CONVERSATIONS WITH SCIENTISTS

Nian Xiang Sun: Miniaturizing Magnetoelectrics

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Northeastern University

"I believe these magneto-electric acoustic antennas are among the most exciting developments in the field of magnetoelectrics and multiferroics in the last 20 years. And, if realized, miniature biomedical systems ... could be among the most important developments in the next 20 years."

Nian Xiang Sun is a professor of electrical and computer engineering and director of the W. M. Keck Laboratory for Integrated Ferroics at Northeastern University in Boston, Massachusetts. Sun earned bachelor's degrees in materials science and engineering from Huazhong University of Science and Technology in China in 1993 and a master's degree from the Chinese Academy of Sciences in 1996. Relocating to the United States, Sun received another master's degree in 2001 and a Ph.D. the following year in materials science and engineering from Stanford University in California. Prior to joining Northeastern University, Sun was a research scientist at IBM and at Hitachi Global Storage Technologies.

Sun is the recipient of several awards and honors, including the National Science Foundation CAREER Award, the Office of Naval Research Young Investigator Award, and the first IDEMA fellowship. He is an editor of IEEE Transactions on Magnetics *and a fellow of the Institute of Physics and of the Institution of Engineering and Technology. Operating at the cutting edge of materials science and engineering, Sun has published more than 200 peer-reviewed journal papers, holds more than 20 patents, and has given dozens of keynote presentations at international conferences.*

Sun's research focuses on "integrated magnetics and multiferroics for sensing, memory, power, RF and microwave electronics." Specifically, his lab works on "materials and microsystems for biomagnetic sensing, micromagnetic neural stimulation, room-temperature electro-magneto-encephalography, tunable RF/microwave components, and integrated thermoelectric materials and devices."

Below are Nian Xiang Sun's November 15, 2017 responses to questions posed to him by Today's Science. *Some of the questions deal with how he became interested in science and began his career in engineering, while others address particular issues raised by the research discussed in Small Antennas, Big Applications.*

Q. When did you realize you wanted to become a scientist?

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Small Antennas, Big Applications
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A. I already knew I wanted to be a scientist when I was very little and in primary school. This aspiration has been there ever since, but I realized that I could be a good scientist only when I reached graduate school, when I found out that I could do well in scientific research.

Q. How did you choose your field?

A. I chose my field of research when I was applying for admission to various Ph.D. programs. I was lucky to get admitted to all the top universities in the U.S. I applied to, including Stanford, Caltech, Harvard, MIT, Berkeley, etc. I decided to go to Stanford and do research in an area that can directly benefit human society, instead of choosing a field of pure research that does not have much to do with everyday life.

Q. Are there particular scientists, whether you know them in person or not, that you find inspiring?

A. Yes, when I was little, I read many stories of famous scientists who impacted our lives, and these have inspired me throughout my life.

Q. What do you think is the biggest misconception about your profession?

A. The biggest misconception about my profession, being a professor, is that people tend to believe that professors have a lot of leisure time. As a matter of fact, I am much busier now than I was when I was in industry (working, e.g., at IBM). You have to like being a professor in order to do well at it.

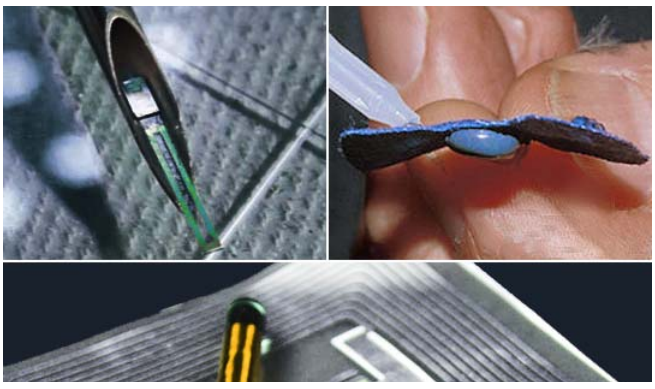
Q. Your antenna, if I understand correctly, translates electromagnetic waves into acoustic resonance, and this enables the use of much smaller antennas. Does using acoustic resonance create any new problems—less accuracy or more interference, for example?

A. Acoustic resonance does not automatically lead to less accuracy or more interference.

Q. Your article states that your new approach allows antennas to be miniaturized by one or two orders of magnitude. Is this sufficient for most conceivable applications, or would further miniaturization be desirable, if possible?

A. Further miniaturization would certainly be desirable. But there are no known ways for further miniaturization at this moment.

Q. One application mentioned for your research is to allow more miniaturized implantable medical devices that could receive messages. Are there any concrete projects going forward now in that area?



Top Left and Bottom: Medical Design and Outsourcing; Top Right: Jason Edwards/National Geographic/Getty Images

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A. Yes, we are working hard with a couple of large teams on projects related to implantable medical devices with our acoustic antennas.

Q. Where do you spend most of your workday?

A. I spend most of my workday in my office or traveling. I work with physicists, materials scientists, electrical engineers, medical doctors such as neurosurgeons, etc.

Q. What do you find most rewarding about your job? What do you find most challenging about your job?

A. Having the freedom to work on things that interest me is especially rewarding. The most challenging thing about my job is getting funding to keep the research going.

Q. What has been the most exciting development in your field in the last 20 years? What do you think will be the most exciting development in your field in the next 20 years?

A. I personally believe these magnetoelectric acoustic antennas are among the most exciting developments in the field of magnetoelectrics and multiferroics in the last 20 years. And, if realized, miniature biomedical systems enabled by these compact magnetoelectric antennas and by magnetoelectric random access memory could be among the most important developments in the next 20 years.

Q. How does the research in your field affect our daily lives?

A. Our research can have an enormous impact on people's lives. For example, I developed FeCoN films [soft magnetic thin films] when I was a graduate student. These films have ended up in most of the hard disk drives that we use in computers, other internet-access devices, etc. Also, our new compact antennas have the potential to be used in biomedical devices, smartphones, IoT [the Internet of Things], etc., which all greatly impact our daily lives.

Q. For young people interested in pursuing a career in science, what are some helpful things to do in school? What are some helpful things to do outside of school?

A. Stay focused on your course work, be proud of being a nerd, and, most importantly, challenge your teachers, even though it is hard to do. Explore your interests, using the internet for that purpose.