

Profiles in Ceramics: **Robert D. Maurer**



Some 30 years ago, the slogan “reach out and touch someone” may have seemed like part a sci-fi plot to Robert D. Maurer. But today, this scientist knows first hand how his role in the development of glass optical fibers revolutionized the telecommunications industry.

He also knows that this technology has enabled millions of people not only to reach out more quickly and easily over the phone, but even more infinitely and readily via the Internet.

Furthermore, his achievement is still hot news, because 10 years after his retirement, Maurer was presented with the 1999 Draper Prize by the National Academy of Engineering. The award was given in a ceremony this past February for his role in the development of fiber optic technology.

Maurer, who had studied and worked in light scattering since early 1950, spent nearly 40 years in science and research in applied physics and glass at Corning Glass Works, N.Y. During that time, he worked with Don Stookey, Peter Schultz and Don Keck, the latter two were members of his team that made the optical fiber discovery.

There has been a tremendous sense of gratification and career fulfillment, Maurer said, particularly because his goal as an industrial researcher was either to make or to contribute to something that would have a strong economic value in this country.

He surpassed his own expectations. “Last year, more than 70 million kilometers of

fiber were made worldwide. This year, there will be even more.”

While many people believe that without this discovery, the Internet as we know it today would not exist, Maurer has a different take on it.

“I take a lot more satisfaction in the improvement of our general communication infrastructure and how this is used by everyone to keep our economy going. That’s my major impact in terms of ceramics, without question.”

In addition to the Draper Prize, Maurer earned numerous other honors in the last decade, including the U.S. Department of Commerce American Innovator Award, 1995; University of Arkansas Distinguished Alumni Citation, 1994; and election to National Inventors Hall of Fame in 1993.

Maurer, a fellow in the ACerS, IEEE and APS, has written or contributed to more than 50 technical papers and was responsible for 16 patents, including the one for the optical waveguide technology.

Equally as important an accomplishment, but perhaps not as publicly known, is Maurer’s nearly 50-year marriage to Barbara, and their three children, Robert, James and Janet.

From Humble Beginnings

The legacy began July 20, 1924, when baby Maurer was born to John and Josephine in Arkadelphia, Ark., the eldest of three sons. Their life was one of lower middle class, by

Kathy L. Woodard
Contributing Editor

today's standards, Maurer related. His father was in the Army and stationed at a small local college where he remained until retirement.

Arkadelphia, a small college town of about 5000, was a place where everyone knew everyone else, and not too many of the residents moved out of the area, Maurer said. It was a simple life, not impoverished, but not wealthy by any stretch—it was an area similar in roots to those of President Bill Clinton, Maurer said.

Childhood years centered around school, and the nearby river was a big attraction. Swimming, catching snakes and turtles, and keeping the latter for pets—at least for a short while—were primary sources of recreation, he said. As he got older, tennis became a favorite activity, as was building model airplanes.

Class sizes were small, and for the most part, Maurer recalled, he went all the way through high school with the same classmates. Although not quite at the top of the class when he graduated high school, he was at least in the top 10 percent.

"I had a fairly good time of it; studied, but not very hard. I was mostly interested in technical things and by the time I was in high school, I knew I wanted to have a technical job. Chemistry was always an interest."

There was definite interest in going on to college, he said, but some concern over funding—the looming of World War II caused additional concern.

In the Army Now

Maurer enlisted in the U.S. Army Reserves and started at the University of Arkansas in 1943; within a matter of seven months, every able-bodied man was called up by the Army, including the reservists.

During the early part of his enlistment, the Army provided educational opportunities to the soldiers, linking them with programs at colleges in the areas they were stationed. For slightly less than one year, Maurer studied pre-engineering at the state college at Huntsville, Texas, through the Army's specialized training program.

Maurer's division, the 99th, was shipped overseas late in 1944, where they saw combat along the German



Infant Robert with his parents, John and Josephine Maurer.

border, as well as in France and Belgium. Wounded in action—he stepped on a land mine while on combat patrol—Maurer was returned to the States and spent more than 20 months in the hospital before getting a disability discharge. He subsequently was awarded the Purple Heart.

For the Love of Physics

Financially aided now by the GI Bill, Maurer returned to the University of Arkansas in the fall of 1946, where he registered in the chemical engineering program. It was not long, however, before he realized that physics was more to his liking, and he changed programs.

"I was not really sure what I wanted to do at that time, but all my teachers were dedicated in physics and I think



Young Robert (l) with friends Evelyn and Glenn Allen.

some of that rubbed off."

In 1948, Maurer graduated with a B.S. in physics; his plans were to go immediately into the Ph.D. program, but because so many GI's were coming back into the system, he was not so sure how easily he would be accepted. He initially applied only to Harvard and the Massachusetts Institute of Technology (MIT). Having no timely response, Maurer said, and getting nervous, he drove to Washington University in St. Louis, where he applied and was accepted.

"Then the other acceptances came through. Choosing between Harvard and MIT was difficult, but I was more interested in practical experience. MIT was primarily an engineering school and did have a good physics department so I started there."

Life as a Graduate Student

Like the other students who had not earned their undergraduate degree from MIT, Maurer said the experience was initially overwhelming.

"It was a pretty tough first year; most of us ended up taking some MIT undergrad classes. I am not sure what it was, but when you learn how to operate in a place like that, the stress wears off."

Getting a research fellowship and having the opportunity to work in a low-temperature laboratory in the summer helped Maurer not only cope, but also gain practical experience he could apply to his thesis.

"I was fortunate enough to find a project of interest to everyone worldwide, and had done some experimental work in second sound velocity in liquid helium."

The purpose of the thesis, Maurer explained, was to discriminate between two competing theories. His work was centered on theories about the nature of liquid helium, which carried over into a prediction of what second sound velocity should do as a function of temperature. Using the function of temperature, Maurer said, he could measure velocity and check out the predictions.

"I still had a long way to go in my course work, and for the next three summers, I continued experimental work in the laboratory."



Baby Robert with his mother, Josephine.

Herlin's Influence

A strong influence on his life during this time was Professor Melvin Herlin—it was his approach to physics and doing experiments that provided the greatest influence, Maurer said.

“He did not push people into academic work. At that time, many professors had a tendency to try and create students in their own image by encouraging them to go into academics, but then the academic world soon filled up and more students gravitated to industrial.”

Herlin's experimental style is the backbone of Maurer's lifelong philosophy: to do experiments based on an idea, then research with the experimental data.

In the summer of 1951, Maurer took his orals, graduating officially with the winter class later that year, he said.

It was also the year that Maurer married, having met his wife-to-be the year before.

For a while he continued low-temperature research at MIT in the division of industrial cooperation, as a paid employee. However, it was time to make a career decision.

Realizing that he did enjoy industrial work, Maurer could have pursued a job with Bell Laboratories—as many of his friends were—working with semiconductor applications.

After interviewing with a number of firms, he chose Corning Glass Works because of his interest in the area of materials and condensed matter. “Corning appealed to me because glass seemed like such an interesting topic, and I didn't know much about it. And I liked the idea of a smaller town.”

From MIT to Corning

In late 1952, Maurer, wife and infant son moved to Corning—a bit of culture shock for Barbara to move to such a small town, having come from Boston. “And housing was short, we had limited choices of where to live. I had been all over the place, but my wife found it quite an adjustment and all these things added up to a struggle, initially.”

Hired as a physicist, Maurer said he did not make much of an impact on the ceramics industry in the beginning. What he did work on was various economic applications for glasses.

At that time, the company was making ultrasonic delay lines of glass, such as those used in radar where a signal is delayed and then compared to the signal coming back to determine a moving target indicator.

Other projects he worked on as physicist included heat transfer in forming glass, while at the same time, also working on light scattering as a means of studying glass structure.

“We had some practical applications to see whether glass was completely homogenous, or if it contained any initial crystalline structure that went into the melting,” he said.

While it was a practical area of work, Maurer stated that it was also interesting to see what else could be determined about the nature of glass. This was not only helpful information, but also useful knowledge when he began his work on optical wave-guides.

First, Glass-Ceramics

Working with Don Stookey and other Corning notables of the same era within the fundamental research group, Maurer began to study glass-ceramics, which was an area quickly



Maurer prior to being shipped overseas in 1944.

becoming popular within the industry. Using what he had learned about light scattering, Maurer began to study processes that were occurring in glasses.

“We were learning about the nucleation process, which was the basis of the whole thing—that you could form an article of glass that allows you to use glass machinery easily, that you could heat treat and transform the article into ceramic without any pores or other defects.”

This was useful technology, he stated, and sufficiently interesting to Howard Lillie, manager of research at Corning and president of the International Glass Congress. Lillie was of similar professional spirit,



Maurer in Boy Scout uniform, age 13.



Maurer (at podium) received the ACerS Glass Div.'s Morey Award in 1976.

Maurer said—he had an experimental attitude towards things.

“You get the data, and then figure out what is going on. And that is really what I did, how I made the reputation in wave guides.”

Optical Waveguides

In the 1960s, Maurer was promoted to manager of the applied physics group at Corning, but was able to remain hands-on in technical work and research. There was a high level of interest in optics at that time, and it was while working on glass lasers that Maurer had his first introduction to optical waveguides.

Some of his knowledge came from papers by Elias Snitzer who was with the American Optical Co. and through his own experimentation with glass fiber waveguides. It was more of a casual interest at that time; (I was) not seeking to accomplish anything in particular, Maurer shared.

“I was interested in all aspects of optics, but found it more interesting to see that wave-measured light gave you certain kinds of patterns.”

The Search is On

It was around 1966, Maurer recalled, when one of Corning's scientists, Dr. William Shaver, was assigned the task of contacting laboratories to find out what was going on in the world of telecommunications. Shaver, who was in the United Kingdom at that time,

went to U.K. office that controlled all communications in that country. It was here that he first heard about optical fibers for telecommunications.

Maurer credits the idea for this technology to Charles Kao, who then worked at the Standard Telecommunications Lab in the United Kingdom.

At the same time, those in the communications industry were working on millimeter waveguides for the next generation of communication transmission in trunk lines—a high-volume transmission, Maurer explained. Bell was in the forefront of the preliminary work at the time, Maurer believed, and on the verge of manufacturing the waveguides technology—because the world was going to demand something different.

“The industry knew something was needed. Look at history, there is an almost linear increase going back to the telegraph, about the amount of information put on communications lines—the telegraph, telephone, coaxial wave guides, etc. All those things have put on a uniform increase since 1890.”

In Kao's eyes—and Maurer's—the concept of millimeter waveguide technology would soon be pushed into the background by fiber optics.

“But still most of the people I talked to thought millimeter waveguides would be first, then optical technology used sometime in next generation of technology,” Maurer said.



Barbara and the Maurer's three children, Robert, James and Janet.

Knowledge is Power

Armed with this knowledge and information, Maurer knew his role was to try and do something. While others in the laboratory also could have done so, he had the most suitable background and expertise. In 1966, he elected to look into the fiber optic technology, but with no particular sense of urgency.

“There was no great rush as far as I knew from talking to industrial people. We proceeded rather slowly, looking at the conventional fibers Corning was manufacturing.”

With existing fibers that had an attenuation of 1000 decibels per kilometer—and a goal of practical fibers at 20 decibels per kilometer—Maurer knew much needed to be done to determine what was the problem in transmission. While the variance was

ROBERT D. MAURER MILESTONES

- 1944–46** Served in U.S. Army, 99th Division; wounded in action; earned Purple Heart
- 1948** B.S. in Physics, University of Arkansas
- 1951** Ph.D in Physics, Massachusetts Institute of Technology
- 1952** Joined Corning Glass Works
- 1963** Promoted to Manager, Applied Physics Group
- 1966** Began investigation of fiber optic technology
- 1970** Announced the creation of the first fiber optic waveguide
- 1972** U.S. Patent 3659915, May 2, (co-inventor Peter Schultz)
- 1975–92** National Research Council
- 1976** W. Morey Award, The American Ceramic Society (ACerS)
- 1978** The first Prize for Industrial Physics, American Institute of Physics
- 1979** Morris N. Liebmann Award, IEEE
- 1979** Election to the National Academy of Engineering
- 1979** L.M. Ericsson International Prize for Telecommunications, Swedish Academy of Engineering
- 1986** IRI Achievement Award, Industrial Research Institute
- 1987** John Tyndall Award, Institute of Electrical & Electronics Engineers (IEEE)/Optical Society of America
- 1989** Naval Research Laboratory Citation
- 1989** International Prize for New Materials, American Physics Society
- 1999** Draper Prize, National Academy of Engineering



In his Corning lab, Maurer began working with lasers in 1963.

great, there was logic behind determining the validity of the lower number, he shared.

“This was an approximate number arrived at by taking the power of conventional laser at the time, the sensitivity of the detector and arriving at the fact that you could stand to lose 99% of your light between the laser and detector. Then you had to go at least a kilometer if you were going to use it for long distance communication to make it practical.”

After the initial examination and talking to those in the field that believed in the technology, Maurer’s next step was an attempt to make the fiber from high-silica glasses, which he knew could be made rather high-purity by vapor phase processes. But knowledge was power, or at the very least, provided him with options.

“Not knowing what kind of glass would provide a lower refractive index cladding, I elected to go to another glass with a higher refractive index than silica.”

The attenuation factor was arrived at, he said, not based on scientific or technical information that he evaluated, but by actually making the fibers and looking at the problems caused by the intrinsic properties of the material, such as fabrication bubbles.

Once ready to begin the process, Maurer opted to use silica with titanium to comprise the core, and found



At the presentation of the Charles Stark Draper Award in February 2000, Maurer is flanked by Neal Lane (l), science advisor to the President, and William Wolf, president, National Academy of Engineering.

the glasses, but there was only one furnace at Corning that would draw fibers from glasses that were high in silica, because silica is extremely viscous.

Nonetheless, the idea had merit to Maurer. After all, he was following the pattern that had worked thus far in his professional career. "I had the idea for the experiment, performed it, then analyzed the results."

A Team by Design

A high attenuation prevented accurate measurement of the first fiber, and Maurer soon realized the process was going to entail quite a bit of work. Hiring Donald Keck into his group, and the subsequent hire at Corning of Peter Schultz, provided Maurer with the expertise and skill to complete his team over the next several months.

The collective expertise of the group, which annealed the fibers and helped with the attenuation, put the team on the right track. Through trial and error, and by experimenting with temperatures and times in the special furnace, resulted in the optimum annealing schedule for the fibers. Simultaneously, changing composition of the glass began to yield results in the titanium concentration, as well.

Breakthrough Achieved

By 1970, through improving the process, reducing the titanium concentration and other steps, the end product was created below the 20 decibels per kilometer attenuation figure. Still of the mindset that there was no sense of urgency, Maurer announced the findings in a paper at a conference on trunk communications in the United Kingdom.

"It caused quite a stir. It turned out that nobody else had tried to make this type of fiber, as far as I knew. Perhaps the reason was they, too, thought there was no rush. But it also is true that they were all using a different approach, a double crucible."

This double crucible required meltable glasses of lower viscosity, and silica cannot be melted like that, Maurer revealed.

Despite the success of the vapor phase technique used to make the fiber—a process which is still the industry standard of manufacture



*Robert and Barbara Maurer
at the Draper Award ceremonies.*

today—the world was not quite prepared for this fiber.

"There was a long period of time trying to get people up to speed with this technology," Maurer said. It took approximately seven years before the fiber was actually used in an operating telephone—an almost simultaneous occurrence with GTE in California and Bell Laboratories introducing it in Chicago.

Although it took years to see fruition within the telecommunications industry, Maurer is pleased to have made this major impact upon the glass/ceramics industry and telecommunications technology.

Subsequent work was dedicated primarily to strengthening and improving the fiber and process.

During the latter years of his tenure with Corning, Maurer became somewhat an expert in defending the patent and technology—owned jointly by himself and Schultz—in the courts.

Because their concept of high-silica fibers was an article patent, Maurer shared, the process was protected no matter how it was manufactured—but there were always those with a ready challenge, he said.

"There was an awful lot of testimony that I had to go through, and trials up to the time I retired. But the patent was always upheld and even in settlements, the validity of the patent was

recognized. That was probably the most stressful and time-consuming part of my career."

The Retirement Years

After his retirement in 1989, Maurer continued to consult, picking and choosing those projects that caught his attention. Gradually that stopped.

However, with three adult children and eight grandchildren now ranging in age from 4 to 14—and more time to devote to Barbara—Maurer enjoys having personal time. The couple travel a bit in the country, visiting their children who live in California, Oregon and Detroit and spending time with the grandchildren.

He reads and when the urge strikes, does some work in his shade garden at their home of 44 years at Painted Post, N.Y., and still enjoys spending time on the river.

For him the future is set. For new technologies yet to be discovered in ceramics, who knows, he said.

"The fibers were a complete surprise. I think there are other research projects going on somewhere out there that will come as a complete surprise—a major application in technology. No one knows what is ahead.

"I am a physicist, but those aspiring to science should keep as broad a view as possible, look for the opportunities and try to shift your interest, seize the opportunities when they arrive." ■