

LIGHT AGE, INC.

Exploiting Alexandrite's Unique Properties for a Less Expensive, More-Reliable Tunable Laser

Lasers today drive many devices throughout the consumer and commercial worlds. There are tiny ones in printers and CD-ROM players, small ones in medical instruments and large ones in satellite communications systems. Besides coming in different sizes, lasers vary in the wavelength and strength of the light they produce. In almost all applications, the wavelength and power of the beam are fixed.

COMPOSITE PERFORMANCE SCORE

(based on a four star rating)

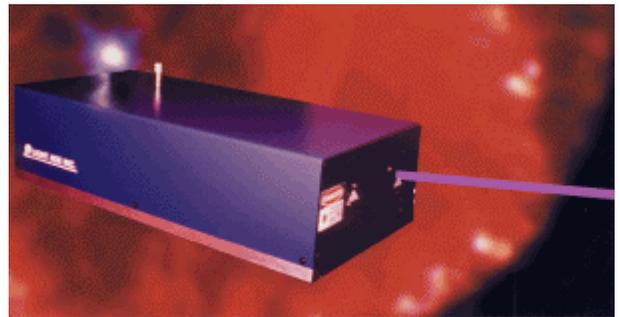
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Tunable Lasers for Many Uses

This ATP project with Light Age, a small privately held company, developed a convenient, reliable, tunable, compact laser source of ultraviolet (UV) light suitable for spectroscopy, medical applications, photochemical research, electronics fabrication, and laboratory studies of atomic and molecular science. Of particular importance, the new laser can be tuned to the shorter UV wavelengths known as vacuum UV (VUV) light.

The new device is the brightest (most powerful) available tunable source of laser light over much of the UV spectrum.

Light Age was founded in 1985 by two scientists who, at AlliedSignal, had pioneered and managed the development of a tunable-wavelength laser based on the alexandrite crystal. The new light source developed in the ATP project offered improvements over the AlliedSignal technology and is less expensive, operationally simpler and more reliable than other tunable laser light sources. It uses the fundamental output of the alexandrite laser, which is broadly tunable between 700 and 800 nanometers (nm). That output is then converted to UV wavelengths of 190-200 nm, 240-270 nm or 350-400 nm. The new device is the brightest (most powerful) available tunable source of laser light over much of the UV spectrum.



The Pal/Pro UV laser system, tunable to 248 nanometers, 193 nanometers, and other ultraviolet wavelengths.

Surgery and Photolithography

The new tunable laser is particularly promising for corneal sculpting and angioplasty because it provides the control needed for these advanced applications. Its advantage stems from the fact that laser beams of certain wavelengths affect some tissue types but not others. The laser can be tuned, for example, to the wavelength of a light beam that destroys diseased tissue while leaving healthy tissue undamaged.

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PROJECT HIGHLIGHTS

Project:

To develop a safe, compact, convenient, reliable, less-expensive, broadly tunable laser source of ultraviolet (UV) light — particularly at shorter UV wavelengths — suitable for use in science, medicine and photolithography.

Duration: 4/1/1991 — 9/30/1993

ATP Number: 90-01-0212

Funding (in thousands):

| | | |
|---------|---------|-----|
| ATP | \$1,965 | 49% |
| Company | 2,067 | 51% |
| Total | \$4,032 | |

Accomplishments:

Light Age accomplished its R&D goal. The company also:

- introduced several new or improved laser products incorporating the ATP technology, including:

UVo™ — a continuous-wave, diode-pumped, solid-state laser producing UV light, PAL/UV™ — a solid-state laser source of 193-nanometer light, and PAL/PRO™ — a narrow spectral bandwidth version of the PAL™ laser;

- increased revenues an average of 50 percent per year since the end of the ATP project in 1993, with 1997 revenues exceeding \$2.8 million on sales of lasers incorporating the new technology; and

- received more than \$10 million worth of product orders, which are currently being filled.

Commercialization Status:

Light Age lasers incorporating the ATP-funded tunable-laser technology are being sold and put to use in academic R&D and in clinics, hospitals and doctors' offices around the world.

Outlook:

Prospects for wider use of this technology are promising, particularly in medicine for corneal sculpting and angioplasty. Products based on the ATP-funded technology may generate large payoffs to the U.S. economy in science, health care and electronics manufacturing. The company's lasers are also being used in studies to refine and extend global weather prediction methods. If atmospheric research using the new lasers leads to improved weather forecasts, the benefits in this area alone could be huge for businesses and individuals worldwide.

Number of Employees: 10 at project start, 28 at the end of 1997.

Composite Performance Score: * *

Company:

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Another, quite different potential application is in photolithography equipment for the production of faster, higher-density, next-generation computer chips. Shorter-wavelength light is needed to produce the finer features on these chips. And reliable lasers that can generate shorter-wavelength light are needed to move beyond this manufacturing choke point. As recently as 1995, almost all chip photolithography used light in the near-UV range (around 350 nm) produced by UV light bulbs. Today, the industry is rapidly moving toward deep-UV laser sources that produce light at 248 nm. Future generations of computer chips may require VUV laser sources that produce light at wavelengths of about 193 nm or even shorter.

Large Benefits to Intermediate Users and Customers

Light Age makes UV and VUV lasers costing \$20,000 to \$200,000. They are used in applications such as health care and scientific equipment that may generate big payoffs to the economy as a whole. In most of these

payoffs to the economy as a whole. In most of these markets, the company's technology faces global competition. Nonetheless, Light Age is already a significant exporter of laser systems for scientific and medical applications and expects strong, continued growth of these exports.

Economic benefits are accruing to intermediate customers and end users of the new technology in medical applications. Many applications of the new laser technology are in environments such as medicine and weather forecasting, where the economic benefits to others besides Light Age are likely to be large.

Light Age is already a significant exporter of laser systems...

Potential for Improved Weather Prediction

The company's lasers are being used in institutional and government research on the upper atmosphere to refine and extend global weather prediction methods. In these applications, lasers are a required technology. The research uses UV lidar (light detecting and ranging) to illuminate particular atoms in the mesosphere — about 70 miles above the earth. Specific effects of the illumination are viewed with powerful telescopes, recorded and used to determine the temperature of the environment at that altitude.

This research aims to develop methods for measuring the temperature and wind speed at very high altitudes. Current measurement systems mainly use only ground-level data. Researchers believe that data on several atmospheric strata measured at selected points around the earth could significantly improve the quality of the very large weather prediction computer models now in use. If research using the tunable laser does lead to better weather predictions, the benefits would likely be huge for businesses and individuals not just in the United States, but around the world.

The tunability of the alexandrite laser from Light Age has made this new research feasible. To show their effects, different types of atoms must each be illuminated by a lidar laser of a specific wavelength. With the Light Age laser, that wavelength can be set by a technician using conventional controls. Alternative laser sources for this research are hand-constructed for just one wave-length, which limits their use and makes them much more expensive than the mass-produced Light Age lasers.

Greater Sales and Revenues

Light Age has done well commercially. The company has expanded product offerings and increased sales each year since beginning the ATP project in 1991. The new technology helped Light Age boost revenues an average of more than 50 percent per year after completing the project in 1993. In 1997, the company generated more than \$2.8 million in revenues and, at the beginning of 1998, had back orders worth more than four times its 1997 sales.

Light Age sees itself as an up-by-your-own-bootstraps company in terms of finances. A large part of its success comes from paying detailed attention to financial management, tightening its budgetary belt, retrenching temporarily when needed, pushing new technology-driven products through to market and staying in product areas where its strengths lie. The company has adopted a stringent approach to financial matters, plowing all earnings back into additional research. ATP's participation compelled Light Age to

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adopt rigorous financial discipline during the company's early development in order to meet the ATP requirement for cost sharing. The belt-tightening was difficult for Light Age in the short run, company officials say, but served the long-term interests of the company.

The ATP funds enabled Light Age to double its research budget during the funding period, a move that allowed the research and development work to be completed 12 to 36 months sooner than it would have been without the award. In addition, company officials say, the visibility generated by winning the ATP award helped Light Age establish agreements with research partners and, coupled with the success of the ATP project, enabled it to secure additional funding from private investors.