ELECTRONICS

# What If Your Fitbit Could Run on a Wi-Fi Signal?

New 2-D electronic technology may reap radio energy to power an array of devices such as hearing aids, sensors and other gadgets that make up the Internet of Things

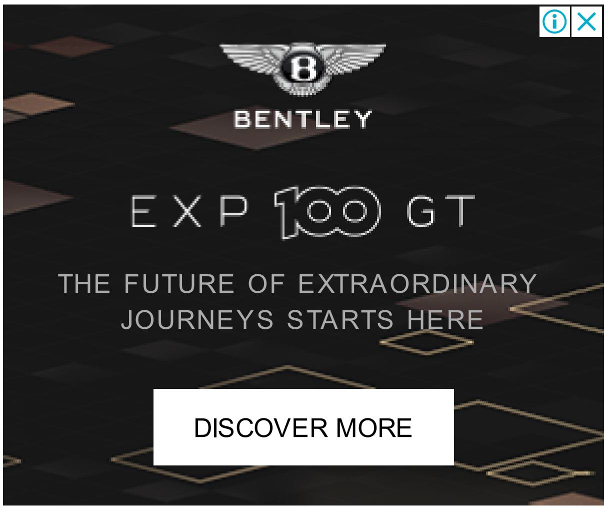
By Jeff Hecht on January 29, 2019 أعرض هذا باللغة العربية

Credit: Getty Images

A flexible, flat semiconductor material that can harvest energy from radio signals

A Massachusetts Institute of Technology team reports in *Nature* that a film of molybdenum disulfide (MoS2)—a two-dimensional material because it is just three atoms thick—can act like an antenna to convert radio signals from wi-fi, cell phones and radio or television broadcasts into power for wireless devices. It could drive power-thrifty pacemakers, hea the Internet of Things (IoT).

Power furnished would not be enough to charge cell phones and tablets without dramatic breakthroughs, and even the Fitbit is bit of a stretch. But a small step toward wi-fi generated power may be at hand. “The future of electronics is bringing intelligence to every single object from our clothes to our desks and to our infrastructure,” says MIT electrical engineering professor Tomás Palacios. “The key missing building block is how to bring energy to all these billions of devices.” He says sheets of MoS2 are promising because they are flexible and can be produced inexpensively by roll-to-roll printing.



The group demonstrated a flexible material that can harvest radio energy at frequencies up to 10 gigahertz, which covers the widely used 2.4 and 5 gigahertz bands that carry wi-fi signals as well as other radio traffic. Flexibility is important for wearable devices and many other sensing applications, but other flexible materials generally absorb little radio power at frequencies above 1.6 gigahertz, limiting their potential for energy harvesting. Palacios says the two-dimensional semiconductor can reap 30 to 50 microwatts from ambient wi-fi signals of about 100 microwatts, enough to operate pacemakers, hearing aids, strain sensors, communication links and many low-power IoT objects. Such a system could potentially operate without a battery, lowering weight and avoiding leakage from a medical implant’s power source inside

The MIT work “is an important first demonstration of harvesting energy from ambient wireless signals...made all the more compelling because everything was integrated onto the same flexible substrate,” says Deji Akinwande, an electrical and computer engineer at The University of Texas at Austin who was not involved in the work. “The next challenge is to [illegible] duce higher powers which are needed for contemporary mobile applications.”

Energy-harvesting systems already power other remote devices to avoid the need for frequent battery replacement. Most present systems draw power from light, temperature differences or kinetic movement, says Andreas Schneider, CEO of EnOcean, a German maker of battery-free self-powered devices that was not involved in the research. He says photovoltaic cells can procure enough light energy to power indoor devices at lighting levels of a hundred lux, roughly the level of hallway lighting and less than a third of standard office illumination levels. Pushing a mechanical switch can produce enough energy to send a signal to turn on a lamp across the room or up the stairs. Temperature gradients along hot water pipes can send signals to the heating system. The company, however, found ambient radio signal power was inadequate for present devices unless extra local radio transmitters were added, which Schneider says “you wouldn’t want to sit next to” because of worries electromagnetic fields might reach unhealthy levels.

Looking to the future of 5G wireless networks and the IoT, Palacios says “you could potentially use solar cells, but you only have sunlight during the day. So the other option is to harvest energy already present in radio-frequency signals," like wi-fi, which transmits most of time.”

Both radio-energy harvesters and radio-signal receivers collect energy when passing radio waves interact with antennas. Electromagnetic forces tug back and forth on electrons in the conductive material, inducing an electric current that alternates in direction as the waves alternate in phase. Antennas that collect signals for radio receivers transmit the fluctuating signals to circuits that amplify and convert them to audio or video frequencies. Antennas that pickup radio energy send the fluctuating current to an electronic device called a rectifier that transmits current in only one direction, converting the incoming alternating current into direct current that can power electronic devices or charge batteries.

Rectifiers usually are semiconductors whereas antennas usually are metallic and highly conductive. Molybdenum disulfide is “a really good semiconductor,” Palacios says. It can be modified to make it highly conductive, so it can serve as both antenna and rectifier—a device called a rectenna, which was invented in the 1960s and now is used in radio-frequency identification (RFID) and proximity cards.

Today most rectennas are small, rigid chips of inflexible semiconductors like silicon, which have good frequency response but are limited by their inflexibility. The MIT group is the first to have made large, flexible rectennas that can harvest energy from widely used unlicensed radio frequencies up to 10 gigahertz without needing a voltage from a battery to trigger the process. Flexibility and thinness are important for use in wearable devices and in “smart skins” that can be applied to infrastructure, aircraft or other objects for continual monitoring or as part of a distributed network of intelligent sensors. Layers only three atoms thick can be grown by a process widely used in semiconductor manufacturing—chemical vapor deposition—at low cost over a large area and still operate at very high frequencies.

The technology is still in the laboratory. Production needs to be scaled up, and the films need to be integrated with the devices they will power. Another challenge will be designing devices to run on only tens of microwatts of power. But Palacios expects to see the first commercial applications in five to seven years. “The main thing you need is to scale things up, in terms of a manufacturing approach that will allow us to fabricate sensors over a very large area at low cost,” he notes. Among the additional applications he expects is lighting small displays by providing 30 to 50 microwatt power and linking implantable medical devices with external monitoring equipment. For a few applications, at least, energy can truly be plucked from thin air.

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