GUEST EDITORIAL

IMMERSION LITHOGRAPHY

Surfacing as a strong contender to extend the limits of optical microlithography is immersion lithography. A few years ago, immersion lithography was viewed as a research topic, not a serious method for integrated circuit fabrication. In recent years however, the pace of wavelength transitions has slowed as the development of all aspects of proposed next-generation lithography (NGL) technologies (including optical materials, exposure tools, resists, sources, masks, and pellicles) has not matured at the rate required for insertion to manufacturing. In addition, the economics of lithography have started to force smaller device makers to give up hopes of staying at the very leading edge. Thus, a relatively simple extension of 193-nm lithography using water immersion to increase depth of focus (DOF) at existing apertures and to increase resolution with apertures higher than 1.0 has taken hold of the imagination of many workers in the field. Further, the search is on for optical fluids that can be used to extend 157-nm exposure tools to even finer resolution limits. This special section on immersion lithography has collected many papers from these international efforts to outline the current hot pace of development.

Burn Lin of TSMC, this journal's editor-in-chief and one of the main proponents of immersion lithography, has contributed two papers to this issue. The first deals with the impact of polarization-dependent stray light on lithographic process windows. The second examines DOF issues in multilayered media and demonstrates the DOF improvement expected when comparing immersion to dry (i.e., in air) lithography.

Workers from the University of Wisconsin, the University of Alaska, and the Massachusetts Institute of Technology (MIT) Lincoln Labs (Wei et al.) give a preliminary analysis of the fluid flow characteristics of a liquid between the projection lens of a scanning exposure tool and the silicon wafer.

Biswas and Brueck of the University of New Mexico present a vector simulation study of imaging interferometric lithography as well as projection lithography using dipole illumination for 193-nm water immersion.

Smith and coworkers from the Rochester Institute of Technology present results from research into 193-nm excimer laser immersion lithography at extreme propagation angles, including analysis of polarization effects and the influence of microbubbles on imaging.

Workers from Boston University and MIT Lincoln Labs (Baek et al.) contribute a simulation study of process latitude in 193- and 157-nm immersion lithography.

The impact of scattering of bubbles in water is characterized analytically with Mie scattering theory in the paper by Gau et al. from TSMC.

Accurate measurements of several important optical constants of high-purity water near 193 nm are given in the paper by Burnett and Kaplan from NIST.

The paper by Kunz et al. of MIT Lincoln Labs details the search for suitably transparent fluids for 157-nm immersion. More than 50 flourocarbon liquids were measured for transparency over the range 150 to 200 nm.

A short letter from Nellis and Wei of the University of Wisconsin presents simulations to assess the pressure rise effects of short-duration high-power laser pulses (as typically used in scanners) on water.

In a special subgroup entitled Technology Updates, we have collected three papers that describe the current status to develop commercial tools for immersion lithography. The design of microlithographic projection lenses, both dry and wet, at Carl Zeiss is surveyed in the paper by Ulrich et al. Two major equipment suppliers of microlithographic exposure tools, Nikon (in the paper by Owa and Nagasaka) and ASML (in the paper by Mulkens, Flagello et al.), have contributed articles that describe the challenges and prospects for building immersion 193-nm scanners.

Several papers that did not complete the review cycle in time for this issue are scheduled to be included in the April 2004 issue. I would like to thank Dr. Donis Flagello for his help in putting this special section together. I hope you enjoy reading these papers.

William H. Arnold
Guest Editor

 1537-1646/2004/$15.00