IBM CORPORATION

Methods for Making New Optical Switches

Information is transmitted in a variety of ways in a developed economy: by surface mail, telephone, facsimile, e-mail, radio and TV broadcast, and data downloading. Several technologies are useful for each type of transmission, and in some instances, both electrical and optical methods can be used. Optical transmission has a signal-quality advantage over electrical transmission in cable TV, telephone trunk lines, undersea cables and other cable applications.

COMPOSITE PERFORMANCE SCORE
(based on a four star rating)
* *

Faster, Cheaper Optical Transmission of Data

Optical fiber is rapidly replacing metal wires in terrestrial and oceanic transmission, both for voice and data, because of cost savings and improved performance. Optical methods also have a potential advantage for transmitting information from component to component within computers. If optical signals could replace electrical signals in this context, bandwidth could be multiplied many fold, while heat generation and cross-talk — significant problems in computers — could be greatly reduced.

New Optoelectronic Polymer and Prototype Switches

IBM's ATP project aimed to develop optical switches to link the optical fibers running between components in computers. Current-generation switches convert data

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from an optical to an electrical signal, do the necessary switching, and then convert the data back to an optical signal, a process that involves expensive components and significantly limits the speed of the system.

IBM's proposed technology would help achieve the technical advantages of optical signals over electrical signals in computers. IBM researchers succeeded in developing high-speed, inexpensive optoelectronic switches using nonlinear optical polymeric waveguides suitable for use in the data communications industry.

.... this technology...may...be useful in telecommunications, rather than computers.

Specifically, the project developed a general method for identifying and synthesizing particular dipolar molecules, known as chromophores, that are chemically stable at temperatures exceeding 300 C. Researchers were able to incorporate these molecules into thermally stable polymers, producing the desired optoelectronic polymer.

Market Fails to Materialize as Expected

Commercialization by IBM is not expected in the foreseeable future, even though IBM completed working prototypes of polymeric switches. The need for such switches in the envisioned application changed, and a broad market opportunity did not materialize. Technological change in this industry is rapid, and trends can suddenly switch directions.

PROJECT HIGHLIGHTS

Project:
To develop a low-cost, near-net-shape gelcasting process for making structural ceramics in a safer, less-costly way than conventional gelcasting based on acrylamide, a cumulative neurotoxin.
Successful development of this process would open the door to commercial gelcasting production of these high-performance ceramics.

Duration: 7/1/1992 — 6/30/1995
ATP Number: 91-01-0017
Funding (in thousands):

ATP	$1,136	56%
Company	884	44%
Total	$2,020	

Accomplishments:
AlliedSignal achieved its R&D goal. The company also:
- presented the new technology at several professional conferences;
- invested after the ATP project another $3 million of its own money on additional gelcasting R&D aimed at the development and installation in 1998 of an automated gelcasting system that can fabricate ceramic automotive turbogenerator wheels at a rate of 10,000 per year; and
- received funding from the Department of Energy and the Defense Advanced Research Projects Agency to further advance gelcasting technology, with the specific goal of establishing viable manufacturing processes.

Commercialization Status:
Commercialization is in progress, and the first gelcast parts made with the new technology are expected to reach the market very soon. Opportunities exist for commercialization in a variety of fields.

Outlook:
The company is making excellent progress toward its commercialization goals and is expected to start producing gelcast parts in large volume in the near future. Users of vehicles or equipment made with gelcast ceramic parts will benefit from lower cost and better performance, with potentially huge benefits accruing in areas like auto engines, commercial aircraft and industrial applications such as stationary power generation.

Composite Performance Score: * *

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New Opportunities Arising

The rapid expansion of digital data transmission, however, is likely to open up opportunities for low-cost, high-speed optoelectronic switches in the future, and devices based on polymeric materials are viable candidates. Thus, chances are good that this technology will ultimately be used in important applications. Of the six key researchers on the project, five have left the company for other jobs. Knowledge spillover may occur elsewhere, as these researchers use their knowledge of the technology in new applications. They conjecture that the technology may be useful in the near future in telecommunications, rather than in computers. One potential application, according to project researchers, is in wavelength division multiplexing (sending light of more than one wavelength through a single optical fiber), where the technology might provide significant enhancements for high-speed, broad-band telecommunications. Another possible application is in microprocessor chip-to-chip interconnects, but semiconductor industry experts suggest that the need for those interconnects may not become apparent for 10 or more years or might not ever arise.

No broad market benefits have emerged yet, because there are no commercial products incorporating the technology, either in the intended or other applications. It is likely, however, that the rapidly expanding use of digital data communication will lead to opportunities for low-cost, high-speed optoelectronic switches in the future.

The support enabled company researchers to publish more than 20 papers in professional journals, enabling the technology to be disseminated among other researchers.

The ATP-funded technology is a core technology for the polymeric materials and devices that IBM demonstrated, these products have potential in a number of future applications.

Through its research under ATP funding, IBM was able to gain access to cutting-edge work being done on optoelectronic devices at the University of Colorado. The support enabled company researchers to publish more than 20 papers in professional journals, enabling the technology to be disseminated among other researchers. The knowledge gains are well documented.

Figure 1 Patent Tree for Project Led by IBM Corporation: Citations by Others of IBM Corporation Patents