



# S&T NEWS BULLETIN

THE LATEST IN SCIENCE AND TECHNOLOGY RESEARCH NEWS

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## FEATURE ARTICLES

### [3-D-printed magnets: How can you produce a magnet with exactly the right magnetic field?](#)

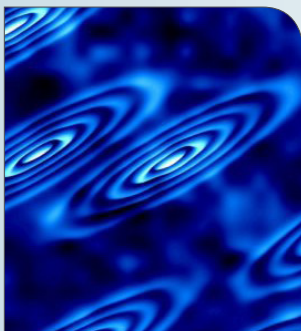
[Science Daily, 25OCT2016](#)

It is difficult to produce a permanent magnet with a magnetic field of a specific pre-determined shape. An international team of researchers (Austria, Germany) created the first-ever 3D printer which can be used to produce magnetic materials. The magnet printer uses specially produced filaments of magnetic micro granulate, which is held together by a polymer binding material. The printer heats the material and applies it point by point in the desired locations using a nozzle. The result is a three-dimensional object composed of roughly 90% magnetic material and 10% plastic. At the very end of the process, the finished article is exposed to a strong external magnetic field, converting it into a permanent magnet. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Advanced manufacturing, Featured Article*

### [Unusual quantum liquid on crystal surface could inspire future electronics](#)

[Science Daily, 21OCT2016](#)



Strange electron orbits form on the surface of a crystal in this image created using a theoretical data model. Credit: Image courtesy of Ali Yazdani, Department of Physics, Princeton University

Fundamental explorations of materials may provide the basis for faster and more efficient electronic technologies. A team of researchers in the US (Princeton University, UT Austin) demonstrated that the electrons, when kept at very low temperatures where their quantum behaviors emerge, can spontaneously begin to travel in identical elliptical paths on the surface of a crystal of bismuth, forming a quantum fluid state.

They found that all the electron orbits spontaneously lined up in the same direction. This behavior occurred

because the strong magnetic field caused electrons to interact with each other in ways that disrupted the symmetry of the underlying lattice. By adjusting the strength of the magnetic field, you can force the electrons to interact strongly and actually see them break the symmetry. [TECHNICAL ARTICLE](#)

*Tags: Materials science, Advanced materials, Featured article*

## S&T NEWS ARTICLES

### ADVANCED MATERIALS

#### [Professor creates self-folding, origami robots](#)

[PhysOrg.com, 25OCT2016](#)

A team of researchers in the US (Harvard, MIT) made robots with paper sandwiched between layers of pre-stretched polystyrene and placed strips of copper along the fold lines of the robot. Microchips installed on the robot send electric current through copper, making them heat up. When that happens, the polystyrene material contracts, causing the joint to buckle and fold. They are interested in expanding it to a very large scale, where it could be useful both for architecture, temporary housing, and space exploration. [TECHNICAL ARTICLE](#)

*Tags: Advanced materials, Autonomous systems & robotics*

#### [3D Structure Shrinks When Heated](#)

[American Physical Society Focus, 21OCT2016](#)

Using a 3D printing method that prints using two different materials, an international team of researchers (USA - UC Southern California, Lawrence Livermore National Laboratory, MIT, UCLA, Singapore) printed the struts and the frame from the same polymer but mixed copper nanoparticles into the frame material. The nanoparticles decreased the frame's thermal expansion, creating enough of a mismatch with the struts to trigger the expected folding. Testing several such structures they found that it is possible to precisely tune the negative thermal expansion effect to potentially tailor

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materials to meet the specific needs of each situation.

#### TECHNICAL ARTICLE

Tags: *Advanced materials, Materials science*

### **Superomniphobic tape adheres to any surface** PhysOrg.com, 20OCT2016

Fabrication of most superomniphobic surfaces requires complex process conditions, specialized and expensive equipment or skilled personnel. Researchers at Colorado State University have developed free-standing, flexible, superomniphobic films which can be stored and delivered to the end-users, who can readily attach them to virtually any surface. The hierarchical structure, the re-entrant texture, and the low solid surface energy render the films superomniphobic for a wide variety of liquids. They are flexible, have applications in enhanced chemical resistance and enhanced weight bearing. TECHNICAL ARTICLE

Tags: *Advanced materials, Materials science*

## AUTONOMOUS SYSTEMS & ROBOTICS

### **Disrupting the research process: changing materials science with robotics, AI and autonomy**

Nanowerk, 24OCT2016

A team of researchers in the US (AFRL Dayton, industry partners) built an Autonomous Research System (ARES), a research robot capable of closed-loop iterative materials experimentation. ARES exploits advances in autonomous robotics, artificial intelligence, data sciences, and high-throughput. In situ techniques it is able to design, execute and analyse its own experiments orders of magnitude faster than current research methods. They demonstrated that it successfully learned to grow single-walled carbon nanotubes at targeted growth rates. ARES has broad implications for the future roles of humans and autonomous research robots, and for human-machine partnering. OPEN ACCESS TECHNICAL ARTICLE

Tags: *Autonomous systems & robotics, Science without borders*

### **Enhancing the reliability of artificial intelligence**

PhysOrg.com, 21OCT2016

As computers become more common in 'high-stakes' applications like robotic surgery, terrorism detection and driverless cars, researchers ask what can be done to make sure we can trust them. The Centre for the Future of Intelligence in the UK brings together four of the world's leading universities (Cambridge, Oxford, Berkeley and Imperial College, London) to explore the implications of AI for human civilization. Together, an interdisciplinary community of researchers will work closely with policy-makers and industry investigating topics such as the regulation of autonomous weaponry, and the implications of AI for democracy.

Tags: *Autonomous systems & robotics, Artificial intelligence, S&T UK*

### **Flying drones could soon re-charge while airborne with new technology**

Science Daily, 20OCT2016

Researchers in the UK removed the battery from an off-the-shelf mini-drone and demonstrated that they can wirelessly transfer power to it via inductive coupling. On the ground, a transmitter device made out of a circuit board is connected to electronics and a power source, creating a magnetic field. The drone's electronics is calibrated at the frequency of the magnetic field. When it flies into the magnetic field, an alternating current voltage is induced in the receiving antenna and the drone's electronics converts it efficiently into a direct current voltage to power it. The breakthrough could allow flying drones to stay airborne indefinitely. Wirelessly transferring power could have applications in sensors, healthcare devices and interplanetary missions.

Tags: *Autonomous systems & robotics*

## BIG DATA

### **Automating big-data analysis**

MIT News, 21OCT2016

Last year, MIT researchers presented a system that automated a crucial step in big-data analysis that is useful for making predictions. Now the team (MIT, industry partner) describes an approach to automating most of the rest of the process of big-data analysis. The papers focus on time-varying data. The goal of the analysis is to produce a probabilistic model that will predict future events on the basis of current observations. OPEN ACCESS TECHNICAL ARTICLE 1, 2

Tags: *Big data*

## BIOTECHNOLOGY

### **Nanofiber coating prevents infections of prosthetic joints**

Science Daily, 24OCT2016

In a proof-of-concept study with mice, scientists at Johns Hopkins University show that a novel coating they made with the antibiotic rifampin in combination with one of three other antibiotics coated on nanofibers has the potential to better prevent at least some serious bacterial infections related to total joint replacement surgery. They were able to completely eradicate infection with this coating. TECHNICAL ARTICLE

Tags: *Biotechnology*

### **Computer uses light to control 'cyborg' bacteria** Futurity, 19OCT2016

Two interfaces link machine and organism: the computer communicates with red and green light, which the biotechnologically modified bacteria can perceive. In the opposite direction, communication functions via an optical measurement of the growth rate of the bacteria culture, the results of which are fed into the computer in real-time.

*continued...*

“For a successful technology, reality must take precedence over public relations, for Nature cannot be fooled.” RICHARD FEYNMAN

Researchers in Switzerland found that when the computer illuminates the *E. coli* culture with a red light, the bacteria stop producing methionine and grow more slowly as a result. If it is lit with a green light, on the other hand, methionine production is stimulated and the bacteria grow more rapidly. [OPEN ACCESS TECHNICAL ARTICLE](#)

Tags: *Biotechnology, S&T Switzerland*

## COMMUNICATIONS TECHNOLOGY

### [Designing the future internet](#)

[EurekAlert](#), 20OCT2016

As part of the NSF initiative, Future Internet Architecture launched in 2010, researchers at Rutgers University proposed a “MobilityFirst” project which is centered on shifting from the current internet protocol to name-based routing. Names would represent people, mobile phones, internet devices, small sensors or any other objects connected to the internet. The benefits of the MobilityFirst project include more flexible services, better security, support for mobility across many technologies, efficiency and the ability to handle large volumes of traffic and data.

Tags: *Communications technology*

## ENERGY

### [Engineers design ultralow power transistors that could function for years without a battery](#)

[Science Daily](#), 20OCT2016

Researchers in the UK have developed a transistor harnessing leakage of electrical current. The design is based on a Schottky barrier which keeps the electrodes independent from one another, so that the transistors can be scaled down to very small geometries. The transistors can be produced at low temperatures and can be printed on almost any material, from glass and plastic to polyester and paper. The transistor’s operating voltage is less than a volt, with power consumption below a billionth of a watt. This ultralow power consumption makes them most suitable for applications where function is more important than speed, which is the essence of the Internet of Things.

Tags: *Energy, Battery, S&T UK*

### [New perovskite solar cell design could outperform existing commercial technologies](#)

[Science Alert](#), 20OCT2016

An international team of researchers (UK, USA - Stanford University, University of Washington, Belgium) developed a device that consists of two perovskite solar cells stacked in tandem. Perovskite that absorbs lower-energy infrared light delivers a 14.8 percent conversion efficiency. A tandem device consisting of two perovskite cells has

combined efficiency of 20.3 percent. Their cells exhibit excellent thermal and atmospheric stability, unprecedented for tin-based perovskites. [TECHNICAL ARTICLE](#)

Tags: *Energy, Advanced materials, Solar energy*

### [Self-healable battery](#)

[Science Daily](#), 20OCT2016

The electrodes in the batteries developed by an international team of researchers (China, South Korea) consist of layers of parallel carbon nanotubes. Between the layers, the scientists embedded the necessary lithium compounds in nanoparticle form  $\text{LiMn(2)O(4)}$  for one electrode,  $\text{LiTi(2)(PO(4))(3)}$  for the other. The electrodes are fixed on a substrate of self-healing polymer. Between the electrodes is a solvent-free electrolyte made from a cellulose-based gel with an aqueous lithium sulfate solution embedded in it. After a break, it is only necessary to press the broken ends together for a few seconds for them to grow back together. The electrolyte is free of organic solvents, it is neither flammable nor toxic. [TECHNICAL ARTICLE](#)

Tags: *Energy, Battery*

## INFORMATION TECHNOLOGY

### [First Computer to Match Humans in Conversational Speech Recognition](#)

[MIT Technology Review](#), 24OCT2016

Researchers at Microsoft measured the human error rate on the widely used NIST 2000 test set, and found that their latest automated system has reached human parity. Their automated system establishes a new state-of-the-art, and edges past the human benchmark for error rate of professional transcriptionists and the CallHome portion of the data they tested. This marks the first time that human parity has been reported for conversational speech. The key to their system’s performance is the systematic use of convolutional and LSTM neural networks, combined with a novel spatial smoothing method and lattice-free MMI acoustic training. [OPEN ACCESS TECHNICAL ARTICLE](#)

Tags: *Information technology, Artificial intelligence*

### [New special-purpose computer may someday save us billions](#)

[Science Daily](#), 21OCT2016

An international team of researchers (USA - Stanford University, Japan) has built what’s called an Ising machine. Rather than using magnets on a grid, they used a degenerate optical parametric oscillator, that, when turned on, will represent an upward- or downward-pointing spin. Nearly all of the materials used are off-the-shelf elements that are already used for telecommunications. That, in combination with the simplicity of the programming,

*continued...*

makes it easy to scale up. The machine is currently able to solve 100-variable problems with any arbitrary set of connections between variables, and it has been tested on thousands of scenarios. [TECHNICAL ARTICLE](#)

*Tags: Information technology*

### [Computer scientists find ‘inexact computing’ can improve answers](#)

[PhysOrg.com, 20OCT2016](#)

An international team of researchers (UK, Switzerland, India, USA - Rice University) showed it is possible to leapfrog from one part of a computation to the next and reinvest the energy saved from inexact computations at each new leap to increase the quality of the final answer while retaining the same energy budget. They took advantage of the Newton-Raphson approach which is used in supercomputing to allow high-performance computers to find successively better approximations to complex mathematical functions and demonstrated that the solution’s quality could be improved by more than three orders of magnitude. A specific goal is to encourage the application of this approach as a way to advance the quality of weather and climate modeling by improving model resolution. [TECHNICAL ARTICLE](#)

*Tags: Information technology*

## FEATURED RESOURCE

### [The Networked Quantum Information Technologies Hub \(NQIT\)](#)

NQIT is the largest of the four Hubs in the UK National Quantum Technology Programme to establish a quantum technology industry in the UK. [RSS](#)

### [Moving toward computing at the speed of thought](#)

[PhysOrg.com, 20OCT2016](#)

Researchers at West Virginia University are monitoring people’s brain activity in real time and recognizing specific thoughts. Their research is helping to move us toward what might be called “computing at the speed of thought.” Low-cost open-source projects such as OpenBCI allow people to assemble their own neuroheadsets that capture brain activity noninvasively. Once human thought can communicate directly with computers, a new world will open before us. As technology continues to progress and become easier to use, the dioramas built of cardboard, modeling clay and twigs by children 50 years ago could one day become explorable, life-sized virtual spaces.

*Tags: Information technology*

### [Silicon colour centre could be used for information processing](#)

[Nanotechweb, 19OCT2016](#)

An international team of researchers (USA - Harvard University, Sandia National Laboratory, Russia, Germany) placed silicon atoms inside nanophotonic diamond devices with cross sections so small that a single colour centre can block the flow of light. They used a photonic crystal cavity to increase the interaction strength even more by bouncing the light back and forth over the colour centre thousands of times. The strong interaction allowed them to control the internal states of the centre to control the flow of light and make a switch from it. One of the biggest advantages of the new system is that it is possible to create millions of the devices on a single chip using semiconductor fabrication techniques. The devices might even be employed in classical information processing. [TECHNICAL ARTICLE](#)

*Tags: Information technology, Communications technology*

## MATERIALS SCIENCE

### [Researchers find way to tune thermal conductivity of 2-D materials](#)

[Nanowerk, 21OCT2016](#)

2-D materials have unique electronic and chemical properties and hold promise for use in creating flexible, thin, lightweight electronic devices. In one class of 2-D materials the “thermal anisotropy ratio” is about 50. A team of researchers in the US (University of Illinois, Urbana Champaign, North Carolina State University, industry partner) found that introducing lithium ions between the layers of MoS<sub>2</sub> puts the layers of the 2-D material out of alignment with each other increasing the material’s thermal anisotropy ratio from 50 to more than 100. They showed that stacking disorder and mixture of phases is an effective mechanism to modify the anisotropic thermal conductivity of 2D materials. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Materials science*

### [‘Snap freezing’ produces different state](#)

[Nanowerk, 21OCT2016](#)

Researchers in Japan discovered that if the cooling rate is faster than a certain value, several correlated-electron materials are frozen into a different charge or spin state—a bit like a glass. The researchers believe that this phenomenon could be used in phase-change memories, which store data by using these states of matter to represent the ones and zeros used in computing. They aim to develop a new class of high-speed nonvolatile memories that are based on the ground state and the quenched state. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Materials science, S&T Japan*

**The nanostructured cloak of invisibility**

Nanowerk, 21OCT2016

To increase the bandwidth of anti-reflective coating, researchers in Germany developed a two step process to imitate the moth eye principle, that is, to cover the surface with nanometers high column-like structures that taper conically toward the tip. They deposited gold particles in a regular honeycomb pattern on a large surface where the gold particles settle in the points of crossroad. The crossroads serve as mask in a chemical etching process. They experimented with various column heights and confirmed that they achieved the best transmittance values for different wavelengths with different column heights. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Materials science, S&T Germany*

**MICROELECTRONICS****A complete waste of energy**

Nanowerk, 25OCT2016

According to the National Resource Defense Council, Americans waste up to \$19 billion annually in electricity costs due to always-on digital devices even when they are turned off. A team of researchers in the US (University of Utah, UC Berkeley) devised a new kind of switch for electronic circuits that uses solid electrolytes such as copper sulfide to literally grow a wire between two electrodes when an electrical current passes through them, turning the switch on. When the polarity is reversed, the metallic wire between the electrodes breaks down and the switch is turned off. A third electrode is used to control this process of growing and breaking down the wire. Switches could be built onto a computer processor or in solid-state memory chips without expensive retooling of manufacturing plants. As researchers continue to optimize the process turning the devices on and off will be comparable to the current silicon-based electronics. [TECHNICAL ARTICLE](#)

*Tags: Microelectronics*

**PHOTONICS****Converting optical frequencies with  $10^{(-21)}$  uncertainty**

PhysOrg.com, 21OCT2016

Researchers in China introduce an optical frequency divider with division uncertainty at the  $10^{-21}$  level, three orders of magnitude better than the most accurate optical clocks, promising optical frequency division without degrading the performance of optical clocks. They hope this type of optical frequency divider will be also instrumental in precision measurement. In atomic and molecular precision spectroscopy, hopes are high that accurate and stable clock light can be transferred to wider spectral range. Numerous applications rely on accurate frequency ratio measurement between spectrally-separated optical clocks or frequency

conversion of optical clocks. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Photonics, S&T China*

**Light speckles having a conversation**

Science Daily, 20OCT2016

An international team of researchers (the Netherlands, USA - Lawrence University) show that enhancing the intensity of one speckle enhances the intensity of the surrounding area and the amount of light that is reflected diminishes. Inside the layer, energy redistribution seems to take place as if the transmitted and reflected light speckles talk to each other. This implies a new type of correlation between transmitted and reflected light. This new knowledge can lead to better energy harvesting using solar cells and it can lead to sharper medical images. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Photonics*

**Researchers demonstrate extension of electronic metrology to the multi-petahertz frequency range**

PhysOrg.com, 20OCT2016

Researchers at the University of Central Florida took advantage of the fact that when electrons speed up, they emit high-order harmonics, which just happen to be a direct reflection of the motion of those electrons. They noted that the light was emitted in bursts lasting less than 500 attoseconds. These findings suggest that it should be possible to build devices that use lasers to push the oscillating frequency of electrons up to 100 times that of devices currently used to test the limit into the multi-petahertz range. It is still not clear if the laser-pulsed approach causes any negative impact on current production. [TECHNICAL ARTICLE](#)

*Tags: Photonics*

**QUANTUM SCIENCE****A new class of materials could realize quantum computers**

PhysOrg.com, 21OCT2016

An international team of researchers (Switzerland, Germany, France, Ukraine, Czech Republic, Austria) studied the electronic and spin structure of thin films of GeTe and doped Mn using photoemission. The study revealed the intertwined nature of the electric and magnetic properties of the new class of materials, multiferroic "Rashba semiconductors". They showed that the electric and magnetic polarization are exactly antiparallel, the properties extend throughout the whole of the material and are not confined to a small region. The electronic structure is similar to that of topological insulators, but in 3D. This property forms the basis for the formation of Majorana particles to be used in quantum computers. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Quantum science, Advanced materials*

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### [Inside Microsoft's quest for a topological quantum computer](#)

Nature News, 21OCT2016

Microsoft is hoping to encode its qubits in a kind of quasiparticle: a particle-like object that emerges from the interactions inside matter. Some physicists are not even sure that the particular quasiparticles Microsoft are working with—called non-abelian anyons—actually exist. But Microsoft hopes to exploit their topological properties, which make quantum states extremely robust to outside interference, to build topological quantum computers. Microsoft spoke to Nature about the company's work.

Tags: *Quantum science*

### [Quantum computers: 10-fold boost in stability achieved](#)

Science Daily, 19OCT2016

An international team of researchers (Australia, Japan) created a new quantum bit, made up of the spin of a single atom in silicon and merged with an electromagnetic field known as 'dressed qubit'. Since the electromagnetic field steadily oscillates at a very high frequency, any noise or disturbance at a different frequency results in a zero net effect. The researchers achieved an improvement by a factor of 10 in the time span during which a quantum superposition can be preserved. It can be controlled by simply modulating the frequency of the microwave field, just like in an FM radio, unlike an "undressed qubit".

The research opens new avenues to build and operate the superpowerful quantum computers of the future.

[TECHNICAL ARTICLE](#)

Tags: *Quantum science*

## SCIENCE WITHOUT BORDERS

### [Scientists can listen to proteins by turning data into music](#)

Science Daily, 20OCT2016

An international team of researchers (Finland, USA - Eastern Washington University, UK) reports the use of a melody generation software where the inputs are derived from calculations of evolutionary information, secondary structure, flexibility, hydropathy and solvent accessibility from multiple sequence alignment data. The melodies so generated are derived from the sequence, and by inference, of the fold, in ways that give each fold a sound representation that may facilitate analysis, recognition, or comparison with other sequences. The researchers say they will be able to use them to discriminate between different protein structures and spot irregularities like mutations. [OPEN ACCESS TECHNICAL ARTICLE](#)

Tags: *Science without borders, Biology*

## SENSORS

### [Nanoantenna lighting-rod effect produces fast optical switches](#)

PhysOrg.com, 21OCT2016

An international team of researchers (UK, Spain) used vanadium dioxide which can be switched from an insulator to a metal by increasing the temperature above the phase transition point (68 °C). The nanoantenna assists phase transition by locally concentrating energy near the tips of the antenna where the antenna resonances are most sensitive to local perturbations. Antenna-assisted switching thus results in a large effect while requiring only a small amount of energy. The findings could lead to transistor-type switches for light with nanometer-scale footprint for data communication and tunable antenna-assisted processes. [OPEN ACCESS TECHNICAL ARTICLE](#)

Tags: *Sensors, Microelectronics* ■

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