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'Doped water' could extend 193-nm immersion litho

By David Lammers, EE Times
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LOS ANGELES — Researchers speaking here at the International Sematech Immersion Lithography Workshop said they are investigating liquids that may work better than purified water for 193-nm immersion scanners for processing chips.

Bruce Smith, a professor at the Rochester Institute of Technology, said he has studied various forms of "doped water" that have a higher index of refraction than the 1.43 of water. By mixing water with sulfates, alkilis such as cesium, or various phosphates, Smith said he has created ionized liquids that could serve to extend 193-nm immersion lithography.

"As long as we don't poison our graduate students, we might as well go ahead and try it," Smith said, drawing laughter from the nearly 300 attendees at the immersion workshop on Tuesday, Jan. 27th.

Smith and his colleagues at RIT — backed by grants from the Defense Advanced Research Projects Agency, the Semiconductor Research Center, Dutch lithography vendor ASML, and others — have developed several experimental immersion scanners. Most recently, they have begun working with a 193-nm immersion microscanner, with a field size of about 2 mm. Called the "AquaCat," the system adds water supply and retrieval capabilities to an Exitech microscanner equipped with a Corning-Tropel lens with a numerical aperture of 1.05.

Smith showed patterns with 38-nm lines and spaces at the workshop. He said liquids with a refractive index of 1.6 could extend immersion 193-nm scanners to a 30-nm half pitch, which would serve the industry for the 32-nm node expected to enter early manufacturing at the end of this decade.

That would set up a competition between 193-nm immersion and the extreme ultraviolet (EUV) lithography being promoted by Intel Corp.

Will Conley, a Motorola assignee to International Sematech, said while Smith's group is pursuing inorganic additives to water, a team at Sematech is working with organic materials. "We are trying to seed the idea of other fluids for depth of focus improvements," Conley said.

As light passes through air, the index of refraction is zero, which increases to 1.43 as light passes through purified water. The bending of light rays as they pass through a roughly 1-mm film of water between the lens and the wafer promises to extend the resolution of 193-nm lithography, with a significant boost in the depth of focus.

Conley said if the index of refraction for doped water could be improved to 1.53, it would result in a further 10 percent increase in the depth of focus, compared with water as the immersion fluid. That jumps to a 20 percent improvement for a liquid with a 1.6 index of refraction, which several researchers mentioned as a possible target.

Karen Brown, who headed up Sematech's lithography program from 1994 to 1998 before becoming deputy director of the National Institute of Science and Technology (NIST), said the new liquids are encouraging. "Immersion with water is going to happen over the next two years. But if adding cesium or one of several other additives helps the industry extend 193-nm, then people will do that. It provides an affordable form of lithography," said Brown, who is now a consultant based in Austin, Texas.

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