the chemists club

Fall 2012

Alumna profile: Zhenan Bao

By the skin of her tech

Electrical devices come in all shapes and sizes, but the traditional design paradigm has always been a box. The rise of polymer-based electronics seems poised to create a paradigm shift—by making possible a new generation of flexible, stretchable devices. Zhenan Bao, SM'93, PhD'95, an associate professor of chemical engineering at Stanford University, has an ambitious vision for that technology: to combine bendable organic polymers into a new kind of device that she calls an "electronic skin."

Such flexible electronics have many advantages over the copper- and silicon-based kind. Numerous applications have been suggested, such as ultrathin, lightweight solar panels and computer displays with the thinness and bendability of paper. But their biggest advantage might be cheaper costs, in terms of both raw materials and production. Bao says that the best designs for polymer-based conductors and semiconductors are already comparable to amorphous silicon transistors, "but that's not good enough. We need to get them to a level similar to polysilicon transistors in order to be attractive enough for mainstream electronic components."

Continued from cover

Alumna profile: Zhenan Bao

Bao started down this path as a graduate student in the lab of chemistry professor Luping Yu, developing a way to synthesize conducting and semiconducting polymers. After earning her doctorate, she went to work for Bell Labs, which was starting a program to use organic materials to make thin-film transistors, key components for most electronics. "I thought that with the synthesis background I had, I could make a contribution quickly," she says. "My work has been evolving into new directions over the years, but the fundamental core of my work has always been rational design of materials and molecular engineering."

The electronic skin is one of the many fruits of that evolution. Like real skin, this material would be stretchable and bendable and would contain various sensors. Already Bao's group has demonstrated a touch sensor sensitive enough to detect a fly landing on it. Electronic skin also would be biodegradable and compatible with the human body. "If we can create it, we can apply that research to make things like diagnostic devices, flexible displays, and even integral medical devices," she says. But unlike skin, Bao's electronic variety would be powered by sunlight and contain a layer of sensors for specific proteins, providing a swift biochemical analysis with a single touch.

To bring her vision to reality, Bao and two former lab members started a company, C3Nano, three years ago. So far, they've raised $10 million to develop flexible and stretchable transparent electrodes for computer touch screens.

There's a vast difference between running a start-up and running a research group, she's found. Unlike laboratory demonstrations, commercial products need to be reliable and mass-produced. "It's a great learning process, and it's exciting to learn about business and what it takes to develop a product. That makes me rethink what aspects are important to consider when developing a new idea."

Although she's part of a chemical engineering department, Bao feels that the fundamental training she received in graduate school was instrumental for the further development of her career. "When students come to me and want to join the group and ask what kind of project they should work on, I always tell them it's most important to have a solid fundamental foundation first," she says. "Then they can solve any problem."

Link with us

The Department of Chemistry encourages all alumni to connect with current chemistry students and each other on the social networking site LinkedIn. The department's group, called The University of Chicago Department of Chemistry Network, can be found at tinyurl.com/7efp2t2. Feel free to post questions for discussion and add your own two cents in comments. The more students and alums who interact, the more useful the group will be.

CORRESPONDENCE

The recent issue of *Chemists Club* was stimulating indeed!

Perhaps because I live in a retirement community where the average age may be close to 80 (and I'm 93), I am overly impressed by such youthful faces—not just the recent alum, but also those of distinguished faculty members.

I flash back to the sunny afternoon when I was walking toward the campus, past the entrance to the stadium on Ellis. Was it 1942 in the spring? A delivery truck was there, and sitting near the curb were a number of cases clearly labeled "Mallinckrodt URANIUM."

I thought that was a crazy place to deliver chemicals. Who would want uranium there? And ever since the details about the first pile were announced, I've wondered how crazy to allow such labeling were the brilliant people associated with the project!

Frank L. Lambert, PhD'42
Professor emeritus, Occidental College

Chemists Club invites all alumni to share their stories and news. Just send an e-mail to chemistsclub@uchicago.edu or a letter in care of the editor to the Department of Chemistry.

SUPPORT THE DEPARTMENT OF CHEMISTRY Scientific research is an endothermic process: it requires constant external inputs to continue. The Department of Chemistry would not be able to continue its mission of research and education without aid from its friends and alumni. You can help keep the process of scientific discovery going by making a gift to the department. Just send a check to:

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The students, faculty, and staff of the department are grateful for your support.

CHEMISTRY EVENTS The calendar of named lectures for the 2012–13 academic year, as well as the most up-to-date information about Department of Chemistry lectures and events, can be found online at event.uchicago.edu/chem/index.php.

LET'S KEEP IN TOUCH The Department of Chemistry is updating its records. Send your current e-mail address and other contact information to Casey Stringham at chemistsclub@uchicago.edu.

IN MEMORIAM

Liselotte Closs
1927–2012

A chapter of the Chemistry Department's history closed forever on January 7, 2012, when Liselotte Closs (Lilo to her friends) died in Massachusetts at the age of 84. She and Gerhard Closs were a formidable husband-and-wife team of chemists who, together and apart, made influential discoveries in the field at Chicago in the late 20th century.

Liselotte Pohmer was born in 1927 in Germany; Gerhard Closs was born a year later. They met while studying chemistry at the University of Tübingen, in the lab of future Nobel laureate Georg Wittig. Gerhard moved to America to accept a postdoctoral position at Harvard University, where he married Lilo in 1956. In 1957, Gerhard took a position as an assistant professor in the University of Chicago's Department of Chemistry, and the couple moved to the Midwest.

Because University anti-nepotism rules prevented wives from holding positions in the same departments as their husbands, Lilo worked as an unpaid volunteer in Gerhard's lab. It was an intellectually fruitful partnership; the couple coauthored 15 papers between 1959 and 1969, including pioneering studies of chemically induced dynamic nuclear polarization and the use of magnetic resonance to study chemical reactions.

Over the course of his career, Gerhard also made important contributions to the understanding of photochemistry and photosynthesis. Outside the lab, he enjoyed classical music and sailing on Lake Michigan. He served as the section head in Argonne National Laboratory's chemistry division from 1979 to 1983 and was chairman of the Department of Chemistry from 1990 until his death in 1992.

Lilo believed that her generation in Germany had not done enough to prevent World War II, and so she left her husband's lab in 1968 to work for the presidential campaign of Senator Eugene McCarthy, a vocal opponent of the Vietnam War. Late r she took a position in the Ben May Cancer Institute in the lab of Elwood Jensen. There she helped develop a diagnostic kit for breast cancer that is now the standard test for that disease worldwide. She retired from science in 1983 and changed careers, opening a knitting shop in the Chicago suburbs.

Upon Gerhard's death, the Department of Chemistry founded the Gerhard Closs Research Fund in his memory. With Liselotte's death, the department has renamed it the Gerhard and Liselotte Closs Research Fund. Those who wish to make a gift in the Closses' memory are invited to contact Laura Baker at the Department of Chemistry at 773.702.8639 or lbaker@uchicago.edu.

FACULTY KUDOS

Aaron Dinner, **Joseph Piccirilli,** and **David Mazziotti** have been promoted to professor of chemistry, all effective July 1, 2012.

Steven Sibener has won the 2012 American Vacuum Society (AVS) Prairie Chapter Award for Outstanding Research. He will accept the award and present the opening plenary lecture at the forthcoming AVS meeting in September.

Chuan He has won the 2012 Mr. and Mrs. Sun Chan Award in Organic Chemistry. Presented at the biennial International Symposium for Chinese Organic and Inorganic Chemists, this award is given to an organic chemist under the age of 45 in recognition of his or her outstanding achievements. He is the second Chicago faculty member so honored; chemist Luping Yu received the award in 1998.

Gregory Engel has been named a 2012 Sloan Research Fellow. Fellows are selected by the Alfred P. Sloan Foundation on the basis of their independent research accomplishments, creativity, and potential to become leaders in the scientific community through their contributions to their field. The fellowship consists of a $50,000 research grant, which may be applied to any aspect of the fellow's research.

Engel has also been awarded a Camille Dreyfus Teacher-Scholar Award, which provides an unrestricted research grant of $75,000 to early-career faculty in chemistry. Criteria for selection include an independent body of scholarship attained within the first five years of their appointment as independent researchers and a demonstrated commitment to education, signaling the promise of continuing outstanding contributions to both research and teaching.

Engel's teaching has won him recognition from the University as well: a 2012 Quantrell Award for Excellence in Undergraduate Teaching. The award comes with a $5,000 prize and is generally thought to be the nation's oldest prize for undergraduate instruction.

Engel has also been promoted to the rank of associate professor with tenure.

Staff profile:

Melinda Moore

In service to students

There is no phase of a chemistry graduate student's education at Chicago that Melinda Moore, AB'74, AM'77, PhD'83, the department's student service representative, doesn't have a hand in. Have a question about applying to graduate school? See Melinda. Need to get on the payroll? See Melinda. Need to register for next quarter's classes? See Melinda. Planning the year-end party? Yep, see Melinda.

Moore's history with the Chemistry Department goes back to 1981. A graduate student in anthropology, she was looking for a job that she could do part time while finishing her dissertation and found a position administering grants for the department's scientists. It was just supposed to be something to tide her over, but she found she enjoyed the work and eventually took it on as a full-time career.

The department was a different place back then, Moore remembers. Each research group had its own administrators, and there were fewer centralized staff. It was a more formal time too. She recalls a colleague instilling in her an attitude "almost of awe" towards the faculty, a far cry from the casual, collegial anthropology department she was used to.

She worked grants administration for 20 years before becoming the student service representative in 2001. Today she oversees all aspects of a graduate student's experience, from the moment their application gets delivered to Searle to the moment they get their diploma. She's responsible for setting up the recruitment events in February and March, an undertaking that involves planning parties, outings, poster sessions, and one-on-one meetings with faculty members for dozens of prospective young chemists over the course of three days—and doing it all over again the next month for a second group. She makes sure the students get through academic progress reports and candidacy exams and that they turn in their dissertations on time and remember to fill out their paperwork to graduate.

Moore also helps students work through any bureaucratic tangles, such as making sure foreign students' parents have visas so they can come for graduation. ("I do many different things," she says, "but my favorite would be any time I can help a student out of an administrative difficulty.") She says her job gives her a "sense of satisfaction and accomplishment to know I'm helping the top researchers in the world to accomplish their goals. It's a very worthwhile place to work because you know so many worthwhile things are being done here—so many things that will make our future better."

Graduate student profile:

Nicole Tuttle

Splice of life

A living cell is a veritable chemical factory, constantly breaking up proteins and constructing new ones. But not every machine in this factory is well understood. Fifth-year graduate student Nicole Tuttle, SM'09, is trying to remedy that biological lacuna using chemistry; after all, as she says with a little exaggeration, "biology is just chemistry writ large."

Her research focuses on a component called the spliceosome. In order to express the instructions contained in DNA, a cell first copies that information into RNA, which the spliceosome cuts into noncoding sections called introns and coding sections called exons. The spliceosome then discards the introns and links together the exons to create instructions for the cell to carry out.

How the spliceosome actually does its job is not fully understood. It's not a simple molecule; the yeast cells that Tuttle works with contain spliceosomes with five strands of RNA and roughly 80 other proteins. (Human spliceosomes are similar but even larger.) With the other chemists in the lab, who help her design experiments to test hypotheses about the role of particular atoms, "we're discovering all kinds of interesting new things about regulation and splicing. It's enormously complex."

The lab of associate professor of chemistry Joseph Piccirilli, where Tuttle works, has been studying catalytic RNA molecules for 20 years. Yet she says there's much more to learn about the role RNA plays in the cell. "We've discovered in last two years that it's much broader than we ever imagined," including the first hints as to what shape the spliceosome itself takes and where it contacts the RNA.

Before Tuttle came to Chicago, there was a detour: two years teaching science to sixth-graders in Atlanta under the auspices of Teach for America. It was a hectic and chaotic experience, but she's glad she did it. "It exposed me to a world I didn't know existed and persuaded me that there were questions of social justice out there that needed to be addressed."

"One thing my students in Atlanta taught me was that really anybody can be successful at science if they're well taught," she says. "I think students who come in without that strong math and science background sometimes struggle because we assume some knowledge that they don't necessarily have." Tuttle herself is a good example of how influential teaching can be. As a high schooler, she had no interest in biology, considering it disordered by comparison to chemistry. Seeing how evolution tied all the strands of biology together fired her interest in the field—and, through her research, may even change its course.

"One thing my students in Atlanta taught me was that really anybody can be successful at science if they're well taught."

Faculty Q&A

Yossi Weizmann

Yossi Weizmann is assistant professor of chemistry. He earned his bachelor's degree from the Braude Academic College of Engineering in 2000 and his master's of science and doctorate in chemistry from the Hebrew University of Jerusalem in 2002 and 2007, respectively. He was a postdoctoral scholar at MIT from 2008 to 2011, when he came to Chicago to join the Department of Chemistry faculty.

What's the main focus of your research?

I have two different subjects I'm working on, both connected to DNA. It is the building block of life, and we can program it to our own needs. The big idea is to understand how DNA folds, functionalize it, and then use it as a platform to develop desired functional structures and superior sensors.

One direction is related to diagnostics; we are trying to create an ultrafast, sensitive assay for viruses, pathogens, and genetic disorders, which can also be used for forensic applications. The other direction is programming DNA to create complexes with designed functionalities and structures. DNA scaffolds offer two significant advantages: size-scale and programmability. The use of a polymeric DNA template for precisely controlled and programmable scaffolds to organize functional nanomaterials at the nanometer scale paves the way for nanoassemblies in electronic devices, biosensing, catalysis, and building complex nanostructures. For example, if you have something that requires an enzymatic cascade to produce a specific product, we can use DNA nanostructures to create and mimic that enzymatic cascade in vitro.

Why use DNA for this?

If you want a biosensor to target, for example, a virus, first you need to know the virus's genetic sequence. Once you know that, you can design a specific sequence of DNA that will recognize a genetic sequence in that virus.

Next you need to find improved systems to replicate the virus's genetic material in quantities large enough to test. Right now the polymerase chain reaction (PCR) is the gold standard for replicating trace amounts of DNA. But to carry out PCR, you need, in principle, three steps. First, you heat your sample to very high temperatures to unravel double-stranded DNA. Second, you reduce the temperature to get the DNA polymerase started. Finally, you heat it again to replicate the strands. This thermal cycle requires special instrumentation, and it's difficult to build it into a portable device.

We are working on a very sophisticated method that can do the same task at a fixed temperature, with better sensitivity, and in 15 minutes instead of two hours. Since the temperature is fixed, we don't need sophisticated instrumentation, and it requires less energy. Making it portable means we can move the device to where it's needed, instead of waiting for results to come back from a lab. The speed and mobility are particularly important for homeland security or the military, where the applications are time-sensitive.

In your work, you often create what you call hybrid materials and emergent properties. What are those?

We call them hybrid because we integrate two worlds, chemistry and biology. We can take, for example, carbon nanotubes, which are inorganic materials, and immobilize biological material on them or combine them with biological materials like DNA to create a hybrid, with the aim of creating a superior sensing device.

Having emergent properties—ones that you cannot predict or understand in terms of the properties of the constituent material—means you can design materials with specific properties for a specific problem. For example, I was in the Israeli Army. I know that if you're in battle and want to know if you've been exposed to nerve gas or a biological warfare agent, you cannot wait three hours to find out. You want something that can give you an answer immediately. Or if you're in homeland security and you want to detect explosives like TNT, PETN, or RDX, you want to do it fast. If you don't, it's too late.

When did you first become interested in using DNA for this purpose?

I grew up a farmer—my parents have cows for milk, so I worked on the farm from a very early age. My first experience as a researcher was in plant molecular biology, where I was trying to improve plants' properties. Then I moved into practical applications in the medical field; I found this area very attractive.

There are two kinds of research—fundamental and practical—and I do both. Fundamental work in my lab focuses on understanding how DNA is folded and how the enzymes work with it. But I'm also a very practical person. My goal is to make people's lives better through applications of my research. Hopefully, by creating things like an early diagnostic test for cancer, we can save lives. This is my motivation.

Congratulations

AB and SB Recipients

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Dear friends,

Students are the lifeblood of the Department of Chemistry and, in no small part, our raison d'être. They play a central role in both the design and the execution of our research programs, and, without them, our work would grind to a halt. But they are also the way we propagate our field, handing Chicago's legacy of excellence in chemistry down to the next generation. We try to recruit the best students, give them the best education possible, and provide them with the resources they need to develop into independent scientists and leaders.

We have 174 graduate students registered for this coming year, including an excellent incoming class of 31. Recruiting graduate students is a major production, as many of you will recall from your own student days. This issue's staff profile is of Melinda Moore, who, as student service representative, plays a central role in the department's recruiting operation.

There are two ways you can help us with graduate student recruiting. First, please talk up the department with any aspiring chemists you know. For a prospective student, a few minutes chatting with an alum are worth an hour of poring over our website. Second, please consider making a donation to the Chemistry Alumni Fellowship Fund. This fund helps us to provide competitive stipends to our students, which is critical for competing with our peer institutions for the top talent. I have written it before, but it bears repeating: recruiting top students helps us to recruit top faculty, and vice versa. Both efforts are critical for the future success of the department.

Best regards,

Richard F. Jordan
Professor and Chairman