

PROCEEDINGS OF SPIE

# ***Alternative Lithographic Technologies III***

**Daniel J. C. Herr**  
*Editor*

**1-3 March 2011**  
**San Jose, California, United States**

*Sponsored and Published by*  
SPIE

**Volume 7970**

Proceedings of SPIE, 0277-786X, v. 7970

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

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Please use the following format to cite material from this book:

Author(s), "Title of Paper," in *Alternative Lithographic Technologies III*, edited by Daniel J. C. Herr, Proceedings of SPIE Vol. 7970 (SPIE, Bellingham, WA, 2011) Article CID Number.

ISSN 0277-786X  
ISBN 9780819485298

Published by

**SPIE**

P.O. Box 10, Bellingham, Washington 98227-0010 USA  
Telephone +1 360 676 3290 (Pacific Time) · Fax +1 360 647 1445  
SPIE.org

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## Introduction

This year's Alternative Lithographic Technologies III conference built on last year's momentum and opened to a standing room only audience of more than 420 colleagues. While challenges remain, each NGL appears to be moving forward toward their niche applications. There seems to be growing support for extensible patterning options to leverage the integration of more than one tool exposure tool option, as suggested by Yan Borodovsky. For example, EUV, 193i double patterning, or imprint may be used to define large arrays of regular features that are selectively cut into desired feature shapes by another imaging process, such as maskless patterning.

The community's sustained support for directed self assembly appears to be gaining traction within the patterning community. Chris Bencher, of AMAT, and Joy Cheng, of IBM, gave a linked pair of talks, which suggested that directed self assembly technology's demonstrated performance, defectivity and process window adds credibility to DSA's position as a potential patterning solution option on the ITRS roadmap. The AMAT study reports the first rather rigorous analysis of DSA related defect levels on 300-mm wafers, in a near manufacturing environment. This study found no DSA related defects on the patterned areas considered, which places an upper limit on DSA defectivity at <25 defects/cm<sup>2</sup>. The follow-up IBM presentation suggests that the status of current DSA technology appears to be similar to that of 193i, at a similar phase of its development. The following EE Times article provides an independent perspective on the status of the emerging alternative lithographic technology:

**Dylan McGrath, "Momentum builds for directed self-assembly."  
EE Times News and Analysis (March 2, 2011). Accessed April 4, 2011.  
<http://www.eetimes.com/electronics-news/4213705/Momentum-builds-for-directed-self-assembly>**

SANTA CLARA, Calif.—Directed self-assembly (DSA)—a technology based on a concept that was virtually unknown outside of research labs a few years ago—has emerged as a legitimate contender for use in future semiconductor manufacturing.

"Directed self-assembly cannot be ignored," said Christopher Bencher, a member of the technical staff at Applied Materials Inc., at the SPIE Advanced Lithography conference here Tuesday (March 1). Bencher further suggested that DSA should be moved from the list of emerging lithography technologies to the "current" technologies list.

At SPIE, Bencher presented data on self-assembly patterning for cells with a half-pitch of less than 15-nm that was collected through a joint project with IBM Research. Bencher noted that while lithographers have been enthusiastic about DSA, the biggest concern has been defect density. Bencher said his project demonstrated the use of DSA to build 12-nm line/space structures across an entire 300-mm wafer with a very low rate of less than 1 percent of "dislocation" defects.

Hundreds of particle defects were also measured during the project, but, according to Bencher, particle defects introduced through the use of DSA are no different than particle defects encountered during the use of any new process technology material and will be reduced through better filtration in the fab. Bencher's project was concerned mainly with dislocation defects because, he said, this is a new type of defect inherent to DSA. "This clearly puts us on a trajectory to make DSA feasible, with fairly good defect control," Bencher said.

In DSA, a block copolymer or polymer blend is deposited on a substrate, usually by spin coating, and subjected to an annealing process that "directs" it to form ordered structures. Researchers say DSA is compatible with conventional 193-nm lithography equipment and would eliminate the need for dual exposure steps.

DSA first landed on the International Technology Roadmap for Semiconductors (ITRS) as a potential solution for leading-edge, critical layer lithography in 2007 and remained part of 2009 ITRS. The technology is also considered complementary to next-generation lithography candidates such as extreme ultraviolet (EUV) lithography and nano-imprint lithography. But even the most enthusiastic supporters of DSA acknowledge that the technology is years away from being used in CMOS production, even in a best case scenario. Defect density is only one of a number of technical hurdles DSA must overcome to be viable in volume production. Yoshi Hishiro, director of R&D at materials supplier JSR Micro Inc., estimated that DSA was at least two to three years away from being used in niche CMOS production.

Attendees at SPIE are nervous about the prospects for EUV, long considered the front runner to replace optical lithography. Intel Corp. hopes to put EUV into production at the 10-nm node, but this week its lithography director said EUV is running late for 10-nm design rule definition. Development of power sources for EUV lithography tools remains behind schedule, and several SPIE attendees expressed concern that EUV was still dealing with "basic physics" issues."

On 2 March, the 2011 Alternative Lithographic Technologies III conference also hosted a panel discussion entitled "Economics of Lithography for Alternative Applications." Historically, cutting-edge lithography has been tailored to projected IC industry requirements. However, these requirements are diverging from those of other emerging application opportunities, such as in the optics, biotechnology, or even the hard disk areas, which are driven by very different economic models. This panel discussion provided a forum to illuminate this blind spot and clarify the projected patterning requirements for these emerging application spaces.

Have we passed the tipping point for one or more of these emerging patterning technologies? That question may best be answered at next year's conference, which promises to deliver new breakthroughs in these alternative technologies and their emerging application opportunities.

**Daniel J. C. Herr**

