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ATHANASSIOS KALIUDIS

60 years of lasers: interview with legend Michael Bass

One of the pioneers of laser technology, Professor Michael Bass has been responsible for numerous innovations in this field since 1961. We talked to him about unfinished research, the remarkable potential of diode lasers – and Bass's future as a TV reporter.

Professor Bass, your achievements in the realm of research and development are both numerous and legendary. Has there ever been a nut you simply couldn't crack?

Actually it was a diamond rather than a nut! Obviously I've come up against all sorts of perplexing problems in my career, but the whole business with the diamonds still irks me even now.

What exactly happened?

Some eight years ago a colleague and I were commissioned by a diamond producer to investigate the optical properties of synthetic diamonds, specifically CVD diamonds. We got some excellent results for the absorption of laser light from the near ultraviolet to the 10 micrometer wavelength region. But when we started using shorter wavelengths we were surprised to see a violet-hued luminescence that varied in intensity and color depending on where we started on the diamond's growth axis. That didn't bother our client because he was satisfied with the results we had achieved already and didn't want us to probe any further. My supposition is that this variable luminescence has something to do with the diamond's growth process. It still irritates me that we had to leave that research unfinished!

Well, I guess it was a minor issue...

Unfortunately not! You shouldn't underestimate the importance of diamonds in laser technology. In the future, diamonds will play a major role in the methods we use to convey high-power laser light without it causing damage along the way. The thing that makes them so interesting is their high thermal conductivity. This means that optical elements made of diamond, such as mirrors, lenses or coatings, can dissipate the heat of a high-power beam while maintaining its power. Obviously we already use high-power lasers without diamonds, but only by splitting the power and using large optics to cope with the high heat input. Diamonds could enable us to build smaller systems that would probably also be more robust. So why not use them?

Perhaps because they're so expensive?

Sure, but that high price is artificial. It all comes back to the jewelry industry and the monopolies established by dealers who can fix the price at whatever level they choose. But, from a technical point of view, it would be easy enough to turn synthetic diamonds into a cheap, mass-produced product. Diamonds have so much potential as an optical material for laser systems. So I hope someone else completes my research soon!

Professor Michael Bass is one of the founding figures of laser technology. Bass has been working with lasers since 1961 – almost since they emitted their first pulse. He is responsible for numerous developments in solid-state and dye lasers, uses of semiconductor lasers, optical glass fibers and models of fiber lasers. The recipient of many prizes and awards, Bass was inducted into the Florida Inventors Hall of Fame in 2019. (Picture: Marc Schmidt / Fotogloria)

If you were suddenly 30 again, what would you choose to work on?

Ultrashort laser pulses, without any doubt at all. There are three reasons I find that area of work so exciting. Firstly, the physics behind it is simply fascinating, studying how light interacts with materials on such a tiny time scale. Secondly, there are so many potential applications in biology, chemistry, physics and many other fields. And, on top of all that, there are numerous applications in material processing. If I was 30 again, I would opt to work on developing simpler optical systems and more robust configurations for ultrashort pulsed lasers and achieving higher average powers on a reliable basis. If we could make this amazing technology even better and simpler, I think industry would use it even more.

What other developments should we be striving for in laser technology?

Back in the 1960s, who would have thought that the most popular laser would turn out to be a semiconductor diode laser? Yet now they are everywhere, from laser printers to data acquisition devices and data transmission systems. And they still have so much more to offer. In material processing, diode lasers are primarily used to pump solid-state lasers. I think we can turn them into even better pump lasers by tweaking them to improve their beam quality and increasing their range of wavelengths. But why limit them to the role of pump lasers? I think we can further improve diode lasers in the future and then use them more often as a direct beam source for lots of other material processing applications. Maybe even for ultrashort pulses. I'm sure it will take researchers a long time to get there, but I don't see any reason not to try.

> **Innovation is what happens while you are working on something else**
>
> Professor Michael Bass

Are you still actively engaged in research work?

Luckily for me, the internet keeps me in the loop. I'm currently collaborating with a former student who is now a full professor. We're working on a special case in which ultrashort pulses cause damage to optical materials. We can swap views on the subject without actually having to be in the same room. I also regularly get requests from students or post-docs to check something they've written, which I'm always happy to do. And I try to keep up with the latest developments by reading scientific articles. As I said, it's marvelous that the Internet makes everything so easy, especially when I think how I used to spend time rummaging through card files in libraries hoping to find the information I needed! But my latest project is something quite different.

How so?

I'm helping a friend set up a new local broadcast TV channel here in Florida. Until recently I knew nothing about the television industry, so first I had to puzzle out how it all works. Now we're almost ready. The new channel will launch this year – and I will be appearing on screen, too!

A second career in television?
Doing what exactly?

Exactly what you're doing now, interviewing people! One new show that I am working on will be all about medicine. My aim will be to help people gain a better understanding of the diagnosis and treatment they get from their doctors.

Nothing to do with lasers?

Not this time. Although, to be honest, is there any aspect of modern life that doesn't involve lasers?

Good question! What do you think?

Perhaps politics, but even that can't escape the reality of computers, cell phones and fiber optics. Every area of modern life, including politics, relies on communication technology, and all communication technologies depend on lasers. In fact, this is an excellent example of the speed with which laser technology has penetrated our daily lives. I always feel that the year 1980 gave us two miracles: firstly, the US beating the Soviet Union at ice hockey in the Winter Olympics and, secondly, the fact that millions of people watched the game live on television. It was transmitted using a laser-based fiber optics system just ten years after the development of the world's first low loss optical fiber. The second miracle is arguably the most significant one!

» **If I was 30 again, I would opt to work on ultrashort pulsed lasers.**

Professor Michael Bass

What's the secret to achieving those kinds of miracles? You have come up with so many inventions over the course of your career. What is your top tip for creating innovations?

As I've often tried to explain to my students, creativity is often the result of a happy accident. Take my own example: in 1973, shortly after I arrived at the University of Southern California, I met a couple of frustrated gastroenterologists who could see ulcers bleeding in patients with their endoscope but had no way to treat it. I casually suggested using optical fibers to guide laser light into the stomach and cauterize the bleed. I thought it was a pretty innovative idea – and it was, we received a patent for this concept – But it turned out that there were no fibers robust enough to do the job at that time. So I set about working with what we could get and encouraging others to develop the kind of fibers we needed. It was this development process, motivated by the problem of bleeding ulcers, that gave rise to the new optical fibers that could be used in medicine that were the real innovation! That's often how it works. Many of the things I've developed originated from ideas I had that initially didn't work. In each case, I puzzled out what I needed to make the idea work. And it was often the inventions that emerged from that secondary process that were the more significant ones, if you see what I mean. You could almost say that innovation is what happens while you're working on something else.

No concrete tips then?

The directors of research labs and development departments will tell you that you need to create an environment where lots of creative people can share their ideas. Something like everyone standing around the coffee machine and new ideas emerging one by one. I don't deny that an open and creative atmosphere is important. But you can't force innovation and breakthroughs and you certainly can’t teach them. New ideas either emerge or they don’t – and the reason for this success or failure is often a mystery.

Crazy, isn’t it?

Not really, I think it’s actually rather comforting!

Professor Michael Bass lives in Vero Beach, Florida. (Picture: Marc Schmidt / Fotogloria)

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