RIT demos 38-nm resolutions with 193-nm immersion

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ROCHESTER, N.Y.--Pushing the theoretical limits of optics, Rochester Institute of Technology (RIT) next week will disclose that it has demonstrated image resolutions down to 38-nm with a prototype 193-nm immersion lithography tool.

The breakthrough indicates that immersion lithography is advancing much faster than previously thought and the technology has the potential to scale down far below the 45-nm node. It also implies that the technology could push out the need for 157-nm or extreme ultraviolet (EUV) technologies, according to analysts.

In immersion lithography, the space between the projection lens and the wafer is filled with a liquid. Immersion technology could offer better resolution enhancement and higher numerical apertures (NA) over conventional projection lithography.

RIT has built its own, prototype immersion "microstepper," which has a field size of 2-mm and an NA of 1.25. The 193-nm prototype tool has demonstrated the ability to print lines and spaces down to 38-nm in the lab, said Bruce Smith, associate dean of the College of Engineering and the Intel Professor of Microelectronic Engineering at RIT.

The results imply that immersion is a "strong candidate" for the 35-nm node, which is slated for the 2011 to 2013 time frame, Smith said. "This represents the best results of any group to date," he said. "We're on the edge of the theoretical limit," he told *Silicon Strategies* in an interview.

RIT will disclose its results at the Immersion Workshop in Los Angeles from January 26-27. Last year, RIT disclosed that it had received funding from ASML Holding NV, International Sematech, and the Semiconductor Research Corp. (SRC) to develop technologies based on immersion lithography. RIT also disclosed it had developed two internally-developed, immersion scanners, capable of printing 70-nm (half-pitch) images (see Febrary 27, 2003 story). The Defense Advanced Research Projects Agency (DARPA) is also funding the RIT project, it was noted.

Since last year, RIT has apparently made several strides in the arena. The university has demonstrated sub-45-nm resolutions with its own, 193-nm "wet" tool, based on an excimer laser developed by GAM Inc.

The university is also working with photomask and photoresist suppliers as well. It is working with Photronics Inc. on the photomask front and Clariant, Shipley, and Tokyo Ohka Kogyo on the resist side of the equation.

With its prototype tool, RIT is taking somewhat of a different approach to immersion. The R&D tool makes use of a single dispersion head or nozzle to introduce water to the wafer. "We're using small volumes of water," Smith said.

Until now, there were two schools of thought in terms of how vendors would introduce water to the wafer in immersion lithography: bath verses shower. ASML, for one, believes the "shower approach" is more viable than the "bath" technique (see December 3, 2003 story).

RIT also claims to have resolved one of the biggest fears in immersion--microbubbles. To solve this issue, the liquid goes through a "double boiling method" before it is introduced to the wafer. In doing so, "the water is de-gassed, where no bubbles exist," he said.

Most agree that 193-nm immersion will make use of pure water. But the next step is to improve what researchers call the refractive index of water. Researchers are looking to develop additives in order to improve the index, which, in turn, could propel immersion technology even further down the scaling curve, Smith said. "We could extend 193-nm technology for a long, long time," he added.

Still to be seen, however, is when immersion will be inserted in projection fabs. "I don't want to speak for ASML, Canon, or Nikon, but the early tools will be out within one year to 18 months," he said. Production tools are not expected to be out until 2006, it was noted.