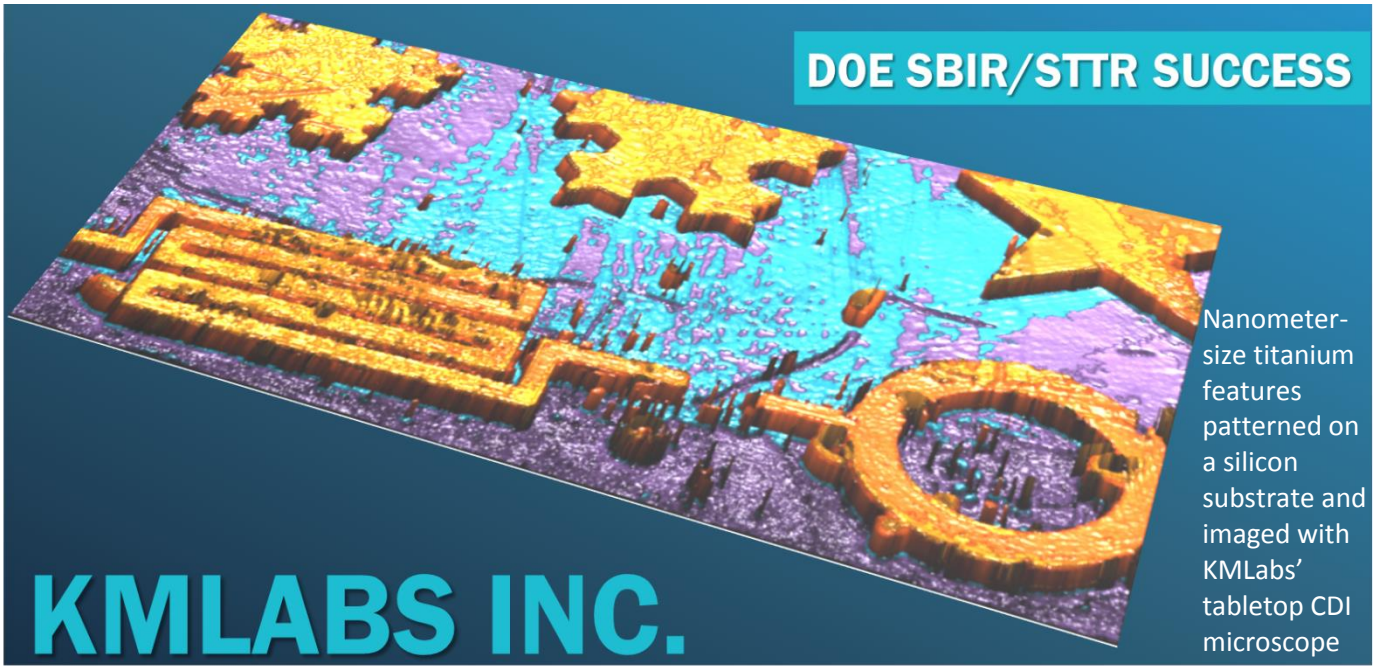
SBIR·STTR America's Seed Fund

U.S. DEPARTMENT OF ENERGY | SBIR/STTR Programs Office

DOE SBIR/STTR SUCCESS



KMLABS INC.

Nanometer-size titanium features patterned on a silicon substrate and imaged with KMLabs' tabletop CDI microscope

KMLabs offers a clear demonstration that commercial success can originate directly from fundamental physics research, even when demand for a product comes predominantly from the scientific community. Kapteyn-Murnane Laboratories LLC or KMLabs, Inc. was founded in 1994 by two physics professors at University of Colorado, Henry Kapteyn, now KMLabs' CTO and co-chairman of the board, and Margaret Murnane, current board member. The idea of creating a company came because of overwhelming requests from other universities and scientific institutions to get help, information, and parts in order to reproduce Kapteyn's and Murnane's scientific achievement—the first ultrafast laser capable of pulses lasting just 10 femtoseconds, something considered esoteric until then.

FACTS

PHASE III SUCCESS

KMLabs product sales reach $ 14 Million.

KMLabs secured >$ 13 M in two rounds of investment led by Intel Capital

IMPACT

Femtosecond-pulse EUV and soft X-ray table top sources are the next generation materials characterization tool enabling 3D, fast, element sensitive and high resolution imaging and for future nanofabrication and metrology needs.

DOE OFFICES

Office of Basic Energy Sciences (BES), Office of High Energy Physics (HEP).

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The significance of such a fast laser is that, thanks to a nonlinear optical process known as high harmonic generation (HHG), the laser light can be "upgraded" to radiation with a much shorter wavelength—from extreme ultraviolet (EUV) light to soft X-rays. The result is a coherent, high-power X-ray source with femtosecond to attosecond pulse duration, which instead of being part of a synchrotron research facility, can now fit on a table top or even in a suitcase.

Thanks to the great advances in recent years in another technology called coherent diffraction imaging (CDI), a coherent X-ray source can be used for imaging, with resolution limited only by radiation wavelength, due to absence of any lenses and their unavoidable aberrations. All of this translates in a tabletop, nanometer resolution, 3D microscope that offers elemental and compositional contrast, captures heat, spin, and charge flow, all with a time resolution of 10 fs. We can imagine taking movies of molecules and their interactions, and electronic processes in devices—something previously simply impossible. KMLabs has already demonstrated many of these capabilities with the newly introduced XUUS4™ (eXtreme Ultraviolet Ultrafast Source) light source but additional technical developments will allow for high rep-rates (faster movies), smaller sizes, and lower costs.

In addition, KMLabs' X-ray microscope does not have high vacuum requirements and can be engineered to operate at ambient pressure to image biological processes in animals and humans in real time and at the cellular level. This instrument will revolutionize medical imaging of the brain and other organs and will not be more expensive than today's widespread medical MRI and CT scanner machines.

This is only an example of the applications KMLabs' products can find in the industry and outside of the research labs. In fact, one of the major commercial successes for KMLabs came two years ago in the form of a first round of investment from Intel Capital**,** with participation from The Colorado Impact Fund, to scale up its manufacturing capability and accelerate product development. The reason why a corporation like Intel is very interested in KMLabs esoteric X-ray lasers is that these machines can provide a better, faster and cheaper way to perform the so-called blank defect inspection in semiconductor chips that end up in today's computers and cell phones.

Nondestructive, comprehensive inspection of Si chips becomes more critical each year as the nanoelectronics industry pushes patterning and lithography techniques to higher limits in order to produce solid state components of only a few nanometers in size. Inspection of nanoscale defects that can interfere with performance is very expensive and nowadays is considerable bottleneck in production. This is because conventional diagnostic techniques can more or less address one material property at the time, and separately. As an alternative, KMLabs' X-ray microscope can address future nanofabrication needs by imaging the entire device through its depth, visualizing at the same time properties such as structural defects, surface morphology, interdiffusion at buried interfaces, chemical composition, magnetic properties, heat flow, etc. in a comprehensive 3D picture with nanometer lateral resolution.

KMLabs has come a long way since its founding in 1994 and today, with 35 employees, a new state-of-the-art, 21,000-square-feet facility, a number of prestigious awards and publications, KMLabs is a leader in its sector, offering the widest range of ultrafast lasers in the industry. As Prof. Kapteyn and Dr. Sterling Backus, KMLabs' Chief Scientific Officer, openly acknowledge, this expansion would have not been possible without the DOE SBIR/STTR program. Starting from the first prototype for a Ti : sapphire laser to any of the following critical innovations in laser medium, cryogenics, imaging components, high harmonic source and more, all aspects of KMLabs' technology were developed leveraging several SBIR awards

starting in 2002 with a grant from the Department of Defense and following on with 6 Phase II SBIR awards from the Office of Basic Energy Sciences (BES) and the Office of High Energy Physics (HEP) of the Department of Energy (DOE). As of today the sales of products developed by KMLabs through DOE SBIR/STTR R&D have reached a total of $ 14M. KMLabs proudly defines itself as a company with a strong program of SBIR/STTR-funded research. “This means,” Dr. Backus points out, “that SBIR government grants are leveraged with a clear strategy for moving from research to industrial markets. 80% of the company resources are employed towards the goal of product sales in commercial markets in the U.S. and abroad. This is achieved with the help of a newly acquired business team with expertise in sales and marketing of lasers and other advanced technologies, and by forming and maintaining strong customer relationships at all stages.”

The XUUS4 tabletop X-ray generator is used together with the CDI method to provide nanometer resolution 3D tomography images.

Written By Claudia Cantoni, Commercialization Program Manager, DOE SBIR/STTR, April 2018.