Rui	Guo*	Auburn University
Sangeetha	Hari	Delft University of Technology
Chirs	Hartnett	University of Tennessee
Sean	Hou	Louisiana State University
Md Tamin	Humayun	University of Illinois at Chicago
Hao	Jiang	University of Massachusetts at Amherst
Golnaz	Karbasian*	University of Notre Dame

Arshad	Khan	University of Hong Kong
Brett	Lewis	University of Tennessee
Jinyu	Liao	Columbia University
Zhongtian	Lin	Rutgers, The State University of New Jersey
Vitor	Manfrinato	Massachusetts Institute of Technology
Johann	Mika	Technical University of Vienna
Joong-Hee	Min	North Carolina State University
Hongsuk	Nam*	University of Michigan
Gaurav	Nanda*	Delft University of Technology
Marc	Papenheim*	University of Wuppertal
Shuang	Pi	University of Massachusetts at Amherst
Michelle	Pillers	University of Notre Dame
Yan	Ran	Delft University of Technology
Diego	Scarabelli*	Columbia University
Mario	Scotuzzi	Delft University of Technology
Mostafa	Shawrav	Technical University of Vienna
Babak	Shokouhi	University of Waterloo
Robin	Singh	Stanford University
Daniel	Staaks	Ilmenau University of Technology
Michael	Stanfor	University of Tennessee
Mansoor	Sultan	University of Kentucky
Atif	Syed	University of Edinburgh
Francesco	Viscomi*	University of Waterloo
Vignesh	Viswanathan	National University of Singapore
Gerward	Weppleman	Delft University of Technology
Sungjin	Wi*	University of Michigan
Robert	Winkler	Graz University of Technology
Pengfei	Xie	Rutgers, The State University of New Jersey
Yujia	Yang	Massachusetts Institute of Technology
Cheng	Zhang	University of Michigan

Table I: Students receiving EIPBN 2015 Student Travel Support. *Students that published papers in the special conference issue of JVST B.

Student Support Grants

Student support was provided from government and corporate sources as shown in Table II. The remainder required to support all first author requests was provided by undesignated sponsorships.

Sponsor	Contribution
National Science Foundation	$15,000
Department of Energy	$5,000
Tokyo Electron	$2,500
Mentor Graphics	$1,000
NuFlare	$1,000
Total	$24,500

Table II: Sponsors of EIPBN 2015 Student Travel Support.

Prof. Reginald Farrow at the New Jersey Institute of Technology solicited funds from the DOE Office of Science. NJIT dispersed the full granted funds to EIPBN 2015 and waived any facilities and administration costs.

IV. Peer-Reviewed Publications from EIPBN 2015

Extended abstracts of papers presented at the conference are available online: http://eipbn.omnibooksonline.com/. All participants that presented papers at the EIPBN 2015 Conference had the opportunity to submit journal articles to a special publication of the Journal of Vacuum Science and Technology B (JVSTB). JVSTB generally publishes those submitted articles that are accepted after peer review in the Nov/Dec issue of the same year as the conference. See JVSTB Vol. 33, No. 6 (http://scitation.aip.org/content/avs/journal/jvstb/33/6)for the EIPBN 2015 published articles. At the time of this report there were 61 papers from the conference submitted for publication from the 2015 conference with 47 accepted and one still in progress. There were 11 papers from students published in the special volume and are listed in the Appedix.

V. Conclusion

The 59th International Conference on Electron, Ion and Photon Beam Technology and Nanofabrication, 2015, held at the Manchester Grand Hyatt in San Diego, CA from May 26 to May 29, 2015 was a great success in large part because financial support allowed robust participation from students. The students gave oral and poster presentations of their research and many will publish peer-reviewed articles in a special conference issue of the Journal of Vacuum Science and Technology B. The Department of Energy Office of Basic Energy Sciences supported 10 students from US universities with a $5,000 grant (DE-SC0013773). On behalf of the Steering Committee of EIPBN I would like to thank DoE for its support of student participation at this very worthwhile conference.

Reginald C. Farrow, Ph.D.

APPENDIX

Publications by EIPBN 2015 Student Travel Award Recipients

High resolution nanofabrication using self-assembly of metal salt-polymer nanocomposite film
Celal Con, Ferhat Aydinoglu and Bo Cui
J. Vac. Sci. Technol. B 33, 06F304 (2015); http://dx.doi.org/10.1116/1.4935654

Bosch etching for the creation of a 3D nanoelectroporation system for high throughput gene delivery
Paul Bertani, Wu Lu, Lingqian Chang, Daniel Gallego-Perez, Ly James Lee, Chiling Chiang and Natarajan Muthusamy
J. Vac. Sci. Technol. B 33, 06F903 (2015); http://dx.doi.org/10.1116/1.4932157

Fabrication and comparison of MoS2 and WSe2 field-effect transistor biosensors
Hongsuk Nam, Bo-Ram Oh, Mikai Chen, Sungjin Wi, Da Li, Katsuo Kurabayashi and Xiaogan Liang
J. Vac. Sci. Technol. B 33, 06FG01 (2015); http://dx.doi.org/10.1116/1.4930040

Analytic estimation and minimization of line edge roughness in electron-beam lithography
Rui Guo, Soo-Young Lee, Jin Choi, Sung-Hoon Park, In-Kyun Shin and Chan-Uk Jeon
J. Vac. Sci. Technol. B 33, 06FD07 (2015); http://dx.doi.org/10.1116/1.4936070

Fabrication of nanodamascene metallic single electron transistors with atomic layer deposition of tunnel barrier
Golnaz Karbasian, Alexei O. Orlov and Gregory L. Snider
J. Vac. Sci. Technol. B 33, 06FG02 (2015); http://dx.doi.org/10.1116/1.4932156

Fabrication and comparison of MoS2 and WSe2 field-effect transistor biosensors
Hongsuk Nam, Bo-Ram Oh, Mikai Chen, Sungjin Wi, Da Li, Katsuo Kurabayashi an Xiaogan Liang
J. Vac. Sci. Technol. B 33, 06FG01 (2015); http://dx.doi.org/10.1116/1.4930040

Helium ion beam induced growth of hammerhead AFM probes
Gaurav Nanda, Emile van Veldhoven, Diederik Maas, Hamed Sadeghian and Paul F. A. Alkemade
J. Vac. Sci. Technol. B 33, 06F503 (2015); http://dx.doi.org/10.1116/1.4936068

Flexible composite stamp for thermal nanoimprint lithography based on OrmoStamp
Marc Papenheim, Christian Steinberg, Khalid Dhima, Si Wang and Hella-Christin Scheer
J. Vac. Sci. Technol. B 33, 06F601 (2015); http://dx.doi.org/10.1116/1.4929885

Fabrication of artificial graphene in a GaAs quantum heterostructure
Diego Scarabelli, Sheng Wang, Aron Pinczuk, Shalom J. Wind, Yuliya Y. Kuznetsova, Loren N. Pfeiffer, Ken West, Geoff C. Gardner, Michael J. Manfra and Vittorio Pellegrini
J. Vac. Sci. Technol. B 33, 06FG03 (2015); http://dx.doi.org/10.1116/1.4932672

Enhanced adhesion of electron beam resist by grafted monolayer poly(methylmethacrylate-comethacrylic acid) brush
Francesco Narda Viscomi, Ripon Kumar Dey, Roberto Caputo and Bo Cui
J. Vac. Sci. Technol. B 33, 06FD06 (2015); http://dx.doi.org/10.1116/1.4935506

Fabrication and comparison of MoS2 and WSe2 field-effect transistor biosensors
Hongsuk Nam, Bo-Ram Oh, Mikai Chen, Sungjin Wi, Da Li, Katsuo Kurabayashi and Xiaogan Liang
J. Vac. Sci. Technol. B 33, 06FG01 (2015); http://dx.doi.org/10.1116/1.4930040