The Photon:

Spotlight

On Alumna Anna Mathai

A blast from the past--Anna at a microscope in the Center for Superconductivity

Say you're running a company that develops and sells optical networking. Or how about, say, superconductors. Now how are you going to market your product to both a highly technical and non-technical audience? Easy answer: hire a Maryland Physics graduate.

In 1995, Alumna Anna Mathai graduated with a Ph.D. from the Department after working with the Center for Superconductivity and is currently a product manager for TeraBurst Networks, an optical networking company located in Sunnyvale, California. Before that she worked as a regional product manager for KLA-Tenor Corp. in San Jose developing marketing strategies for semiconductor technology.

But how in the world did she get there and why? Let's start off at her alma mater...

After earning her B.S. from the Indian Institute of Technology, Anna came to the Department to pursue a doctorate. While here, she explored various research interests, specifically in the experimental areas and researched a bit with the space physics group. Then she spoke with Physics Prof. Fred Wellstood about his work with the Center for Superconductivity (CSR). "Maryland had the nice mix of a large department--I could try out a bunch of areas. The CSR was starting up then and when I talked with Fred [Wellstood], he was just real enthusiastic, and the group was really good."

Anna was convinced. Working in the CSR with Dr. Wellstood, she dealt mostly with Superconducting Quantum Interference Devices, otherwise known as SQUIDs, and was well equipped with know-how and Ph.D. in hand. So, after graduation, Anna moved out to California to work for Conductus, Inc. as a part of their technical staff developing SQUIDs for a variety of applications.

She worked for Conductus for about two years, then she made a switch to another company and another sort of job. From Conductus, Anna moved to KLA-Tencor Corp. to work as a technical marketing engineer for two years

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On The Center for Superconductivity Research

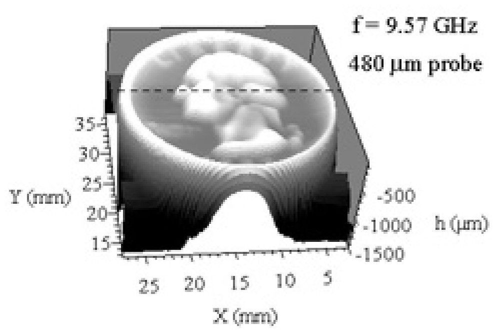
The Scanning Near-Field Microwave Microscope

by Steven Anlage
Associate Professor, UM Physics

It all started in the spring of 1994, when an undergraduate Physics major C. P. (Gus) Vlahacos, (B.S. Physics, 1996, M.S. Physics, 1999) was given an unusual assignment by his advisors, Profs. Frederick C. Wellstood and Steven M. Anlage of the Physics Department and Center for Superconductivity research.

We had asked ourselves this question: what would happen if we put a microwave signal into an open-ended coaxial cable (much like the one that brings cable tv to your house), shined it on a sample, and then scanned the sample back and forth right beneath the probe? It was a simple idea, discussed over lunch, and it seemed a bit crazy at the time. We asked Gus Vlahacos to try this crazy idea with some microwave equipment, an x-y scanner, and a computer in the laboratory.

In a few days, Gus brought back images of samples he had found lying about the lab, including printed circuit boards, metallic lines on glass plates, tree leaves, and microwave signals propagating in circuits. Both Prof. Wellstood and I were struck by the dramatic contrast visible in these images, as well as their vivid clarity and sharpness. It was clear that something unusual had been found.

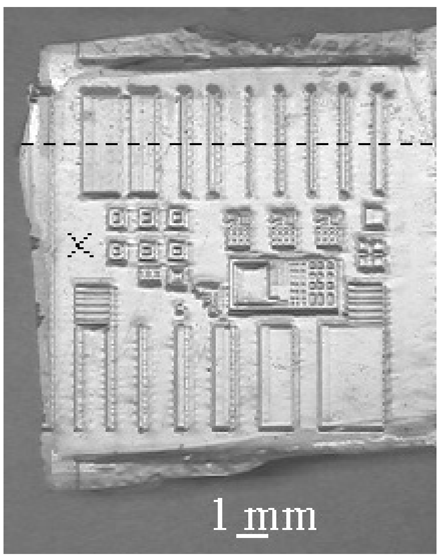


Topographic image of a US quarter scanned by a microwave microscope.

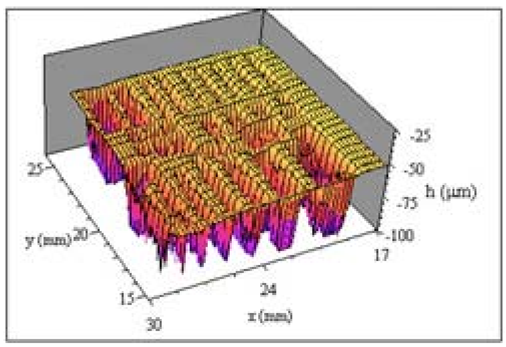
It took several months to completely understand what was happening in this new kind of "microscope." A series of experiments were constructed to clarify the origin of the amazing images generated by the instrument. From these experiments, we discovered that the sample was being probed by the "near-field" electromagnetic fields generated by the open-ended coaxial probe. This meant that the smallest thing we can see is determined by the size of the probe, which we can control, rather than by the wavelength of the radiation. It was demonstrated that extremely high resolution imaging could be possible.

Further efforts to understand and quantify the properties of the microscope were made by students who joined the group. These include two more physics undergraduates, Sudeep Dutta (B.S. Physics, 1998) and Paul Petersan (B.S. Physics, 1998), as well as several graduate students, David Steinhauer (Ph.D., Physics, 2000), Ashfaq Thanawalla (Ph.D., Physics, 2000), Wensheng Hu (M.S. E.E., 1999), John Lee, and Atif Imtiaz, and two post-doctoral researchers, B. Johan Feenstra (now at Philips Research Laboratory, Eindhoven, The Netherlands) and Andrew Schwartz (now head of the EPSCAN™ group at Neocera, Inc.).

The group quickly realized that the microscope could best operate as a microwave resonator. Graduate student David Steinhauer developed a method to make the microscope into a high quality-factor resonator and then invented a method to extract two kinds of images from the microscope while it scanned over the sample. One image was of the reactive response of the sample to the microwaves, while the other measures the lossyness of the material.



Glass chip

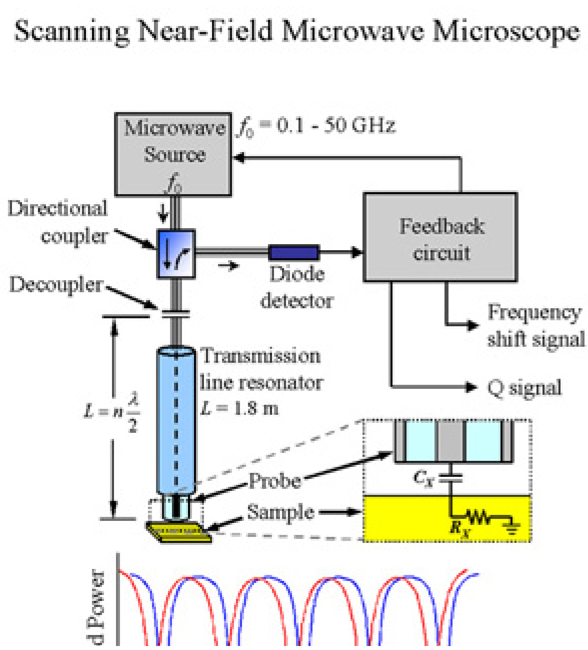


Topographic image of the etched glass chip

The work of Vlahacos, Steinhauer, Wellstood and Anlage culminated in a US Patent on the basic microscope invention (patent # 5, 900, 618) issued on May 4, 1999. The work of the group continued along the lines of creating quantitative images of materials properties. This work also dovetailed nicely with the NSF-sponsored Materials Research Science and Engineering Center (MRSEC) devoted to oxide thin films.

Soon many quantitative imaging methods were invented with the microscope. This includes quantitative imaging of topography, sheet resistance, and dielectric constant. David Steinhauer, assisted by Dr. Feenstra, developed a way to use the two images generated by the microscope to uniquely determine two independent physical properties of the sample. Examples include simultaneous quantitative imaging of sample topography and sheet resistance, or of film thickness and dielectric constant. This development is covered in a pending US patent by Steinhauer, Feenstra, Wellstood and Anlage. Currently, we are pushing the resolution limit of the microscope below 100 nm, with the help of scanning tunneling microscopy techniques. Our efforts focus on localized fundamental electromagnetic measurements of correlated electron systems.

A separate version of the microscope was developed which basically runs in reverse. The idea is to take a "picture" of microwave fields near operating circuits. To do this, we use a coaxial probe to "sniff" the fields just above the circuit. The efforts to make this microscope work, and to develop it as a quantitative tool, were led by Sudeep Dutta, a physics undergraduate student. Sudeep imaged all three components of the microwave electric field quantitatively, and another undergraduate physics major, Paul Petersan, developed a quantitative magnetic field imaging technique.



Sudeep wrote a paper about his work, now published in Applied Physics Letters. {S. K. Dutta, C. P. Vlahacos, D. E. Steinhauer, Ashfaq S. Thanawalla, B. J. Feenstra, F. C. Wellstood, Steven M. Anlage, and Harvey S. Newman, "Imaging Microwave Electric Fields Using a Near-Field Scanning Microwave Microscope," Appl. Phys. Lett.74, 156 (1999). cond-mat/9811140.}

Sudeep is now a graduate student in Physics at the University of California, This commercialization effort has resulted in many benefits to the university. First, one of Prof. Anlage's post-doctoral researchers, Dr. Vladimir Talanov, has been hired by Neocera to help develop the commercial instrument. Neocera also employs David Steinhauer (who is also currently working with me) as a consultant on the microscope commercialization project.

In addition, a number of joint research grants have been obtained for further work on the microscope. These include an NSF-funded Small Business Innovative Research grant, as well as a Maryland Industrial Partnership grant.

The development of the scanning near-field microwave microscope in the Physics department has proven to be a very fruitful endeavor. More benefits are expected as students continue their thesis research on projects related to

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and then as a regional product manager. With her technical and academic experience, Anna had a invaluable background as a technical marketer--she knew the product and the science that made it work. There she basically designed and drove particular account strategies in the semiconductor industry for penetration of Film and Surface Technology (FaST) products.

So why the switch from technical staff to marketing? Anna explains, "When I moved to California, I was working on product development of SQUIDs, but after a while, I wanted to be in a position to more strongly drive the product."

Anna explains that while she enjoyed the small company feel of Conductus and working with the technology directly, she didn't like getting embedded in all the details of "debugging" the products. "I don't miss working weekends to make things work. As a member of the technical staff, it takes so much effort to get [the product] working, and you don't get to direct where it goes. Now I'm involved in the bigger picture."

Currently, she's working for TeraBurst Networks as a product manager in the optical networking field. So, different field but same big picture interests. Anna explains that, "There has been a lot of buzz about networking and I just wanted to be a part of it."

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