



## **Final Report**

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## **I. Introduction**

The 56<sup>th</sup> International Conference on Electron, Ion and Photon Beam Technology and Nanofabrication (EIPBN), 2012, was held at the Hilton Waikoloa Resort in Waikoloa, Hawaii, May 29 - June 1, 2012. The EIPBN Conference is recognized as the foremost international meeting dedicated to lithographic science and technology and its application to micro and nanofabrication techniques. The conference brought together 483 engineers and scientists from industries and universities from all over the world to discuss recent progress and future trends. Among the emerging technologies that are within the scope of EIPBN is Nanofabrication for Energy Sources along with nanofabrication for the realization of low power integrated circuits. Every year, EIPBN provides financial support for students to attend the conference. The 2012 Conference Chairman is Prof. Reginald C. Farrow of New Jersey Institute of Technology and the Program Chairman is Prof. Michael Fritze of the Information Sciences Institute of the University of Southern California. 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:

Richard Blaikie, University of Otago, Dunedin, New Zealand  
Alan Brodie, KLA-Tencor  
Franklin Schellenberg, Consultant  
Martin Feldman, Louisiana State University  
Rebecca Cheung, University of Edinburgh  
Theodore H. Fedynyshyn, MIT Lincoln Laboratory  
Carl Berggren, MIT

The steering committee and attendees view students as the lifeblood of the 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 to the conference came from a mixture of government agencies and private donors. The Department of Energy Office of Basic Energy Sciences provided \$5,000 to support students from US universities to participate at EIPBN 2012 through grant DE-SC0008346.

## **II. EIPBN 2012 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. Although the location for EIPBN 2012 had great financial advantages for the regular business of the conference, from a student's point of view, it was problematic. Unlike locations in the lower 48 states, students cannot all simply pile into a van and share the drive to the conference city, or share a less expensive room near the conference venue once they arrive. Air travel is the only way to come to Hawaii, with air tickets

running from \$700 to \$1400 and in June alternative accommodations in the area of the conference hotel were limited and expensive. Thanks to travel support from EIPBN in combination with a reasonable reduced hotel rate and conference registration rate for students, 101 students attended EIPBN 2012. Students were 21% of the conference attendance, which was a reasonable participation considering the location and the costs. Of those students that attended 57 received travel support from EIPBN through sponsors such as the DOE Office of Science.

#### *Inexpensive Student Registration Rates*

This year, as in previous years, the advance student registration rate was set to \$200, with the on-site student registration set to \$235. Most students (87, or 87% of student attendees) were 1<sup>st</sup> 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. An additional 9 students were present as co-authors on a paper or poster. Some of these may have actually been presenters, as there was no formal comparison of the program and actual speaker / poster presenter. A breakdown of student registrations by primary conference role is shown in Table II.

Student Roles in EIPBN 2012	USA	Canada	Europe/ Middle East+	Asia/ Pacific	Total
1 <sup>st</sup> Author Oral	30	3	5	7	45
1 <sup>st</sup> Author Poster	19	3	9	11	42
Co-author Oral	5	0	0	1	6
Co-author Poster	3	0	0	0	3
Non-author	2	0	2	1	5
Total	59	6	16	20	101

Table II: Roles of students at EIPBN 2012, correlated with the final Table of Contents in the EIPBN 2012 Program of Abstracts, as distributed by Memory stick at conference registration and online.

#### *Inexpensive housing at the Hilton Waikoloa Hotel and Resort*

EIPBN negotiated an arrangement with the Hilton Waikoloa for a limited number of rooms at the reduced rate of \$135.00 per night for students. As it turned out the hotel relaxed the limitation to allow all of the students that needed accommodations the reduced rate until the hotel eventually sold out. It cannot be stressed how much it meant to the success of the conference to have the students residing in the Hilton Waikoloa in affordable rooms.

#### *Student Financial Support*

As in years past, financial support for student travel was provided. Some of these funds were provided by private companies, other support came from government grants from either the National Science Foundation (NSF) or the Department of Energy Office of Basic Energy Sciences (DoE). The amount funded was chosen to correspond on average to the cost of an air ticket to Anchorage to attend the conference. Many typical conference itineraries were entered into travel websites Expedia.com and Orbitz.com to make this estimate. For students from the US / Canada, the average amount was \$885 with \$700 for west coast locations and \$900 for all others. For students from Europe and Asia, the amount was \$1400. 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. This year, we also used student support at the panel discussion, providing roving microphones to allow questions from the audience to be heard. 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.

*Sorting:* At a predetermined cutoff date, the list of requests received up until that date were sorted using the average reviewer's scores for the abstracts. Abstracts receiving higher scores were ranked higher than those receiving lower scores. If there was a tie for a position in the ranking, the date of the Professor's request was also considered, with earlier requests given precedence over later requests.

*Granting:* The final cutoff was determined by the budget set for student support by the Conference Chair. For EIPBN 2012, awards were offered to 59 students. 57 students were accepted the awards and attended the conference. A listing of the roles receiving student support is shown in Table III below.

Student Support at EIPBN 2012	USA	Canada	Europe/ Middle East+	Asia/ Pacific	Total
1 <sup>st</sup> Author Oral	27	2	1	1	31
1 <sup>st</sup> Author Poster	14	3	6	2	25
Co-author Oral	0	0	0	1	1
Co-author Poster	0	0	0	0	0
Non-author	0	0	0	0	0
Total	41	5	7	4	57

Table III: Distribution of Student Financial Support, compared to student roles determined from final Table of Contents in the EIPBN 2012 Program of Abstracts.

A variety of universities, countries, and topics were represented among the students receiving support. Students from 10 countries (including the US) and 33 universities were among the recipients of student travel financial support. We expect the dominance of US recipients reflects not the quality of abstracts, but the general lack of awareness of the program of financial support among overseas (and at some US) institutions. Some counts showing this distribution are shown below in Table IV.

Number	Affiliation	Country
3	University of British Columbia	Canada
2	University of Waterloo	Canada
1	Peking University	China
1	University of Costa Rica	Costa Rica
1	Friedrich-Schiller-Universität Jena	Germany
1	University of Tübingen	Germany
1	University of Wuppertal	Germany
1	Osaka Institute of Technology	Japan
1	EPFL	Switzerland
2	National University of Singapore	Taiwan
1	University of Edinburgh	United Kingdom
1	University of Nottingham	United Kingdom
2	Auburn University	USA
1	Carnegie Mellon University	USA
1	Colorado State University	USA
2	Columbia University	USA
1	Georgia Tech	USA
5	MIT	USA
1	New Jersey Institute of Technology	USA
1	North Carolina State University	USA
5	Princeton University	USA
2	Purdue University	USA
1	Stanford University	USA
2	Steven's Institute of Technology	USA
2	Texas A&M University	USA
1	University of Houston	USA
1	University of Kentucky	USA
1	University of Maryland	USA
5	University of Michigan	USA
2	University of Notre Dame	USA
2	University of Texas	USA
1	University of Utah	USA
1	Yale University	USA

Table IV: Distribution of Countries and Institutions receiving EIPBN 2012 Student support.

The students receiving EIPBN 2012 financial support are listed in Table V.

Name	Affiliation	Name	Affiliation
Qing Dai	Auburn University	Feliz Yesilkoy	University of Maryland
Xinyu Zhao	Auburn University	Alex Kaplan	University of Michigan
Weihua Hu	Carnegie Mellon University	Jong G. Ok	University of Michigan
Lukasz Urbanski	Colorado State University	Ashwin Panday	University of Michigan
Sunwoo Lee	Columbia University	Young Jae Shin	University of Michigan
Erika Penzo	Columbia University	Yi-Kuei Wu	University of Michigan
Nick Petrone	Columbia University	Golnaz Karbasian	University of Notre Dame
Caitlin Chapin	Georgia Tech	Yuning Zhao	University of Notre Dame
Jae-Byum Chang	MIT	Hsiao-Yu Chang	University of Texas
Corey Fucetola	MIT	Jongho Lee	University of Texas
Vitor Manfrinato	MIT	Precious Cantu	University of Utah
Samuel Nicaise	MIT	Weihua Guan	Yale University
Amir Tavakkoli K. G.	MIT	Shenqi Xie	EPFL
Ross Cohen	New Jersey Institute of Technology	Reinhard Geiss	Friedrich-Schiller-Universität Jena
Xu A. Zhang	North Carolina State University	Zhongkai Ai	National University of Singapore
Shoham Bhadra	Princeton University	Vignesh Viswanathan	National University of Singapore
Hao Chen	Princeton University	Masaru Otani	Osaka Institute of Technology
Fei Ding	Princeton University	Can Li	Peking University
Wei Ding	Princeton University	Jose P. Arrieta	University of Costa Rica
Yixing Liang	Princeton University	Tao Chen	University of Edinburgh
Li Fan	Purdue University	Nikola Vladov	University of Nottingham
Leo Varghese	Purdue University	Ronny Loeffler	University of Tübingen
Zhiping Zhang	Stanford University	Andre Mayer	University of Wuppertal
Xiaoguang Dai	Steven's Institute of Technology	Ali Kashefian Naeni	University of British Columbia
Ke Du	Steven's Institute of Technology	Saloome Motavas	University of British Columbia
Yunbum Jung	Texas A&M University	Parham Yaghoobi	University of British Columbia
Yi-Chen Lo	Texas A&M University	Celal Con	University of Waterloo
Ginusha Perera	University of Houston	Ripon Kumar Dey	University of Waterloo
Carlos Andres Jarro	University of Kentucky		

Table V: Students receiving EIPBN 2012 Student Financial Support.

## Student Support Grants

Student support was provided from government and corporate sources as shown in Table 6.

Sponsor	Contribution
ASML	\$2,500.00
Raith	\$2,000.00
GenISys	\$2,500.00
NanoAndMore USA	\$2,000.00
FEI	\$2,500.00
SEMATECH	\$1,000.00
DARPA, ONR	\$25,000.00
DOE Office of Science	\$5,000.00
NSF	\$10,000.00
EIPBN 2012	\$2,600.00
Total	\$55,100.00

NSF funds were solicited by Prof. Hank Smith of MIT, DOE Department of Science funds were solicited by Prof. Reginald Farrow at the New Jersey Institute of Technology, and DARPA funds were solicited by Prof. Steven Chou of Princeton University. All universities dispersed the full granted funds to EIPBN 2012 and waived any facilities and administration costs.

## **IV. Peer Reviewed Publications from Students that Received Support**

All participants that presented papers at the EIPBN 2012 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. 30, No. 6 for the EIPBN 2012 published articles. There were 116 papers from the conference submitted for publication. Of these 78 articles published in the JVSTB special issue. The following is a list of the published articles of which supported students were at least one of the authors:

### *12 Published Papers from EIPBN Student Grant Recipients*

**New types of dose distributions for vertical sidewall minimizing total dose in 3-D electron-beam proximity effect correction of nanoscale features**, Qing Dai, Soo-Young Lee, Sang-Hee Lee, Byung-Gook Kim, and Han-Ku Cho, J. Vac. Sci. Technol. B 30, 06F307 (2012); <http://dx.doi.org/10.1116/1.4767446> (11 pages)

**Fast simulation of stochastic exposure distribution in electron-beam lithography**, Xinyu Zhao, Soo-Young Lee, Sang-Hee Lee, Byung-Gook Kim, and Han-Ku Cho, J. Vac. Sci. Technol. B 30, 06F308 (2012); <http://dx.doi.org/10.1116/1.4767447> (8 pages)

**Defect tolerant extreme ultraviolet lithography technique**, Lukasz Urbanski, Wei Li, Jorge J. Rocca, Carmen S. Menoni, Mario C. Marconi, Artak Isoyan, and Aaron Stein J. Vac. Sci. Technol. B 30, 06F502 (2012); <http://dx.doi.org/10.1116/1.4758758> (5 pages)

**Dual applications of free-standing holographic nanopatterns for lift-off and stencil lithography**, Ke Du, Yuyang Liu, Ishan Wathuthanthri, and Chang-Hwan Choi, J. Vac. Sci. Technol. B 30, 06FF04 (2012); <http://dx.doi.org/10.1116/1.4757110> (8 pages)

**High-resolution nondestructive patterning of isolated organic semiconductors**, Yi-Chen Lo, Dawen Li, Zhenzhong Sun, Shoieb Shaik, and Xing Cheng, J. Vac. Sci. Technol. B 30, 06FB04 (2012); <http://dx.doi.org/10.1116/1.4757956> (5 pages)

**Silver patterning using an atomic force microscope tip and laser-induced chemical deposition from liquids**, Carlos A. Jarro, Eugenii U. Donev, Mustafa Pinar Mengüç, and Jeffrey Todd Hastings, J. Vac. Sci. Technol. B 30, 06FD02 (2012); <http://dx.doi.org/10.1116/1.4764093> (6 pages)

**High aspect ratio features in poly(methylglutarimide) using electron beam lithography and solvent developers**, Golnaz Karbasian, Patrick J. Fay, Huili (Grace) Xing, Debdeep Jena, Alexei O. Orlov, and Gregory L. Snider, J. Vac. Sci. Technol. B 30, 06FI01 (2012); <http://dx.doi.org/10.1116/1.4750217> (4 pages)

**Via-hole fabrication for III-V triple-junction solar cells**, Yuning Zhao, Patrick Fay, Andre Wibowo, Jianhong Liu, and Chris Youtsey, J. Vac. Sci. Technol. B 30, 06F401 (2012); <http://dx.doi.org/10.1116/1.4754306> (6 pages)

**Optimization of the visibility of graphene on poly-Si film by thin-film optics engineering**, Tao Chen, Enrico Mastropaolo, Andrew Bunting, Tom Stevenson, and Rebecca Cheung, J. Vac. Sci. Technol. B 30, 06FJ01 (2012); <http://dx.doi.org/10.1116/1.4758760> (6 pages)

**Piezoelectrically transduced silicon carbide MEMS double-clamped beam resonators** Boris, Sviličić, Enrico Mastropaolo, Tao Chen, and Rebecca Cheung, J. Vac. Sci. Technol. B 30, 06FD05 (2012); <http://dx.doi.org/10.1116/1.4767441> (7 pages)

**Study of defect mechanisms in partly filled stamp cavities for thermal nanoimprint control**, Andre Mayer, Khalid Dhima, Saskia Möllenbeck, Si Wang, Hella-Christin Scheer, Junji Sakamoto, Hiroaki Kawata, and Yoshihiko Hirai, J. Vac. Sci. Technol. B 30, 06FB03 (2012); <http://dx.doi.org/10.1116/1.4756933> (6 pages)

**Cross-linking control during imprint for hybrid lithography**, Khalid Dhima, Christian Steinberg, Saskia Möllenbeck, Andre Mayer, Si Wang, and Hella-Christin Scheer, J. Vac. Sci. Technol. B 30, 06FB08 (2012); <http://dx.doi.org/10.1116/1.4763357> (6 pages)

Articles that were submitted too late for publication in the EIPBN 2012 Conference Issue of JVSTB or for other reasons the final draft did not make the cutoff date for publication in the special issue are not included in the above list and were not tracked by EIPBN for the purpose of this report. However, historically a portion of those submitted papers that will not appear in the special issue will be published in a later issue of JVSTB.

## V. Conclusion

The 56<sup>th</sup> International Conference on Electron, Ion and Photon Beam Technology and Nanofabrication, 2012, held at the Hilton Waikoloa Village resort in Waikoloa, Hawaii, May 29 to June 1, 2012 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 published 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 20 students from US universities with a \$5,000 grant (DE-SC0008346). 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.