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Sematech Advances Feasibility of 193 nm Immersion Lithography for 45 nm

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Sematech researchers have successfully used 193 nm immersion technology (193i) at 1.3 numerical aperture (NA) with azimuthal polarization to pattern features narrower than 45 nm half-pitch in multiple orientations simultaneously. Azimuthal polarization allows for aggressive imaging of arbitrary circuit features beyond simple line-and-space test patterns.

The milestone, announced this week at the 3rd International Symposium on Immersion Lithography here, was reached by a team of engineers and technicians at International Sematech North – part of the Albany NanoTech complex within the College of Nanoscale Science and Engineering of the University at Albany, NY.

Sematech team members utilized an Exitech immersion projection microstepper with 1.3 NA in combination with optical proximity correction (OPC) and other resolution enhancement techniques (RETs) to simultaneously image sub-45 nm linewidths along X and Y axes within the same field. The resulting "pitch," or width of a single line and its adjoining space, was 84 nm.

For 1.3 NA imaging, this is the only OPC model to have been validated against experimental results. "Imaging at 84 nm pitch provides Sematech members with patterning capability beyond anything they are able to obtain on projection exposure tools today," said Andrew Grenville, associate director of Sematech's Lithography Division.

"Semiconductor circuit designs contain complex patterns beyond simple line-and-space resolution gratings," said Grenville. "With this toolset, we are demonstrating feasibility that 193i can be used for 45 nm half-pitch manufacturing."

Lithography Director Michael Lercel added, "This isn't a beauty pageant; we are trying to image real, relevant circuit patterns here."

Leading chip-makers currently are producing advanced semiconductors at 65 nm, with 45 nm manufacturing slated to begin volume production in 2010. Many lithographers consider 193i the leading candidate for manufacturing at that technology level.

Grenville said the Sematech team also employed resist stack optimization of dual-layer bottom anti-reflective coating (BARC) systems in combination with OPC and RET strategies to reach the 45 nm milestone. Experimenters selectively rotated linear-polarized light at the coherence aperture to simultaneously image the sub-45 nm features.

Beyond the 45 nm half-pitch, Sematech has a significant focus on understanding the ultimate limits of 193 nm lithography, especially with respect to high-index materials which may extend 193i to 32 nm. Information generated through this program will enable members to accelerate strategic investment decisions on future lithography technology.

Preparing 193i for manufacturing insertion is among Sematech's top technology challenges, which also include development of infrastructure for photomasks and extreme ultraviolet (EUV) lithography. Sematech helped pioneer the investigation of 193i at the first Immersion Technology Workshop in December 2002, and has continued to drive the industry towards a manufacturing solution.

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