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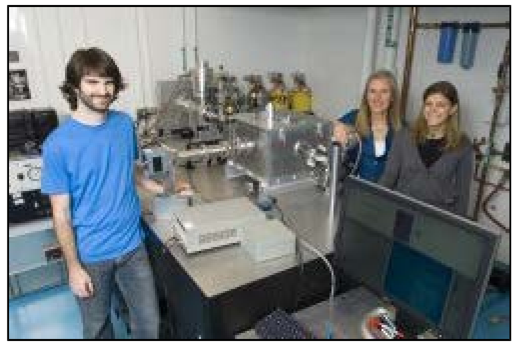
Electrical engineering scientists create high-resolution microscope



Colorado State University engineering researchers, working with counterparts at the University of California, Berkeley, and Lawrence Berkeley National Laboratory, have created the **world's highest spatial resolution extreme ultraviolet (EUV) tabletop microscope that can see objects more than 1,000 times smaller than the diameter of a human hair**.

Semiconductor manufacturers could someday buy the microscope to test for flaws in the masks used to print microchips, which continue to get smaller as technology improves. Currently, this type of experiment is only possible at large light factories called synchrotrons.

The technology involves the manipulation of short wavelength light in the extreme ultraviolet or soft X-ray range of the electromagnetic spectrum with wavelengths 10 to 50 times shorter than visible light.

Using tabletop extreme ultraviolet lasers, the microscope can view features on samples as small as 38 nanometers (billionths of a meter). A typical laboratory microscope can view objects 500 nanometers in size. A human hair is about 60,000 nanometers.

"**There are potentially numerous applications** for this type of technology, especially within the semiconductor industry," said Carmen Menoni, an electrical engineering professor and faculty member in the National Science Foundation's Extreme Ultraviolet Engineering Research Center based at Colorado State.

By 2009, six major technology companies, including IBM, Motorola and Intel, plan to produce computer technologies using EUV light that will allow them to fabricate chips with speeds exceeding 20 GHz - about 10 times faster than existing technologies.

Industry could potentially use a compact EUV microscope to inspect microchip masks for flaws before they're used as the pattern to print millions of semiconductor wafers.

How the microscope works: Extreme ultraviolet laser light is produced in a vacuum chamber where air has been removed to minimize absorption. The light from the laser, in the form of a thin pencil-like beam, is collected by a lens and focused onto the object. The image of the object is then projected by another lens onto a camera, which transfers the image to the computer screen for viewing.

"Our efforts are directed at developing the technology necessary to create a compact EUV microscope that can be easily used by technicians and scientists in their own laboratories," said Courtney Brewer, a graduate student working with Menoni in the center at Colorado State.

This spring, Brewer presented a paper on the microscope at the Conference on Lasers and Electro-Optics in Long Beach, Calif., a forum where the latest breakthroughs in optics and photonics science are reported. Her paper had been selected as a conference highlight - one of six out of 1,700 submissions.

This project is a collaborative effort. Colorado State developed the laser and the microscope for this project; Berkeley researchers created the lenses used in the microscope.

The NSF originally awarded the 5-year, $17 million EUV Engineering Research Center (ERC) in October 2003; in April, NSF renewed it for an **additional $12 million until 2011**.

The EUV ERC combines the complementary expertise of researchers at Colorado State, Berkeley and the University of Colorado-Boulder who are among the world leaders in developing compact extreme ultraviolet coherent light sources, optics and optical systems for nanoscience and nanotechnology applications. Principal investigators include Colorado State Professors **Jorge Rocca** and **Carmen Menoni**, the University of Colorado's Margaret Murnane and Henry Kapteyn, and Berkeley's David Attwood and Erik Anderson. The center also has significant national laboratory and industry involvement. The largest computer chip manufacturers - Intel and Advanced Micro Devices Inc. - are already industrial associate members of the EUV ERC.

In addition to the NSF grant creating the EUV ERC, the team of Menoni, Rocca and Professor Mario Marconi at Colorado State and Murnane and Kapteyn at the University of Colorado recently received a **$900,000 NSF Major Research Instrumentation award** to assist their research in EUV source development. The grant is good through September 30, 2007.

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