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Editors

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Robert J. Socha, ASML US, Inc. (United States)

Introduction

This proceedings volume contains accepted papers from the SPIE conference on Photomask Technology 2012. The conference was arranged through the Bay Area Chrome Users Society (BACUS) and held as part of the 32nd International Symposium on Photomask Technology 10-13 September 2012 in Monterey, California, United States of America.

This year's conference included three invited papers in addition to the annual invited Mask Industry Assessment presentation by SEMATECH, and the best paper by Photo Mask Japan (PMJ) 2012 and a summary of the PMJ 2012 Panel Discussion.

The conference presentations this year were organized in a single track format, allowing every participant the time to get a comprehensive overview of all of the subjects in the field of Photomask. We added electronic voting for best oral paper and a subset of the program committee members selected the best posters. In addition, a Mask Long-Term Durability session was added to encourage focus on this emerging topic. Patterning and Mask Pattern Generators where split into two distinct sessions to allow a more focused discussion on both topics.

One additional highlight of the conference was the keynote presentation by John Chen from NVIDIA. Dr. Chen presented on the importance of the mask and the key role it plays in the lithography process, "The mask has a huge impact if it is not done right". Further he quantified "right" by introducing the three P's: Performance, Precision and Perfection. Showing such linkage between the mask quality and the wafer/chip performance from the view point of the end user was refreshing as it allowed the audience to see how their work is important and valued. In his talk he showed, as an example, the impact of a 1 nm CD variation on the end products. Dr. Chen concluded by reaffirming that the mask and the mask industry are key to the continuation of Moore's Law.

The technical focus of this year's conference has been how to get ready with two technologies in parallel, the arrival of EUV in the mainstream of Mask Technology and the complex extension of Optical Lithography. This is a challenge for the Mask industry as both Litho solutions depend heavily on the Mask readiness. In the 2011 panel discussion titled: "Is it too late for panic?...EUV is real!", the industry consensus was that the mask will not be an obstacle. This year's special session was Optical Extensions. Optical Lithography continues to extend and has surpassed everyone's expectations.

The ability to pattern geometries 10x smaller than the wavelength may need to go a step further! The special session was titled: "Will optical patterning solutions be ready if EUV lithography is delayed?" The session was chaired by Bob Socha and Tom Faure and revealed key mask capabilities and technology plans that can meet that challenge. A group of our industry's top experts were assembled for the discussion:

- Allen Gabor, Senior Patterning Program Manager in Advanced Lithography, IBM Corp.
- Aki Fujimura, Chairman and CEO D2S Inc.
- Yuri Granik, Chief Scientist, Design to Silicon Division, Mentor Graphics.
- Yoshio Kawai, Deputy General Manager, ShinEtsu New Functional Materials Research Center
- Albert Wang, Senior Staff Process Engineer, SanDisk Corp.
- Franklin Kalk, Executive Vice President and Chief Technology Officer, Toppan Photomasks Inc.

We thank all of the participants and especially the authors for providing and discussing their insights. We also thank all of the members of the program committee for their hard work in helping to make this year's conference a success through their efforts which ranged from reviewing abstracts to chairing sessions. Our sponsors also deserve special thanks for their continued support of Photomask Technology. The SPIE organization has our gratitude for their tireless efforts in organizing the conference and ensuring that things ran smoothly as well as their efforts to provide a timely publication of these proceedings. And a special thanks to the BACUS entertainment team who did a fantastic job in bringing back the traditional BACUS entertainment themes!

We hope you find the papers contained in this volume of proceedings to be informative and helpful in your professional endeavors.

Frank E. Abboud
Intel Corporation
Symposium Chair

Thomas B. Faure
IBM Corporation
Symposium Cochair

Thursday Special Session Panel Discussion

Will optical patterning solutions be ready if EUV lithography continues to be delayed?

Panel Moderators: **Thomas B. Faure**, IBM Corporation, **Robert J. Socha**, ASML US, Inc.

If EUV lithography is delayed, lessons learned of extending ArF lithography at the 20nm and 14nm nodes can be applied to the 10nm and 7nm nodes. Most likely the shrink will be enabled by integration of all of the aspects needed to decrease the cost per transistor. These aspects include the mask, the lithography, the EDA, and the design. This panel will focus on the interaction of the mask with lithography, EDA, and design.

In order to focus on the interaction of the mask with integration, the panel will discuss an overview of optical patterning solutions for the 10nm and 7nm nodes for both logic and memory. For these nodes, the mask making challenges will impact the optical lithography extensions which will test and impose limitations on the design and computational lithography ground rules. Furthermore, these issues will require changes in the mask making infrastructure and may require more aggressive mask strategies (PSM rather than binary) and may require a multiple beam mask writer. In order to answer these questions, the panel will discuss these challenges through a diverse group of experts from the mask industry, from the lithography community, from the EDA industry, and from the fabless companies which are end users of the mask.

Panelists:

Allen Gabor, Senior Patterning Program Manager in Advanced Lithography, IBM Corporation
Aki Fujimura, Chairman and CEO, D2S Inc.
Yuri Granik, Chief Scientist, Design to Silicon Division, Mentor Graphics Corporation
Yoshio Kawai, Deputy General Manager, New Functional Materials Research Center, ShinEtsu Chemical Company Ltd.
Tuan Pham, Director of Flash Process & Device Technology, SanDisk Corporation
Geoffery Yeap, Vice President of Technology, Qualcomm Inc.
Franklin Kalk, Executive Vice President and Chief Technology Officer, Toppan Photomasks Inc.

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