GELTECH INCORPORATED

Making Low-Cost, High-Quality Glass Microlenses at Low Temperature

Tiny lenses and other micro-optical components appear in many industrial products such as sensors, laser systems, detector arrays, and fiberoptic data links. Tens of millions of these components are produced every year. Many are made of plastic, are of low quality, and cost little. Others made of silica glass are higher quality, but they cost much more than plastic lenses.

COMPOSITE PERFORMANCE SCORE
(Based on a four star rating.)
★ ★

Technology for Making Small, Complex Silica Micro-Optics

This ATP project with Geltech, a small Florida company, developed a novel method for producing low-cost, high-quality silica-glass microlenses based on "sol-gel" technology pioneered by the company. Geltech was founded in 1985 to commercialize micro-optics technology (dealing with light wavelengths in the range of nanometers to hundreds of microns) discovered at the University of Florida, and it holds exclusive licenses for patents assigned to the university.

. . . the technology could not produce refractive microlenses at a cost low enough to penetrate this market . . .

Casting Silica at Room Temperature

Silica cannot be used with traditional molding techniques because of its very high melting temperature. In addition, conventional grinding and polishing processes limit how small and complex the silica micro-optics can be. Geltech overcame these problems by developing methods to cast net-shape (no grinding necessary) silica-glass micro-optics at room temperature using sol-gel technology.

In the sol-gel process, silicon alkoxides are formed into larger molecules (polymerized) and combined with a liquid in a suspension, or sol, that is cast in a mold at room temperature to make a rigid, wet gel. The gel, in turn, is dried, strengthened and densified at high temperature into a pure, highly homogeneous, silica-glass structure. The ATP project demonstrated that fully dense silica glass — hard, transparent, nonporous glass with a density of two grams per cubic centimeter — can be produced by this process with a quality similar to that of the best fused silica glass.

Signs of Initial Technical Success

Near the end of the ATP project, five of the company's prototype refractive lens devices were tested by a customer and found to perform satisfactorily. In addition, the Army recently gave Geltech a Small Business Technology Transfer Research Phase II award for research using technology partly developed with the ATP funding. Under the contract the company will build prototype windows molded in silica using the sol-gel process. The windows are designed to protect military personnel from intense laser pulses.

. . . used some of the ATP-funded technology to develop a porous-glass product, which has been introduced to the market as a component of a home sensor for toxic gases.

PROJECT HIGHLIGHTS

PROJECT:
To develop a method of casting net-shape (no grinding necessary) pure silica glass micro-optics at room temperature.

Duration: 4/5/1993 — 7/4/1995

ATP Number: 92-01-0074

FUNDING (in thousands):

ATP	$1,323	48%
Company	1,456	52%
Total	$2,779	

ACCOMPLISHMENTS:
Geltech demonstrated that high quality, silica glass micro-optics can be produced by a manufacturing process that includes a room-temperature, net-shape casting method. Also, in activities related to the ATP project, the company:

- had five prototype refractive lens devices tested by a customer and found to perform satisfactorily;
- used the technology to develop diffraction gratings, for use in conjunction with lasers in optical systems, with market introduction just beginning;
- used some of the ATP-funded technology (materials processing and mold fabrication methods) to develop a porous-glass product, which has been introduced to the market;
- used the procedures for making optical-quality molds, developed in the ATP project, as initial steps toward commercialization of plastic micro-optics;
- increased revenues from less than a quarter million dollars in 1992 to $5 million in 1995, with the new technology playing a significant role in the company's revenue growth; and
- recently received a Small Business Technology Transfer Research Phase II award from the Army for research using technology developed in the ATP project.

COMMERCIALIZATION STATUS:
Commercialization of refractive microlenses, one of the major products envisioned in the ATP project, has not occurred because the technology did not produce microlenses with a high enough surface quality to penetrate this market. Geltech began using the ATP-funded technology in 1994 to produce a porous-glass product for a home sensor application, with production reaching a peak of about 500,000 parts per week at the end of 1995 and sales achieving significant levels. Although today the sales of products derived from the ATP technology are relatively small, sales of diffraction gratings — the second major micro-optics product envisioned in the project — have just begun.

OUTLOOK:
Despite the successful commercialization of other products using the ATP technology, it is too early to tell when refractive microlenses will enter the commercial marketplace or whether commercialization of diffraction gratings will succeed. However, if the cost per piece of diffractive gratings continues to drop and Geltech succeeds in selling large volumes of them, producers and users of systems that contain optical components such as printers will benefit from parts that are smaller than their refractive counterparts or that perform functions not possible with refractive parts. Users of one device already on the market, a home sensor product for detecting toxic gases (details are still confidential), are already benefitting from the technology.

Composite Performance Score: ★ ★

COMPANY:
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Number of employees: 7 at project start, 65 at the end of 1997

Secondary Products

Although the ATP-project demonstrated that high-quality, silica-glass micro-optics can be produced by the sol-gel process at low temperature, the technology could not produce refractive microlenses at a cost low enough to penetrate this market. Therefore, the company has been as yet unable to commercialize microlenses produced by the new process.

The company, however, succeeded in using the new technology to produce diffraction gratings, its second major product, with acceptably high surface quality and at reasonable cost. A diffraction grating is a band of equidistant parallel lines (usually more than 5,000 per inch) ruled on a glass or polished metal surface and used to break a beam of light into components of different wave lengths. The company has just begun to offer parts to customers for use in conjunction with lasers in optical systems. It is too early to tell whether commercialization of its diffraction gratings will succeed. Acceptance of this product in the marketplace has taken longer than anticipated.

Geltech also used some of the ATP-funded technology — materials processing and mold fabrication methods — to develop a porous-glass product, which has been introduced to the market as a component of a home sensor for toxic gases. The details of this application are still confi-

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dential. The company is also using some of the technology to develop plastic micro-optics, which are lighter and less expensive than glass micro-optics, with hopes for commercialization in consumer products in the near future.

Geltech officials say the ATP funding helped the company form alliances with research partners and enabled it to conduct research it would otherwise have been unable to do. The funding was also critical in helping Geltech survive as a company. Geltech more than doubled its revenues over the ATP grant period, and the new technology played a significant role in boosting the company's revenues from less than a quarter million dollars in 1992 to about $5 million three years later.

Potential Broad Applications

If the unit-cost of diffraction gratings continues to drop and Geltech succeeds in selling large volumes of them, producers and users of systems that contain optical components will benefit from components that are smaller, lighter and less expensive than their refractive (light-bending) counterparts. In addition, diffractive parts may perform functions not possible with refractive parts. Geltech's sales are small at this point, and specific applications are still in the testing stage, but the potential broad applications and benefits are there.

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The new gelcasting process technology can be used in manufacturing microlenses, microlens arrays, beam splitters and other micro-optics, and the company anticipates moving into these markets when it is economically feasible to do so. The technology has already been applied to refractive lenses, diffraction gratings, and porous glass optics. It might also be used for producing ceramic packages (casings for chips in computers and communications equipment) in electronics manufacturing and for applications in the global surveillance and communications fields.