

## Extending Immersion Lithography to 22 nm and Beyond

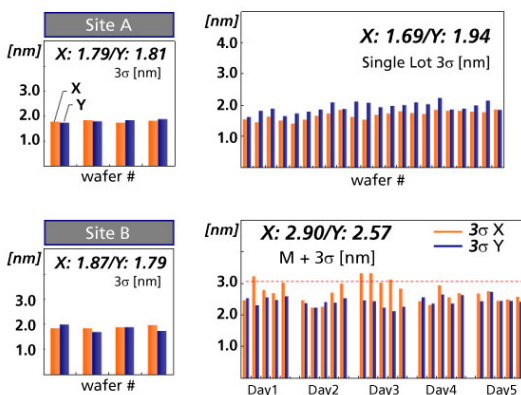
Lithography requirements continue to accelerate, but technical challenges and infrastructure limitations will likely prevent IC manufacturers from adopting EUV lithography (EUVL) until beyond the 20 nm half-pitch. Therefore, it is necessary for leading-edge immersion scanners to both satisfy 32 nm requirements and be extendible to 22 nm applications and below. To successfully extend immersion lithography, today's scanners must provide an affordable lithography solution that delivers high production yields in a timely manner so chip-makers can maximize profits. Nikon developed the NSR-S620D immersion scanner, built upon the

*Streamalign* platform, to not only satisfy the aggressive demands of double patterning (DP) lithography at 32 nm, but also with extendibility for next-generation application. The S620D delivers affordable lithography with ultra-high throughput; maximizes yield through superior overlay and CD uniformity; and ensures the optimal path to profitability with efficient installations, excellent reliability and an extendible platform.

A key challenge for immersion double patterning is affordability, and ultra-high throughput is a critical factor in making DP cost-effective for manufacturing. The S620D wafer stage uses increased scan speed and improved acceleration capabilities to reduce exposure time. Additionally, the Stream Alignment system uses multiple alignment microscopes and Straight Line Autofocus, which maps the entire wafer surface, to dramatically reduce the overhead time. These innovations enable the *Streamalign* platform to achieve 200 wafers per hour, which reduces the cost of ownership. The Stream Alignment system also enables a significant increase in alignment sites with minimal effect on throughput, a vital factor in achieving the productivity and yield necessary for double patterning at 32 nm, and subsequent generations.

The NSR-S620D incorporates the proven Tandem Stage design that utilizes a single exposure stage to optimize accuracy

### Single Machine Overlay and Stability



The NSR-S620D has demonstrated superior overlay accuracy (< 2 nm) and stability at 700 mm/sec scan speed.

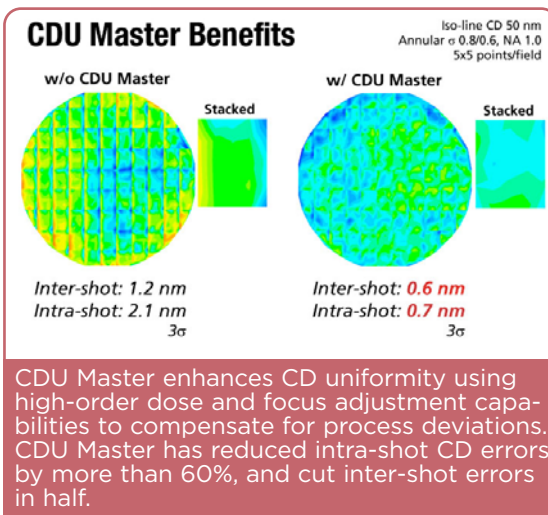
and stability, and eliminates grid matching errors associated with the use of dual exposure stages. Because interferometers alone cannot sufficiently measure stage position to satisfy DP requirements at 32 nm and below, the Bird's Eye Control system uses laser encoders with the interferometers to accurately determine wafer position, independent of potential air fluctuation effects. Together, these innovations enable 2 nm overlay performance with optimal stability, and provide superior focus control. Across-wafer focus variation less than 13 nm (including edge-die) and focus stability within  $\pm 5$  nm over a two-week period have been demonstrated. These overlay and focus performance capabilities enable the S620D to deliver maximized yield for 32 nm applications and beyond.

The NSR-S620D also incorporates a multi-axial catadioptric lens with a 1.35

numerical aperture (NA) to support double patterning for 32 nm and future technology generations. To optimize imaging, enhanced lens materials were developed to reduce S620D thermal absorption by 40 percent compared to the S610C. Such improvements have yielded a lens design with extremely low aberration levels (total RMS average of fifteen S620D lenses is  $< 0.7$  nm) and minimized local flare. In addition, the sophisticated S620D Quick Reflex deformable mirror system enables on-the-fly astigmatism control, while the CDU Master function enhances CD uniformity using high-order dose and focus adjustment capabilities to compensate for process deviations and further increase yield.

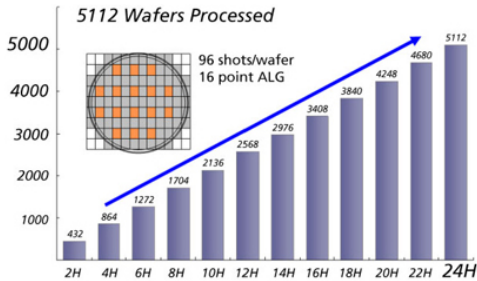
To extend immersion lithography to 22 nm and beyond, the newest scanners must also provide the optimal path to profitability for IC makers. The NSR-S620D utilizes the Modular<sup>2</sup> Structure, which streamlines system installation to minimize the time to begin production, simplifies system maintenance and repairs, and contributes to multigenerational use of this platform with specific individual modules able to be upgraded to support tool extendibility. These critical-layer scanners must also have excellent reliability, and the NSR-S620D has processed more than 5100 wafers per day.

The NSR-S620D uses a 1.35 NA lens and the *Streamalign* platform to deliver the yield, affordability and path to profitability necessary to extend immersion lithography to 22 nm and further. Stream Alignment is combined with other system enhancements





## 5000 WPD In-house Processing



The S620D has processed more than 5100 wafers per day using a single exposure stage system.

to enable 200 wafers per hour throughput and low cost of ownership, while Bird's Eye positioning, advanced aberration control and innovative focus/dose tuning functions support optimized yield for DP applications to  $\leq 22$  nm. In addition, the simplified Modular<sup>2</sup> Structure of the S620D streamlines installation and maintenance to ensure maximum profitability for chip manufacturers.

Given the EUVL technology and infrastructure development delays, as well as the capital cost of lithography scanners, it is critical that today's immersion systems are extendible to 22 nm production and beyond. The Nikon NSR-S620D has achieved 32 nm DP performance objectives, and the innovative *Streamalign* platform enables immersion lithography extension to  $\leq 22$  nm.

Nikon Corporation is a worldwide leader in lithography equipment for the microelectronics manufacturing industry with more than 8,000 exposure systems installed worldwide. Nikon offers the most extensive selection of production-class steppers and scanners in the industry. These products serve the semiconductor, flat panel display (LCD) and thin-film magnetic head (TFH) industries. Nikon Precision Inc. provides service, training, applications and technical support, as well as sales and marketing for Nikon lithography equipment in North America.

### **Takao Naito**

*Chief Executive Officer and President*

### **Hamid Zarringhalam**

*Executive Vice President,  
Technology, Sales, and Marketing*

### **Nikon Precision Inc.**

1399 Shoreway Road  
Belmont, CA 94002  
Toll-free 800.44.NIKON  
Phone 650.508.4674  
npicom@nikon.com  
www.nikonprecision.com