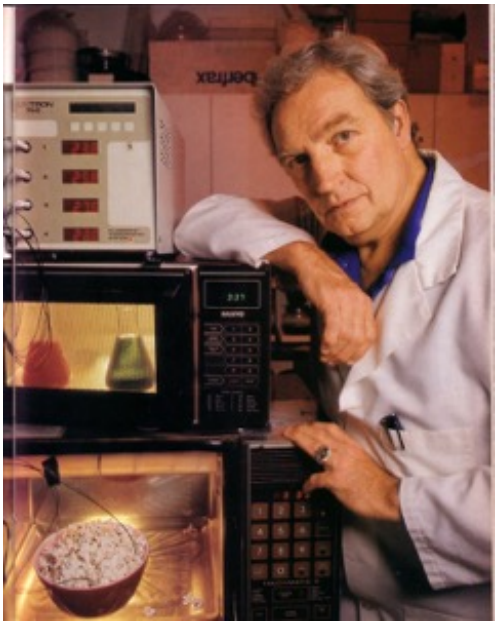
An Interview with Mr. Robert F. Shiffmann – IMPI's President

The first discovery of Mr. Robert (Bob) Schiffmann in the field of microwave ovens and microwave heating was both accidental and serendipitous, as he describes it. In 1959, with a Bachelors degree in Pharmacy and a Masters degree in Analytical and Physical Chemistry, Bob left Purdue University to pursue research on radioactive pharmaceuticals. However, that never happened because he answered an advertisement in the New York Times for a "Physical chemist with a sense of humor". He became a research scientist for DCA Food Industries Inc. (Donut Corporation of America), tasked with studying the physics and chemistry of doughnuts involving some very sophisticated science (heat transfer, fluid dynamics, bubble physics, chemical interactions of various ingredients, change of state, change in volume, and much more).

While studying the heat-transfer characteristics of frying oils, Bob saw a co-worker put a sandwich on a plate inside what he thought was a large chrome refrigerator; but when he saw that the sandwich became hot while the plate remained cold, he realized this was something other than a refrigerator; in fact, it was a Raytheon Radarange, a microwave oven weighing approximately 300 kg, somewhat over 1.5-m high, containing two 800-W water-cooled magnetrons. Bob had never heard of a microwave oven and, questioning his coworker, learned that the heating was by a kind of radar. Intrigued, Bob put his own sandwich in the oven and it also came out hot while the plate remained cold. He then scooped some hot fat out of a fryer, dropped some raw dough into it, and placed it in the microwave oven where it fried! This was the basis of his first patent, and ultimately resulted in manufacture and sale of 25 large industrial microwave donut fryers into bakeries around the world. After that, Bob spent his time microwaving everything he could think of: baking, drying, frying, heating, etc. During this time, he also invented microwave doughnut proofing, the procedure whereby yeast is stimulated causing dough to rise. Bob's procedure reduced the normal 45 to 60-minute process to 4 minutes. Again, this resulted in the manufacture and sale of numerous microwave donut proofers in the United States, Canada and Europe.

In 1971, Bob left DCA to become a minor partner in a two-man consulting company, Bedrosian and Associates, consultants on product and process development. Other than an initial project on the microwave frying of breaded chicken parts, for many years there was very little microwave-related work, so Bob spent his time developing numerous consumer food and nonfood products, many of which reached the marketplace. In 1977, Bob studied the microwave performance of paperboard versus aluminum foil packaging, much of that research is still being quoted today. It was during this time that Bob invented the multi-probe thermocouple temperature measuring system that today is known as the *thermocouple hedgehog* used in laboratories all over the world.



Bob Schiffmann in his laboratory (a picture from an article in ***Discover***, titled "The Little Waves That Could", Nov. 1989. The figure caption was "Microwave researcher Robert Schiffmann stands by the technology's greatest success story").

In 1978, Bob formed his own consulting company, R. F. Schiffmann Associates Inc., and since 1982 has devoted all of the company's time to microwave-related research and development. Since its formation, Bob's company has serviced well over 150 clients in areas as diverse as food, pharmaceuticals, medical devices, aerospace, packaging, metallurgy, foundry, and much more. In 1980, he and his team developed a sophisticated laboratory microwave oven. In that same year he began a program that resulted in the development of the first

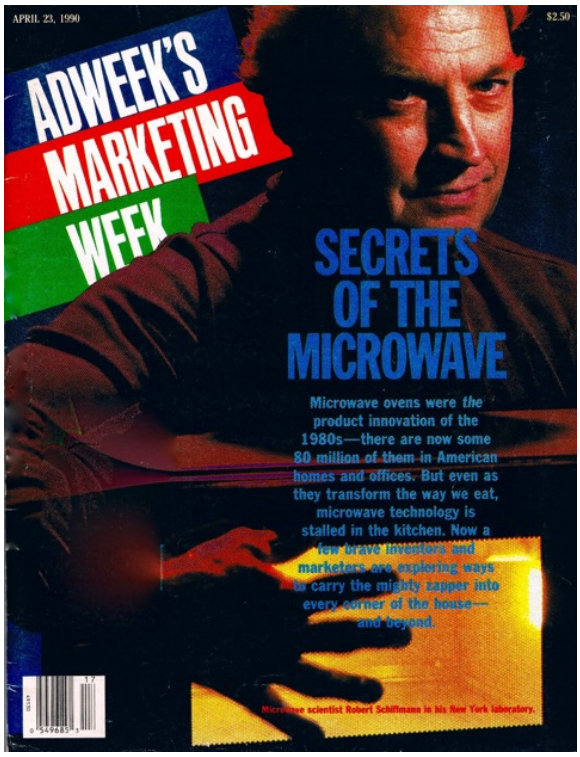
full line of high-quality plastic cookware for microwave ovens. Also at that time, he developed a continuous microwave and infrared system for cooking 30,000 sausage patties per hour, a highly profitable system that ran, without problems, for 10 years. Another highly successful system he developed, that has been operating in South Africa for over 10 years, is the microwave production of muesli.

There were numerous other microwave systems that reached the pilot stage in various food and nonfood industries, including the aerospace and pharmaceutical and personal care product industries. Bob and his team also developed numerous microwavable food products for some of the major food processing companies. There were also a number of research programs, such as determining the cause for spontaneous fracture glass jars during microwaving, and as a result developed a test procedure that predicted jar failure resulting from changes in the production or shipping of products these jars. He also developed a procedure for the conversion of hematite to magnetite at very high efficiency, but unfortunately this never reached commercialization.

Bob has 28 US patents, with numerous foreign analogies, covering inventions including various microwave devices such as conveyor-chokes and environmental control systems for microwave applicators; process patents for microwave frying and dough proofing systems, industrial bread baking systems, continuous extrusion and cooking of skinless frankfurters; the manufacture caramel-coated microwave popcorn; microwave packaging systems, and more.

Bob has been teaching microwave technology courses internationally since 1973. He has also chaired over 20 international microwave conferences. He has over 50 technical publications on microwave energy, and has contributed to numerous textbooks in many areas of microwave applications and technology.

Bob joined IMPI (International Microwave Power Institute) in 1967, was elected its Secretary in 1970, and then President in 1973 (a position he held for 10 years), followed by becoming Chairman of the Board of Governors for two years. He was reelected IMPI's president in 2010, a position he holds today. He is also a Founding Member of AMPERE; Honorary Member of the UK Microwave Technology Association; Emeritus Member of the Institute of Food Technologists and Sigma Xi; and an Honorary Visiting Professor at the Kunming University of Science and Technology, and a Certified Food Scientist (IFT).



Bob Schiffmann and the "secrets of the microwave" on the cover page of ADWEEKS' MARKETING WEEK, April 23, 1990.

Among his many awards, that stand out in Bob's mind, are a Fellow of the Int'l Microwave Power Institute (1983) and the Ricky Metaxas Pioneer Award (2012) granted to him by his peers.

Today, Bob spends most of his time as an expert and expert witness in numerous legal actions. He has served in this capacity in 40 cases to date, including patent infringement, product liability, medical malpractice, breach of contract, felony murder, and more.

We asked Mr. Schiffmann to share with us his experience and views in this interview to *AMPERE Newsletter*. Bob has kindly agreed to respond to our questions, as follows:

Q. Mr. Schiffmann, among the so many projects, initiatives, and developments that you have led in the 56 years of your microwave-heating career, which would you consider as the most significant ones?

A. There have been so many products and processes in which I have been involved, that it's hard to select the most significant ones. One of the joys of my

consultancy is that no one ever came to me with an easy project – if it was easy they would've done it themselves – so I ended up with the difficult-to-solve projects. That suited my nature, because I love hard problems, the harder the better. Also, early in my career, I made a decision that I was not interested in just spending my time finding interesting information with which I would fill up my laboratory notebooks, but rather I wanted to work on things that ended up as something I could look at in a manufacturing plant, or hold in my hand, or see on the shelves of supermarkets, and know that I'm the one who did it. So, I've been satisfied many times over, and my clients have benefited because of that.

Bob Schiffmann and the Metaxas award (2012)

Q. Based on your experience with over one hundred projects and companies, how would you characterize the more successful ones? Can you identify any specific profile that features success stories in microwave-heating?

A. There is an important lesson that one has to learn in my business: "Don't fall in love with your own idea". That's because many of the things that I've worked on, while being technically successful and that met the cost objectives, in most cases, never reached the marketplace or the production plant. There are many reasons for this, including the reluctance to adopt something new when the company has done the same thing for the last 50 years; or to introduce a new product into the marketplace, because that's risky – it might fail, and that will affect the bonuses of many people in a company. It's a bitter lesson, but I've learned that while most companies profess to want to introduce new products, many are reluctant to do so because of the potential for poor performance or failure in the consumer's eyes. In the case of new processes this might involve a capital expense of hundreds of thousands or even millions of dollars, plus all the installation and startup costs, Also, they are likely to have amortized their standard equipment, so most companies don't want to gamble on the new microwave-system, so it's easier to say "no".

Q. You have been working with magnetrons for over 5 decades, and now you - also as IMPI's President - promote the solid-state technology which revolutionize the microwave-heating field. What is your vision regarding the solid-state vs. magnetron microwave heating technologies?

A. The future of solid-state technology in the microwave-heating market is exciting. Right now, the hardware is far too expensive, except for dedicated systems where equipment cost is not important, for example in medical applications. However, with more and more use of this technology, the price of the solid-state hardware will come down significantly. Consider that in 1968 a single transistor sold for $10, while today it's possible to buy 2 billion transistors for $1100 – probably the result of computers and the gaming market. The kind of solid-state technology I'm talking about is unlikely to see that kind of growth, but it will be significant. Looking at it from the point of view of applications to microwave processing of large quantities of materials, some of these require hundreds of kilowatts, and today's power transistors produce only a few hundred watts, so the challenge is very big. Then there's the consumer microwave oven market; in this case, I believe the idea that millions of microwave ovens are sold annually has gotten in the way of a realistic assessment of the likelihood of replacing the four-dollar magnetron and its power supply with a solid-state system. Yes, I believe that there is some potential for real cooking in these ovens, however, it's not engineers buying these ovens but ordinary consumers, who all believe that you can't cook in a microwave oven, and are disappointed by today's microwave ovens marketed as providing real cooking

opportunities, which most consumers find to be very disappointing. Then there's the question of cost: one can go to Walmart, or similar discount stores, and buy a microwave oven for $59 and if anything goes wrong with it, simply throw it away. What I've seen so far is a projection of these solid-state cooking ovens costing hundreds of dollars. Do you really expect consumers to throw away their current microwave ovens in place of one of these? Obviously there will be some high-end consumers who will do that, but for the average consumer – I don't think so. And because the footprint of one of these new ovens will be large, say the equivalent of current microwave ovens, there is not that much counter space available to have both. So I think there are many challenges ahead.

Q. During the years, microwave ISM technologies have been found as potentially applicable in many fields. However, they still have an image of a promise that has not yet been fully fulfilled. Do you share this opinion? What in your view are the obstacles limiting the more massive penetration of microwave technologies into potential markets?

A. IMPI was organized in 1966 because of the potential for microwave industrial processing of materials. I joined IMPI in 1967, and attended my first IMPI symposium in 1968, at which Joel Elman, a vice president at Litton Industries, predicted a large consumer microwave oven market, and few in the audience believed him. Today there are well over 1 billion microwave ovens in the world, but not that many industrial microwave systems, perhaps somewhat over 1200 worldwide (although there are far more RF processing systems in operation). Why? The answers are myriad and could take up pages, but to boil them down to the most important:

- The generation of microwave energy is expensive; therefore, microwave equipment is often far more expensive than conventional heating systems.
- Microwaves use electrically generated power that is far more costly to produce than steam or hot air that may be able to do the same thing, maybe not as quickly or efficiently, but at much lower cost.
- Nearly everybody has a microwave oven, but they really don't understand microwave-heating, and this is not usually taught to engineers at universities. So, often expectations of what micro-waves can do are unrealistic.
- Probably the biggest obstacle is inertia – the resistance to change and to adopt a different way of doing something. In 1980, I created a unique system for the production of sausage patties; it had enormous economic benefits. The user insisted on running a pilot operation that produced 30,000 one-ounce patties before committing to the production system. The final production system was so successful that it ran trouble-free for 10 years before it was shut down when the company was bought, because the product produced by the microwave system was much too good when compared to that being produced in several plants by the purchaser. By the way, the payback time for the entire system, not just the microwave, was 5 months!

When they are properly applied, microwave systems often do as well as or better than conventional systems and may have other advantages, sometimes with unique results. These are the really exceptional systems. And, yes, I believe that there is enormous potential out there still waiting to be discovered or rediscovered. But, you also have to overcome the fact that there are many conventional systems that have been in operation for many years and are unlikely to be supplanted. It's important to stop promoting these as microwave systems, but rather focus upon the processes in which microwave will be part of those systems when they provide a real benefit, not because of the glamour of the word microwave, but because there is a real benefit, especially an improvement in the ROI (return on investment). A weather-stripping manufacturer wants a superior way of extruding and vulcanizing rubber, it may include a microwave component, but that's incidental to a reason for purchasing it, as long as it meets his quality and ROI goals.

Q. Looking from the outside, it seems that IMPI is doing very well during the last years. Actually it seems that IMPI has been revived under your leadership. Can you tell us what is the secret…? How IMPI has been recovered, and what are your future plans for IMPI?

A. I'm happy to tell you the secret, its name is Molly Poisant – IMPI's Executive Director. Molly is a human dynamo who has, like me, taken IMPI, and all it stands for, into her life and personality, and shares a love of the Institute with me. Yes, I've done some good things for IMPI in the 18 years I've been its President

(I sometimes wonder if it's because I am doing good job or because nobody else wants to take on all that work?), but I believe strongly, a belief that I know is shared by all of the IMPI's Board of Governors and the members, that IMPI would not be what it is today without Molly.

Since I began my second period as president in 2010, IMPI has doubled its membership, has added 16 corporate members, and added to its products significantly. We now produce a bimonthly newsletter, five webinars annually, and a Fall Short Course that is aimed primarily at the food industry, plus our annual symposium. We are currently going through a reassessment of our goals and considering refocusing the content of our symposia, as well as adding hands-on workshops. We see IMPI as a living, breathing society that grows and changes with time.

Q. The Journal of Microwave Power and Electromagnetic Energy (JMPEE) has been published by IMPI since 1966. JMPEE is probably the only archived Journal dedicated to microwave-heating, and as such is extremely important to the community at large (including non-IMPI members). Unfortunately, we live in an era that sanctifies bibliometric rating and impact factors. What are your intentions for JMPEE in this regard?

A. The Journal of Microwave Power and Electromagnetic Energy is IMPI's crown jewel. We've been fortunate to have a number of wonderful editors, including you Eli, who maintained a high standard for the Journal. Several years ago the IMPI Board struck a deal with the very fine British publishing house *Taylor and Francis* to take over the management and mechanics of producing the Journal while we maintain editorial control currently under the direction of Prof. Juan Aguilar-Garib. As a result, we've watched the growth in the quality of the Journal in terms of the impact factors, and the number of submissions for publication. I believe we will be able to maintain this very high standard, despite the growth of free online journals, about half of which, according to the New York Times, are anything but high quality and don't provide peer review, something which JMPEE has provided from its inception in 1966. Hence, we see a bright and growing future for our Journal.

Q. The relatively small microwave-heating community world-wide is divided into several independent associations, in US, Europe and Asia. Each association organizes its own conference and distributes its own publications. What is your opinion regarding the possibility to truly join forces and to establish a united international organization that will conduct an annual int'l conference on microwave-heating, and publish a high-impact Journal and magazine dedicated to microwave-heating?

A. Looking back historically, IMPI was the only game in town for many years; however, beginning in 1980, a number of important new societies were formed, dealing with microwave energy and all its ramifications. Each of these societies has its own identity and goals and I don't see the possibility of them all melding together into one big society, but we have done the next best thing. These societies have banded together to pool their resources in the form of MAJIC, a loose consortium made up of the Microwave Working Group, AMPERE, the Japanese Microwave Society, IMPI, and the Chinese Microwave Society. Currently, each society maintains its separate identity, continuing its own activities. However, once every four years they gather at a Global Congress for Microwave Energy Applications (GCMEA): Japan (2008), USA (2012), Spain (2016) and our next meeting will be in Chengdu, China in 2020. Each has been a high-quality conference. This is working very well, and while there is a book of proceedings that is produced for each of these conferences, there is no separate high-impact journal or magazine as you suggest. It certainly would be nice if that were possible, however, my sense is that each of these societies wishes to remain independent and I think that's very important. I've been fortunate enough to attend conferences of each of the societies and am impressed by their quality, so this concept of remaining separate but coming together every four years will continue.

Q. How do you see the structured tension between the secrecy required to maintain intellectual property, and the rapid spread of open knowledge essential for the development of new technologies? How is this tension reflected in microwave-heating associations like IMPI, which gathers scientists and technologists together with businessmen and entrepreneurs, with almost contradicting interests in terms of exposure and secrecy?

A. You asked a very important question, and it's one with which IMPI is struggling right now. As your readers are probably aware, about half of IMPI's members are from the food industry, primarily that

part related to microwave ovens. During the 1970's and 1980's there were many papers presented at IMPI symposia related to the technical issues surrounding microwave ovens, e.g. magnetron design and performance, power supplies, etc., but today, the microwave oven has become a commodity, most of them made in China, and while in those earlier decades the large microwave oven manufacturers such as Amana, Litton, Sharp, etc. always appeared at IMPI symposia, often presenting papers, we never see any of them now. The other dilemma we face is because those members employed by large food companies attend to learn about what's new in microwaves, microwavable foods, packaging, etc. but are not allowed to speak, or present their latest research or product development, because their employers see this as proprietary information. This creates a limitation on the kind of papers that will be presented. We have had great success with special sessions such as an excellent session on Food Safety at IMPI 51, and we shall continue to provide the special sessions. As a result, we are in very deep discussions now about program and activities to maintain and strengthen IMPI's future.

Q. About 25 years ago, in the New Orleans Institute of Food Technologists (1992), you gave an invited keynote speech titled "The future of microwave processing in the food industry". Which of your predictions have materialized (and which have not) in the recent quarter of century? How do you see now the future of microwave processing in the food industry?

A. Microwave processing never achieved its great potential within the food and even nonfood industries. I have been fortunate enough to have been involved in the development of a number of major food processing systems, all but one of which have been shut down for various reasons. The industrial microwave business is still looking for that "killer app" that John F. Gerling has spoken about many times, i.e. an application of microwave heating that is so essential that it leads to many installations rather than just a single system. Even when the microwave heating system provides such enormous benefits, including great energy savings opportunities, as for example a hybrid means of baking bread, its adoption may be unlikely. This again is due to the inertia that exists within industry, the resistance to change what they have been doing for decades. When I was young and new to the field of microwave heating, I was so enamored of it that I thought its potential was enormous and would be adopted everywhere. In my over 50 years of working with microwaves, I have been involved with numerous industrial systems in the food and other industries, but only a small number resulted in significant commercial systems, even when they offered significant increases in ROI. It's time for us to face the fact that microwave energy can provide a unique means of heat transfer that can have great beneficial effects in various applications, but that's not enough to result in a commercially operating system. I've also learned, that these potential applications must be user driven, i.e. that the user, in this case a manufacturer, needs to recognize that there is a potential to improve its process and bottom line if microwave energy can somehow be incorporated with, or replace his present system. But this means that we have to educate the user and that's not easy.

Q. As a consultant, you have served as an expert witness in cases including microwave oven injuries. How would you evaluate the various safety issues associated with microwaves? What is the proper distinction between real safety issues and myths, and how shall our community provide a reliable information in this regard to the media and public?

A. I love being an expert witness; it's usually a lot of fun despite often being very hard work. I always feel like Sherlock Holmes because I invariably find something about which the attorneys knew nothing, and this often led to a breakthrough in the case in favor of the client. As you've indicated, many of my cases relate to injuries occurring in microwave ovens. The microwave oven is rarely at fault, although I am presently an expert in a case involving a fire that occurred in a microwave oven. Most of the injury cases are related to products that have gotten too hot in the ovens, or may have erupted, thereby injuring consumers. I usually do quite a bit of laboratory work in order to identify the cause of the injury. In some cases, I've identified products that should never be microwaved even though they are sold as being "microwavable". In one case, the manufacturer changed its cap supplier and didn't test the product with the new cap; had they done proper testing it would have revealed the problem immediately. The lack of proper testing is usually at the root of most injury cases. Manufacturers simply don't know how to test their microwaveable products, sometimes running

tests in one or two microwave ovens and think they've done a good job. I test them in numerous microwave ovens and also under varying conditions, such as where to place the product in the oven. I had a serious injury case a few years ago in which a small 1-ounce container of a wax-based product heated to only 140°F at the edge of the turntable, but to over 410°F when placed in the center of the injured parties' microwave oven, resulting in melting of the polypropylene container and causing a serious burn injury to the plaintiff.

As to your question about myths vs. reality, this is a battle that I fight on a daily basis. The Internet is a wonderful source of knowledge, but it is also an incredible source of misinformation. There are so many myths out there about microwave ovens and microwave heating; the two leading myths are (1) that the radiation for microwave ovens is dangerous, so don't stand in front of the oven while it's operating; and (2) microwave-heating destroys the nutrients in foods and may even cause cancer. Obviously, both statements are nonsense; microwave energy leaking from an oven can't hurt you; and many peer-reviewed papers have shown that microwave cooking retains nutrients as well as or better than any other means of cooking, especially in vegetables and fish. But try to convince consumers who come to believe all these nonsensical rumors on the web – it's a difficult thing to try to do. You are fighting what is known as "confirmation bias".

Q. In this era of awareness to "healthy food", microwave processing seems to have an image of a yet "suspected" technology. What is your expert opinion in this regard?

A. As I stated in the previous question, microwave cooking is an extremely healthy way of cooking. The two reasons for the loss of vitamins and nutrition in general are the lose of water-soluble vitamins, and the destruction of those that are thermal labile. Well, microwave cooking generally uses very little, if any, water, depending upon the water that naturally occurs inside the fish or vegetables, and also, since it heats the food directly you don't have to heat the air to some very high temperature, or the water to boiling, in order to get the interior hot, so there is good retention of heat-sensitive vitamins. Even with prepared foods, because the air stays cold inside the oven and you're only heating the food, not the air, it means that it's more gentle heating or reheating of the products.

Q. Who is the person whom you would consider as the most influential on your professional life?

A. Let me direct my answers to the three people who've been most influential upon my professional life:

- Howard Roth, my first boss in industry, who taught me that doing good research is fine, but it doesn't mean anything unless you're able to convince people of your results. In my first project working under Howard, I solved a major problem in a few days but it took me approximately a year of intense work to convince the management of the importance and accuracy of my results.
- Jim Jolly, one of IMPI's earliest presidents, an executive at Varian Associates, with whom I worked very closely in my early days of applying microwaves to industrial processing. It was Jim who convinced me to join IMPI, then a brand-new organization, and here I am today.
- Bill Brown of Raytheon, a wonderful man who said to me, while we were hiking during my first IMPI Board meeting in 1970 (I was IMPI's new secretary), that "one day you'll be IMPI's president and I'll be there to help you".

Q. You were honored the first "Ricky Metaxas Pioneer Award" in 2012, and you are well acknowledged as a leader and founder in the microwave-heating field. How in your view should young students be attracted to join the microwave-heating field? How may the worldwide community support them in the development of early-stage careers in the field?

A. First, let me thank my peers for this award; it is easily the most important award I've ever received. It was, and still is, a humbling experience to have received such a wonderful recognition from all my peers.

Students are essential to the continuing health and the future of the microwave-heating field. We must find a way of exciting and encouraging students to recognize and utilize microwave heating in their endeavors. Such things as scholarships, workshops, and internships are essential to exposing students to the many uses and applications of microwave energy. I would like to see microwave technology become part of the curriculum in courses relating to engineering and the various sciences. Microwave-heating has a place in all of these; just look at the terrific work going

on in microwave assisted chemistry. There are many challenges out there for the young student and entrepreneur, in fields as diverse as medicine, materials processing, food technology, chemistry, etc. Every time I energize a microwave oven in my laboratory or in the kitchen, or operate an industrial microwave conveyor system, I still look at whatever is being heated by the microwaves and wonder, "how is it doing that?"

Q. What would be your experienced advice to a young engineer or entrepreneur in the field of microwave-heating?

A. When you look at my academic background you have to ask "How did this guy ever become a microwave – heating expert? After all, he graduated as a pharmacist." That's true, but my academic years were filled with disciplines that most engineers or students of the sciences never study, as I did: anatomy, physiology, botany, microbiology, analytical as well as inorganic and organic chemistries, physics, nuclear physics, biochemistry, statistics, mathematics of all kinds, and more. The result of this is that I can read and understand texts and papers in these various disciplines, maybe not as an expert, but with enough understanding. When all this was combined with my insatiable curiosity (I have a mind like a garbage can) and my total fascination with microwave energy and microwave heating, this led, after many years to become something of a microwave-heating expert. I started in the food industry where I first discovered microwave-heating and went on to work in such diverse things as aeronautics, medical devices, chemistry, and much more.

Now as to the young engineer and entrepreneur, the critical thing is to become adept in science: study not only your various engineering courses, but also lots of physics and chemistry, biochemistry, physical chemistry, etc. It's important that you remain curious about the world around you – did you ever wonder about the adhesive properties that makes duct tape stick the wall? Or, ever watch honey dripping from the spoon? That's the kind of thing that fascinates me, and when I do face a new problem, I immediately start thinking of the physics that surrounds it. You know, the bubble physics that applies to polyurethane foam is the same as that in a cake, except you can eat one of them.

Besides all the sciences, the other thing I urge young engineers to study in-depth is statistics. You are going to need it in order to do good research, and product or process development. How will you know that what you're seeing is real unless you are able to validate it statistically? So, I guess what I'm suggesting is an eclectic outlook on the world and the passion to apply what you know to those things you're trying to learn about.

Q. We are grateful, Mr. Schiffmann, for this inspiring interview, which sheds some light on your leading contributions to the microwave-heating technology over more than half a century. Thanks also for sharing with us your experience and views, as an inventor, scientist, entrepreneur, and a leader. We wish you, Bob, all the best!