Energetiq Technology Inc.: From Semi Fab to **Bio Lab**

The Energetiq management team stands in front of their clean manufacturing facility. Paul Blackborow, CEO (left); Donald Smith, president; and Debbie Gustafson, vice president of sales and marketing.

Courtesy of Energetiq

Lisa Robillard

This company takes a customer-first approach to creating and manufacturing efficient, high-brightness, laser-driven light sources—with applications in the semiconductor industry, analytical spectroscopy and the life sciences.

Energetiq Technology was established fairly recently—in 2004—yet the core team of scientists and engineers has been developing technical products for more than 20 years. The company's founders first met decades ago when they worked together in a small start-up called ASTeX. That company developed plasma products that generate high fluxes of chemical species for etching and deposition processes in the semiconductor industry.

ASTeX grew to be very successful. It had an IPO and was later acquired by the semiconductor industry giant MKS Instruments. "We were very happy working for MKS, but we eventually felt that it was time to get back to our small company roots and build a new business where we could rapidly develop new products and technology that we could apply to emerging problems," said Paul Blackborow, cofounder and CEO of Energetiq. After an amicable departure from MKS, Energetiq founders Don Smith, Paul Blackborow, Matt Besen, Ron Collins and Steve Horne set out to realize their new vision. They were soon joined by Debbie Gustafson, a former manager at ASTeX.

"Throughout our tenure at ASTeX and MKS, our team developed complex, highly reliable subsystems and successfully delivered thousands of them to customers all over the world," said Blackborow. Today, those products are still operating in semiconductor fabrication facilities, and they include the founders' core technologies of high-power plasma physics, plasma chemistry, power engineering, thermal management and gas control.

The EQ-99FC laser-driven light source with fiber-coupled output.

Courtesy of Energetiq

URL:	www.energetiq.com
Headquarters:	Woburn, Mass., U.S.A.
Products:	Light sources within the soft-X-ray, extreme ultraviolet, deep ultraviolet, visible and infrared regions of the spectrum
Founded:	2004
CEO:	Paul Blackborow
Number of employees:	20

The founders searched for opportunities within the semiconductor industry to develop new applications using plasma sources, this time not for generating chemical radicals, but for generating photons. Don Smith, cofounder, president and chief technologist at Energetiq came up with the idea to create a plasma light source for lithography. After combing through existing optics research, Smith and the rest of the development team applied their plasma expertise and sparked a radical invention—the "Electrodeless Z-Pinch" extreme ultraviolet (EUV) light source.

Within a short time, Energetiq's light source was widely adopted within the semiconductor industry for use in next-generation extreme ultraviolet lithography. Today it is considered an industry standard for metrology applications for the 13.5-nm wavelength. Shortly after the EUV product was introduced, a semiconductor customer approached Energetiq with a request to modify the EUV product in order to create a much higher brightness light in the deep ultraviolet.

The team was eager to try a modification, but they soon discovered that a first principles approach was the best way to move forward. Eager to meet their customer's need, the team did more research as well as a series of experiments. As a result, the laser-driven light source (LDLS) was born.

The technology in the LDLS uses a laser to heat a xenon plasma to the high temperatures needed for efficient light production—high enough to deliver a relatively flat output spectrum down to 170 nm in the deep ultraviolet. In traditional approaches such as xenon or mercury arc and deuterium lamps, the brightness, UV power and lamp lifetime are limited by the use of electrodes that couple power to the plasma.

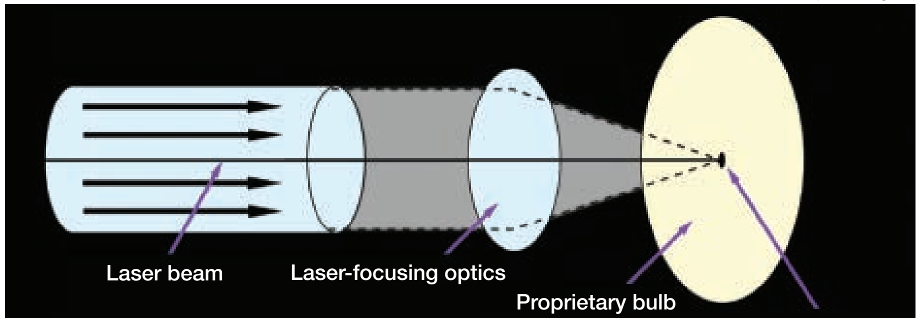
The electrodes limit the brightness in part by restricting the temperature of the plasma. Since the electrodes run hot, they continuously erode, depositing electrode material on the bulb wall. This redeposition causes the output of the lamp to decrease continuously, forcing customers to replace the lamp perhaps every 1,000 hours and to perpetually adjust their instruments.

Xenon, mercury and deuterium arc lamps typically have arc sizes in the millimeter range, reducing the efficiency of optical coupling to sub-mm-width spectrometer slits or sub-mm optical fibers. However, by using a laser to directly heat the plasma, the electrodeless LDLS creates high-brightness plasma with dimensions of approximately 100 µm. This allows for efficient light collection and coupling to the optical instrument. The broad spectral range from the deepest UV bands through the visible and into the infrared results from the higher plasma temperature.

In addition, the electrodeless design removes the major source of failure for traditional electrode-driven lamps—the erosion of the electrodes and the consequent coating of the bulb with light-absorbing electrode material. The LDLS demonstrates a lifetime of at least 10× that of traditional lamps. This long life translates into a lower cost of ownership. In addition, ultrahigh brightness, especially in the deep UV, enables a new class of more sensitive instruments.

LDLS technology is now used in volume production within the semiconductor industry for advanced inspection and metrology applications. After this first iteration of LDLS, the Energetiq team began looking at how they could grow beyond the semiconductor market. The cyclic nature of that industry can make it difficult for small companies to gain traction in the marketplace.

Courtesy of Energetiq



The LDLS focuses a laser to make a 100-µm-diameter high-intensity plasma light source.

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The team realized that the properties of the LDLS—ultrahigh brightness, extremely long life and broad wavelength range—could also be beneficial in analytical spectroscopy. "Many manufacturers of analytical instruments were relying on light sources, like xenon arc and deuterium lamps, that had been invented decades before and were in a mode of modest performance improvement only," Blackborow said. He also noted that other companies were perpetually changing the lamps on their instruments—a step that is necessary with conventional light sources but one that customers aren't typically thrilled about.

By contrast, the initial light sources developed by Energetiq for semiconductor applications were in the kW range of laser power. It wasn't clear that the team could lower the power and cost to levels that would be acceptable to the analytical instrument industry. For the LDLS, Energetiq embarked upon a one-year accelerated development program to meet that challenge and scale output down to tens of watts.

After spending much time with potential analytical instrumentation and listening to their customers talk about desired performance specifications, Energetiq introduced the lower-power LDLS products EQ-99 and EQ-1500 in January 2010. Since then, sales of the product line have grown steadily, and the products have been used in a wide variety of advanced analytical and imaging applications, such as HPLC, materials testing, environmental analysis and advanced microscopes.

As a result of customer collaboration, Energetiq released a version of the EQ-99 with a fiber-coupled output in January of this year. In addition, the EQ-99 LDLS was recognized by Laurin Publishing and Photonics Media as one of 2010's innovative products, winning the Prism Award for Photonics Innovation this past January.

Looking ahead, Energetiq plans to continue supporting analytical instrumentation OEMs by integrating LDLS into their next-generation products. The company will also reach out to researchers around the world to identify applications in the life and materials sciences that can be enabled by LDLS technology.

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