

SPACE WAR  
YOUR WORLD AT WARTERRADAILY  
REAL ABOUT PLANET EARTHENERGY DAILY  
THE GREAT OF ATOM AND NUCLEARSOLAR DAILY  
HOW HOT AT A TIMEMOON DAILY  
THE HISTORY, EXPLORATION AND APPLICATION OF MOONGPS DAILY  
CONNECTING PEOPLE TO ANYWHERENANO DAILY  
SCIENCE AND TECHNOLOGYROBO DAILY  
THE SCIENCE, HISTORY AND APPLICATION OF ROBOTSJAPAN PRESS NETWORK  
Technology - business - cultureMARS DAILY  
THE HISTORY, EXPLORATION AND APPLICATION OF MARS

# SPACE DAILY

your portal to space

Discover more

[Space documentaries subscriptions](#)[Science](#)[Space themed games](#)[VR space experiences](#)[Celestial body jewelry](#)[science](#)[Satellite tracking software](#)[Star charts posters](#)[Space exploration newsletter](#)[Space themed apparel](#)

## CHIP TECH

# Pushing the limits of electronic circuits

by Adam Zewe for MIT News  
Boston MA (SPX) Nov 19, 2021

Ruonan Han's research is driving up the speeds of microelectronic circuits to enable new applications in communications, sensing, and security.

Han, an associate professor who recently earned tenure in MIT's Department of Electrical Engineering and Computer Science, focuses on producing semiconductors that operate efficiently at very high frequencies in an effort to bridge what is known as the "terahertz gap."

The terahertz region of the electromagnetic spectrum, which lies between microwaves and infrared light, has largely eluded researchers because conventional electronic devices are too slow to manipulate terahertz waves.

"Traditionally, terahertz has been unexplored territory for researchers simply because, frequency-wise, it is too high for the electronics people and too low for the photonics people," he says. "We have a lot of limitations in the materials and speeds of devices that can reach those frequencies, but once you get there, a lot of amazing things happen."

For instance, terahertz frequency waves can move through solid surfaces and generate very precise, high-resolution images of what is inside, Han says.

Radio frequency (RF) waves can travel through surfaces, too - that's the reason your Wi-Fi router can be in a different room than your computer. But terahertz waves are much smaller than radio waves, so the devices that transmit and receive them can be smaller, too.

Han's team, along with his collaborator Anantha Chandrakasan, dean of the School of Engineering and the Vannevar Bush Professor of Electrical Engineering and Computer Science, recently demonstrated a terahertz frequency identification (TFID) tag that was barely 1 square millimeter in size.

"It doesn't need to have any external antennas, so it is essentially just a piece of silicon that is super-cheap, super-small, and can still deliver the functions that a normal RFID tag can do. Because it is so small, you could now tag pretty much any product you want and track logistics information such as the history of manufacturing, etc. We couldn't do this before, but now it becomes a possibility," he says.

## Tuning in

A simple radio inspired Han to pursue engineering. As a child in Inner Mongolia, a province that stretches along China's northern border, he pored over books filled with circuit schematics and do-it-yourself tips for making printed circuit boards. The primary school student then taught himself to build a radio.

"I couldn't invest a lot into those electronic components or spend too much time tinkering with them, but that was where the seed was planted," he says. "I didn't know all the details of how it worked, but when I turned it on and saw all the components working together it was really amazing."

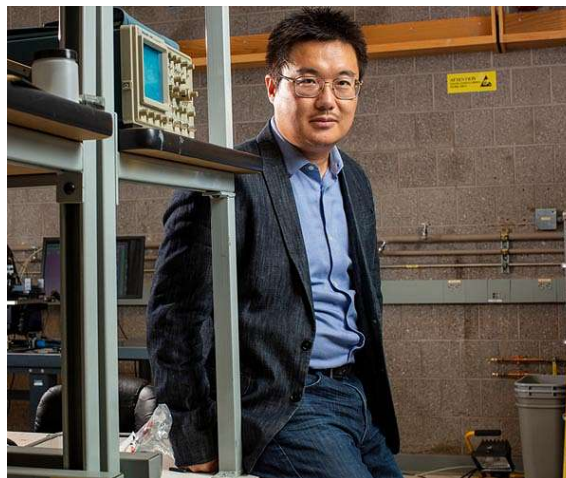
Han studied microelectronics at Fudan University in Shanghai, focusing on semiconductor physics, circuit design, and microfabrication.

Rapid advances from Silicon Valley tech companies inspired Han to enroll in a U.S. graduate school. While earning his master's degree at the University of Florida, he worked in the lab of Kenneth O, a pioneer of the terahertz integrated circuits that now drive Han's research.

"Back then, terahertz was considered to be 'too high' for silicon chips, so a lot of people thought it was a crazy idea. But not me. I felt really fortunate to be able to work with him," Han says.

He continued this research as a PhD student at Cornell University, where he honed innovative techniques to supercharge the power that silicon chips can generate in the terahertz domain.

"With my Cornell advisor, Ehsan Afshari, we experimented with different types of silicon chips and innovated many



Ruonan Han, associate professor in the Department of Electrical Engineering and Computer Science, seeks to push the limits of electronic devices so they can operate efficiently at terahertz frequencies.

mathematics and physics 'hacks' to make them run at very high frequencies," he says.

As the chips became smaller and faster, Han pushed them to their limits.

#### **Making terahertz accessible**

Han brought that innovative spirit to MIT when he joined the EECS faculty as an assistant professor in 2014. He was still pushing the performance limits of silicon chips, now with an eye on practical applications.

"Our goal is not only to work on the electronics, but to explore the applications that these electronics can enable, and demonstrate the feasibility of those applications. One especially important aspect of my research is that we don't just want to deal with the terahertz spectrum, we want to make it accessible. We don't want this to just happen inside labs, but to be used by everybody. So, you need to have very low-cost, very reliable components to be able to deliver those kinds of capabilities," he says.

Han is studying the use of the terahertz band for rapid, high-volume data transfer that could push wireless devices beyond 5G. The terahertz band could be useful for wired communications, too. Han recently demonstrated the use of ultrathin cables to transmit data between two points at a speed of 100 gigabits per second.

Terahertz waves also have unique properties beyond their applications in communications devices. The waves cause different molecules to rotate at unique speeds, so researchers can use terahertz devices to reveal the composition of a substance.

"We can actually make low-cost silicon chips that can 'smell' a gas. We've created a spectrometer that can simultaneously identify a large range of gas molecules with very low false alarms and high sensitivity. This is something that the other spectrum is not good at," he says.

Han's team drew on this work to invent a molecular clock that turns the molecular rotation rate into a highly stable electrical timing signal for navigation, communication, and sensing systems. Although it functions much like an atomic clock, this silicon chip has a simpler structure and greatly reduced cost and size.

Operating in largely unexplored areas makes this work especially challenging, Han says. Despite decades of advances, semiconductor electronics still aren't fast enough, so Han and his students must constantly innovate to reach the level of efficiency required for terahertz devices.

The work also requires an interdisciplinary mindset. Collaborating with colleagues in other domains, such as chemistry and physics, enables Han to explore how the technology can lead to useful new applications.

Han is glad he's at MIT, where the students aren't afraid to take on seemingly intractable problems and he can collaborate with colleagues who are doing incredible research in their domains.

"Every day we are facing new problems and thinking about ideas that other people, even people who work in this field, may consider super-crazy. And this field is in its infancy right now. There are a lot of new emerging materials and components, and new needs and potential applications keep popping up. This is just the beginning. There are going to be very big opportunities lying ahead of us," he says.

#### **Related Links**

[Terahertz Integrated Electronics Group](#)  
[Computer Chip Architecture, Technology and Manufacture](#)  
[Nano Technology News From SpaceMart.com](#)

#### **Thanks for being there;**

We need your help. The SpaceDaily news network continues to grow but revenues have never been harder to maintain.

With the rise of Ad Blockers, and Facebook - our traditional revenue sources via quality network advertising continues to decline. And unlike so many other news sites, we don't have a paywall - with those annoying usernames and passwords.

Our news coverage takes time and effort to publish 365 days a year.

If you find our news sites informative and useful then please consider becoming a regular supporter or for now make a one off contribution.

#### **SpaceDaily Monthly Supporter \$5+ Billed Monthly**

Option 1 : \$5.00 USD - monthly ▾

[Subscribe](#)  
paypal only

#### **SpaceDaily Contributor \$5 Billed Once**

[Donate](#)  

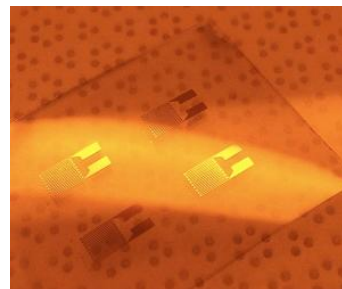

credit card or paypal

#### **CHIP TECH**

### **Study challenges standard ideas about piezoelectricity in ferroelectric crystals**

University Park PA (SPX) Nov 19, 2021

For years, researchers believed that the smaller the domain size in a ferroelectric crystal, the greater the piezoelectric properties of the material. However, recent findings by Penn State researchers have raised questions about this standard rule. Ferroelectric materials possess spontaneous electric dipole moments that can be reversibly flipped by applying an electric field. Domains are areas in the ferroelectric crystal that have the dipole moments aligned in the same direction. Piezoelectricit ... [read more](#)



[Comment using your Disqus, Facebook, Google or Twitter login.](#)

Share this article via these popular social media networks



SPACE TRAVEL

Crew operations aboard Space Station return to normal

Moonshot: Japan recruits first new astronauts in 13 years

First all-private space station mission to include two dozen experiments

NASA receives 11th consecutive clean financial audit opinion

ROCKET SCIENCE

Latest Vega launch paves way for Vega-C

Pangea Aerospace hot fire tests the first MethaLox aerospike engine in the world

PLD Space exhibits the first privately-developed Spanish rocket

Arianespace to launch Australian satellite Optus-11 with Ariane 6

MARS DAILY

NASA's Perseverance captures challenging flight by Mars Helicopter

Curiosity continues to dine on Zechstein drill fines

Twin of NASA's Perseverance Mars rover begins terrain tests

Life on Mars search could be misled by false fossils

DRAGON SPACE

Chinese astronauts' EVAs to help extend mechanical arm

Astronaut becomes first Chinese woman to spacewalk

Shenzhou XIII crew ready for first spacewalk

Chinese astronauts arrive at space station for longest mission

SPACE MART

Bezos' Blue Origin hires lobbyist after 'Space Tax' proposed

Groundbreaking Iridium Certus 100 Service Launches with Partner Products for Land, Sea, Air and Industrial IoT

European software-defined satellite starts service

iRocket And Turion Space ink agreement for 10 launches to low earth orbit

TECH SPACE

Bacteria may be key to sustainably extracting earth elements for tech

UVA researchers advance bioprinting

New holographic camera sees the unseen with high precision

Researchers recreate deep-Earth conditions to see how iron copes with extreme stress

EXTRA SOLAR

The worlds next door: Looking for habitable planets around Alpha Centauri

Alien organisms - hitchhikers of the galaxy

Discovering exoplanets using artificial intelligence

New model will help find Earth-like Exoplanets

OUTER PLANETS

Science results offer first 3D view of Jupiter's atmosphere

Juno peers deep into Jupiter's colorful belts and zones

Scientists find strange black 'superionic ice' that could exist inside other planets

Jupiter's Great Red Spot is deeper than thought, shaped like lens

Discover more

Satellite imagery products

Space tourism packages

Space science research

NASA mission merchandise

Model rockets kits

Space launch updates

Telescope sales

Stargazing tours

Space themed games

Space food kits

The content herein, unless otherwise known to be public domain, are Copyright 1995-2024 - [Space Media Network](#). All websites are published in Australia and are solely subject to Australian law and governed by Fair Use principals for news reporting and research purposes. AFP, UPI and IANS news wire stories are copyright Agence France-Presse, United Press International and Indo-Asia News Service. ESA news reports are copyright European Space Agency. All NASA sourced material is public domain. Additional copyrights may apply in whole or part to other bona fide parties. All articles labeled "by Staff Writers" include reports supplied to Space Media Network by industry news wires, PR agencies, corporate press officers and the like. Such articles are individually curated and edited by Space Media Network staff on the basis of the report's information value to our industry and professional readership. Advertising does not imply endorsement, agreement or approval of any opinions, statements or information provided by Space Media Network on any Web page published or hosted by Space Media Network. **General Data Protection Regulation (GDPR) Statement** Our advertisers use various cookies and the like to deliver the best ad banner available at one time. All network advertising suppliers have GDPR policies (Legitimate Interest) that conform with EU regulations for data collection. By using our websites you consent to cookie based advertising. If you do not agree with this then you must stop using the websites from May 25, 2018. [Privacy Statement](#). Additional information can be found here at [About Us](#).