subsequent commanding success of Ajinomoto Co.

Japan's remarkable achievements in the study of amino acids following the development of its modern chemicals technology were accelerated by its social and cultural climate and by the fact that the staple foodstuffs of the rice and vegetable centered traditional Japanese diet were short on amino acids, leading to recognition of the need to improve nutritional intake.

Today, amino acids are produced the world over, including L-glutaminate (2.07 million tons in 1979), and L-lysine (25,000 tons in 1979). Almost all this production is based on Japanese technology.

The population explosion poses a critical problem of how to ensure an adequate food supply for the people of the world. Japan, through its outstanding amino acid industry, is making a major contribution to meeting this great challenge.

At the same time, Japan has built a rich store of scientific knowledge and industrial know-how concerning fermentation that has worked to its decided advantage as a foundation for bioengineering and many other new industries in the life sciences. The use of recombinant DNA and other genetic engineering techniques for industrial purposes is a prerequisite for the massive culturing of useful varieties of microorganisms for extracting desirable new substances. Japan's sophisticated fermentation technology will play an important role in this area.

Developing original technology requires, above all, patient study, a social climate supportive of it both materially and spiritually, and a strongly entrepreneurial business climate that gives full rein to the exercise of that spirit. The Japanese have proved capable of responding swiftly to any new science or culture they encounter. They have a demonstrated ability to absorb and assimilate those elements suited to their own society. Japanese today are fully aware of their duty to exercise this national characteristic for the good of all mankind. ●

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He has a doctorate in engineering.

The Opto-Electronics Industry

By Takanori Okoshi

Opto-electronics is now being lauded as a high-growth leading-edge industry with virtually unlimited latent growth potential. At the same time, the electronics industry—one of the parents of this powerful new industrial force—is numbered among Japan's top performers.

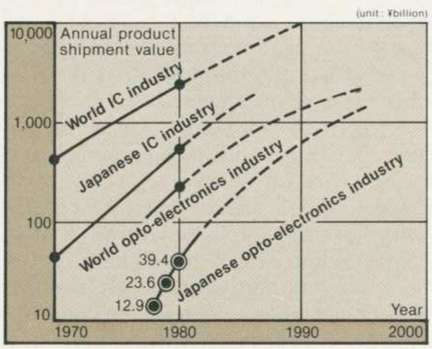
How do these impressions hold up under close statistical scrutiny? How high actually is "high-growth?" A study of recent statistics reveals that opto-electronics has finally begun to transcend the initial phase of vague expectations, and is beginning to evolve into a major industry ranking alongside the electronics—and especially the integrated circuit (IC) industry—that preceded it.

Government statistics on industrial shipment values divide the electronics industry into civilian electronic equipment, industrial electronic equipment, and electronic components. Shipment values in fiscal 1983 for these three sectors came out to ¥3,650 billion, ¥3,720 billion, and ¥3,220 billion respectively. Overall, electronics in Japan today is a ¥10,000-billion industry.*

Opto-electronics is still a border-line industry, and its boundaries are ill-defined. It is thus difficult to arrive at a clear statistical picture as can be done with integrated circuits. Nonetheless, the industry generally appears to be about 20 years behind the electronics industry, and is unlikely to reach the ¥10,000-billion level already posted by its parent in 1980 before the turn of the century.

*Growth projections for the IC and opto-electronics industries, 1970-95, are summarized in the chart.

Growth of IC and Opto-Electronics Industries



(Note) Based on records and projections for growth in annual IC and opto-electronics industry shipment values (global and Japanese).

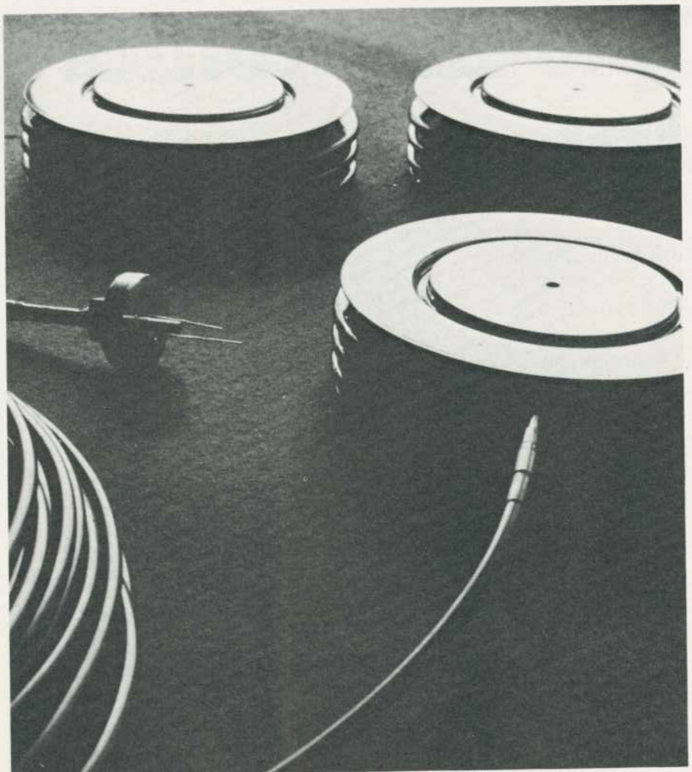
Japan's Role in the Rise Of the Opto-Electronics Industry

Generally speaking, opto-electronics had its beginnings in the laser industry of the late 1960s, subsequently gaining in depth and breadth as optical fiber and fiber-optic communications technologies were developed in the second half of the 1970s. The subsequent appearance of optical memories and medical laser applications rounded out the field as it exists today.

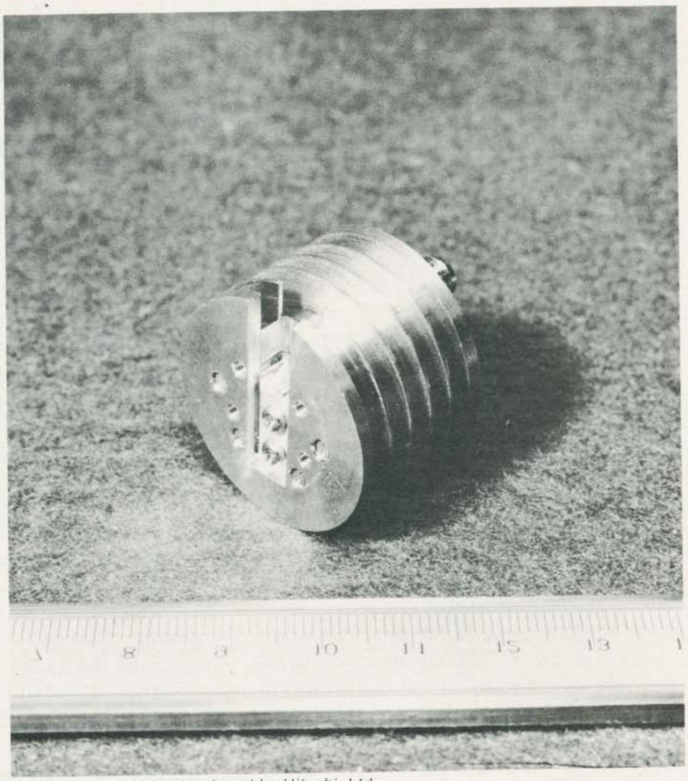
How have Japan's own distinctive inventions and discoveries contributed to this process? In the late 1950s, Dr. Koichi Shimoda, then with the University of Tokyo and now at Keio University, made important contributions to theoretical work on lasers. Similarly, Dr. Iwao Hayashi, formely with the Bell Labs in the United States and now working at the Opto-Electronic Joint Research Laboratory in Kawasaki near Tokyo, played a key role in the development of semiconductor lasers capable of generating continuous laser light at room temperatures when he invented the double hetero junction structure used in these devices.

Japanese scientists have also been leaders in optical fiber work. Dr. Junichi Nishizawa of Tohoku University applied for a patent on optical fiber manufacture in 1964, two years before the publication by Kao and Hockham of what is often considered the seminal article on the topic. Nishizawa and Dr. Shojiro Kawakami subsequently (1968-69) came up with a theory on the optimal design of focusing-type optical fibers that set the standard for further work in the field, while Dr. Teiji Uchida of Nippon Electric Co. and Dr. Ichiro Kitano of Nippon Sheet Glass Co. paved the way for practical fiber-optic communications with their 1969 Selfoc fiber.

More recent Japanese innovations in optical fiber production include a VAD (vapor-phase axial deposition) process developed in 1977 by a team led by Dr. Tatsuo Izawa, then with the Nippon Telegraph & Telephone Public Corp. (NTT) Ibaraki Electrical Communication Laboratories and now at NTT's Musashino labs, and a buried double hetero structure devised by a team led by Dr. Toshihisa Tsukada of Hitachi's Central Research Laboratory. Japanese researchers have



6,000-volt laser thyristor developed by Hitachi, Ltd.



Semiconductor laser developed by Hitachi, Ltd.

also done important work on the stripe structure of semiconductor lasers.

Optical fiber "communication" work got under way in earnest in Japan around 1973-74. NTT arrived at a decision to undertake a full-scale study of fiber-optic communications around 1973, several years after the Bell Labs in the United States had already launched their own development drive. This early lead explains the American control over many key patents in the industry. Yet despite running several years behind the U.S. at first in fiber-optic technology, Japan has displayed remarkable strength in industrial production techniques, and has also earned a solid reputation for effective teamwork. Together, these have enabled Japanese researchers to overtake and pass the U.S. in the actual construction of quality optical communications systems.

This also appears to be true regarding the practical development of optical memory devices. The original optical memory device was invented in the Netherlands, but a Japanese corporate research team picked up on the idea and refined it during the 1970s. Today Japan is recognized as the international leader in optical memory disk production.

Japan's Advantages And Disadvantages

While Japan is generally acknowledged to be the international pacesetter in production technology, it also ranks among the world's most capable nations in new product development. On the minus side, however, Japanese researchers in this field have yet to do the kind of original and fundamental work that could earn them a Nobel Prize for Physics. Most of the key inventions during the initial phase of opto-electronics development were made by Americans and Europeans, especially the British. While Japan has produced Nobel Prize winners in theoretical physics, it will challenge the capacity and resourcefulness of Japanese scientists to perform trail-blazing work in the growing opto-electronics industry.

Another handicap Japan faces in this field is its limited domestic demand. Thus, while its optical fiber industry is the most developed in the world, domestic demand falls far short of production capacity. This perhaps reflects the characteristic Japanese hesitation to embrace a new industry that will affect the common social systems of the general populace. The Japanese, it would seem, are capable of developing outstanding technology in every field, but are nowhere near as good at applying this technology to improve their living environment.

Objectively speaking, Japan should have adopted optical communications technologies on a large scale long ago. Optical fiber is free of interference, and works perfectly well beside, or even in contact with, electric power lines. It can be laid easily and conveniently together with power cables to remove the notorious "electric poles" in Japanese cities which greatly deteriorate their urban elegance, but the Japanese engineers involved with this technology have fallen short when it comes to promoting their creation. At this point, the biggest obstacle to the growth of the industry appears to be the inherent conservatism of Japan's political and economic institutions.

Despite these various disadvantages, Japan has come a long way in its contributions to the worldwide development of opto-electronics, both in basic R&D and production technologies. These contributions should work powerfully to bring international recognition to the great socio-economic value of this remarkable young industry. ●

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