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Alexander Starikov
Jason P. Cain
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Introduction

The 27th conference on Metrology, Inspection, and Process Control for Microlithography was noted for successful exchange of ideas, discussion of challenges and opportunities, and for free-flowing networking with some of the top professionals in the field. Direct engagement and effective dialog with metrology customers across all other conferences at the Advanced Lithography Symposium was instrumental in the increased popularity and the growth of this conference.

One good example of this is the success of joint sessions with other conferences. This year there were two such sessions.

SESSION 5: Accelerated Development of Materials and Processes: Joint Session with Conference 8681 and 8682, a joint session with the conference on Advances in Resist Materials and Processing Technology. Chaired by Clifford L. Henderson and Martha I. Sanchez, this session included presentations on novel uses of metrology technology for characterizing various aspects of photoresist materials:

- "In situ dissolution analysis of half-pitch line and space patterns at various resist platforms using high-speed atomic force microscopy," Julius Joseph S. Santillan, Toshiro Itani [8682-17]
- "Mechanisms of resist pattern size shrinkage caused by electron beam," Seiichi Tagawa, Cong Que Dinh, Satoshi Enomoto, Akihiro Oshima
- "Photoresist shrinkage effects in 16nm node extreme ultraviolet (EUV) photoresist targets," Benjamin Bunday, Cecilia Montgomery, Warren Montgomery, Aron Cepler [8681-18]
- "Precise measurement of photoresist cross-sectional shape change caused by SEM-induced shrinkage," Takeyoshi Ohashi, Tomoko Sekiguchi, Atsuko Yamaguchi, Junichi Tanaka, Hiroki Kawada [8681-19]

SESSION 8: DSA Metrology and Inspection: Joint Session with Conferences 8680 and 8681, a joint session with the conference on Alternative Lithographic Technologies. Back by popular demand and chaired once again by Joy Y. Cheng and Martha I. Sanchez, this joint session covered applications in the emerging field of directed self-assembly (DSA):

- "Defect source analysis of directed self-assembly process (DSA of DSA)" (Invited Paper), Paulina Rincon Delgadillo, Ryota Harukawa, Mayur Suri, Stephane Durant, Andrew Cross, Venkat R. Nagaswami, Dieter Van Den Heuvel, Roel Gronheid, Paul Nealey [8680-20]
- "Line-edge roughness in directed self assembly," Ricardo Ruiz, Lei Wan, Elizabeth A. Dobisz, Kanaiyalal C. Patel, Yves-Andre Chapuis, Taku Iwase, Masaru Kurihara, Hiroshi Yoshida, Thomas R. Albrecht [8680-21]
- "Application of optical CD metrology for alternative lithography," Masafumi Asano, Akiko Kawamoto, Kazuto Matsuki, Stephane Godny, Tingsheng Lin, Koichi Wakamoto [8681-29]
- "Hybrid approach to optical CD metrology of directed self-assembly lithography," Stephane Godny, Masafumi Asano, Akiko Kawamoto, Koichi Wakamoto, Kazuto Matsuki, Cornel Bozdog, Matthew Sendelbach, Igor Turovets, Ronen Urenski, Renan Milo [8681-30]

- "Three-dimensional characterization of block copolymer lithography patterns using resonant x-ray scattering," R. Joseph Kline, Daniel F. Sunday, Wen-li Wu, Gila E. Stein

With nine Keynote/Invited Papers in 2013, the most promising and broadly appealing papers are given the highest visibility and attention. In addition, the best papers of the metrology conference are recognized with the Best Paper Awards.

Starting in 2002, the Diana Nyyssonen Memorial Award has been given each year to the best published paper of the past year conference as selected by the conference program committee. This year, Hitachi High-Technologies America established a generous multi-year sponsorship of the Diana Nyyssonen Memorial Award, adding an honorarium to this prestigious award and we are very grateful for their support.

New this year is the Best Student Paper Award. Established through a generous multi-year sponsorship from KLA-Tencor, this award also features an SPIE citation and an honorarium for the winner. The best student paper is selected by the panel of judges composed of members of the conference program committee, as well as representatives from the National Institute of Standards and Technology (NIST). The Best Student Paper Award judges in 2013 were: Brian Barnes (NIST), Ben Bunday (SEMATECH North), Tim Crimmins (Intel Corp.), Mike Postek (NIST), Matt Sendelbach (Nova Measuring Instruments), Rick Silver (NIST), Costas Spanos (University of California, Berkeley), Alok Vaid (GLOBALFOUNDRIES, Inc.), and John Villarrubia (NIST). Special thanks are also due to John Robinson of KLA-Tencor for coordinating the award-related logistics, enabling smooth on-site student paper evaluations by the judges and selection of the winner, culminating with the Award Ceremony on the last day of the conference.

The winner of the Best Student Paper award at Metrology, Inspection, and Process Control for Microlithography XXVII is Gangadhara Raja Muthinti from University at Albany for his paper 8681-21, "Mueller-based scatterometry measurement of nanoscale structures with anisotropic in-plane optical properties," co-authored with Manasa Medikonda, Jody Fronheiser, Vimal K. Kamineni, Brennan J. Peterson, Joseph Race, and Alain C. Diebold. Congratulations!

Alexander Starikov
Jason P. Cain

The Diana Nyyssonen Memorial Award for Best Paper

Dr. Diana Nyyssonen: 1980
(Image courtesy of Jeffrey Nyyssonen Swing)

Diana Nyyssonen was a pioneer in the field of dimensional metrology.

Her early interests in optics were formed under the tutelage of Professor Edward L. O'Neill at Boston University. In 1965, she went to work for Brian J. Thompson and George B. Parrent, Jr. at Technical Operations, Inc., Burlington, Massachusetts. Diana's knowledge of physical optics and related modeling grew rapidly as she worked on the teams developing the theory of partially coherent imaging, physical models, equipment and applications for the U.S. government, astronomy, and industry. In addition to Brian J. Thompson and George B. Parrent, Diana's professional circle at that time included George O. Reynolds, John B. DeVelis, Adriaan Walther, Philip S. Considine, Richard J. Becherer, and Richard E. Swing.

In 1969, Diana Nyyssonen joined the Image Optics and Photography Section of the Metrology Division at the National Bureau of Standards (NBS), initially working for Calvin S. McCamy on microdensitometry, then on linewidth measurements for integrated circuit manufacturing applications. Sponsored by NBS, Diana also attended the Institute of Optics, University of Rochester at Rochester, New York where Professor B. J. Thompson, Director of the Institute, was her advisor. She completed her Ph.D. in 1975, with her Thesis "High resolution microdensitometry of photographic emulsions" establishing the scientific foundations and the outlook of the things to come. Dr. Nyyssonen's modeling of thin films observed by an optical microscope demonstrated that line (space) width smaller than Rayleigh resolution limit can be measured. She produced linewidth measurements in photomasks with calibration based on physical modeling and first principles, establishing the first critical dimension standards for the microelectronics industry and the foundation of today's dimensional metrology.

Dr. Nyyssonen left NBS in 1985 to form her own metrology company then joined IBM at East Fishkill, New York in 1988. Continuing the development of accurate optical modeling of imaging of thick films with Christopher P. Kirk, NBS and other teams, she started projects on metrology with scatterometry and interference microscopy, modeled imaging in low voltage CD-SEM, and spearheaded the establishment of CD-AFM.

Diana Nyyssonen's personal contributions to the field of dimensional metrology, as well as her collaborations and mentorships in the industry, consortia, and academia, accelerated and influenced the development of basic technology and metrology applications with optical microscopy and scatterometry, SEM, and AFM.

Metrology, Inspection, and Process Control for Microlithography is the leading international forum for the discussion and presentation of technical advances in the broader field of semiconductor metrology. The Diana Nyyssonen Memorial Award for the Best Paper at this Conference recognizes the most significant current contributions.

Due to the Conference's long history, significant attendance and high paper counts, to win this Award requires a very significant new contribution to the field. The selection of the best paper is initiated during the Conference by nomination, followed by extensive review by the Program Committee. It is based on both the technical merit and persuasiveness of the oral presentation and the overall quality of the published paper. Past award winners include leading international researchers in the area of semiconductor metrology and process control whose contributions have fundamentally improved the way semiconductors are manufactured.

We are pleased to honor the winners of the Diana Nyyssonen Memorial Award for the Best Paper of 2012, as well as those who have won in previous years:

2012
Narender Rana and Dario Goldfarb, "Bridging CD metrology gaps of advanced patterning with assistance of nanomolding," Proc. SPIE, Vol. **8324**, 83241M (2012).

2011
Shiano Ono, Miyuki Yamane, Mitsuo Ogasawara, Akira Katakami, Jiro Yugami, Masanari Koguchi, Hiroyuki Shinada, Hiroshi Kakibayashi, Kazuto Ikeda, and Yuzuru Ohji, "High precision edge-roughness measurement of transistor gates using three-dimensional electron microscopy combined with marker-assisted image alignment," Proc. SPIE, Vol. **7971**, 79710M (2011).

2010
David Laidler, Koen D'havé, Anne-Laure Charley, Philippe Leray, Shaunee Cheng, Mircea Dusa, Peter Vanoppen, and Paul Hinnen, "A single metrology tool solution for complete exposure tool setup," Proc. SPIE, Vol. **7638**, 763809 (2010).

2009
Benjamin Bunday, Aaron Cordes, John Allgair, Vasiliki Tileli, Yohanan Avitan, Ram Peltinov, Maayan Bar-zvi, Ofer Adan, Eric Cottrell, and Sean Hand, "Phenomenology of electron-beam induced photoresist shrinkage trends," Proc. SPIE, Vol. **7272**, 72721B (2009).

2008
Alok Vaid, Rohit Pal, Matthew Sendelbach, Shahin Zangooie, Kevin Lensing, and Carsten Hartig, "Scatterometry as technology enabler for embedded SiGe process," Proc. SPIE, Vol. **6922**, 69220U (2008).

2007
Matthew Sendelbach, Javier Ayala, and Pedro Herrera, "Predicting electrical measurements by applying scatterometry to complex spacer structures," Proc. SPIE, Vol. **6518**, 651825 (2007).

2006
Masafumi Asano, Takahiro Ikeda, Toru Koike, and Hideaki Abe, "Inline CD metrology with combined use of scatterometry and CD-SEM," Proc. SPIE, Vol. **6152**, 61521V (2006).

2005
J. S. Villarrubia and B. D. Bunday, "Unbiased estimation of linewidth roughness," Proc. SPIE, Vol. **5752**, 480 (2005).

2004
Christopher P. Ausschnitt, "A new approach to pattern metrology," Proc. SPIE, Vol. **5375**, 51 (2004).

2003
J. S. Villarrubia, A. E. Vladár, and M. T. Postek, "A simulation study of repeatability and bias in the CD-SEM," Proc. SPIE, Vol. **5038**, 138 (2003).

2002
Jon Opsal, Hanyou Chu, Youxian Wen, Y. C. Chang, and Guangwei Li, "Fundamental solutions for real-time optical CD metrology," Proc. SPIE, Vol. **4689**, 163 (2002).

2001
S. Muckenhirn, A. Meyyappan, K. Walch, Mark Maslow, Geert Vandenberghe and Johannes van Wingerden, "SPM characterization of anomalies in phase shift mask and their effect on wafer features," Proc. SPIE, Vol. **4344**, 188 (2001).