



# S&T NEWS BULLETIN

THE LATEST IN SCIENCE AND TECHNOLOGY RESEARCH NEWS

[Advanced materials \(4\)](#)

[Autonomous systems  
& robotics \(1\)](#)

[Big data \(1\)](#)

[Biotechnology \(6\)](#)

[Cyber security \(1\)](#)

[Energy \(3\)](#)

[Information technology \(1\)](#)

[Materials science \(5\)](#)

[Microelectronics \(1\)](#)

[Photonics \(2\)](#)

[Quantum science \(2\)](#)

[S&T policy \(2\)](#)

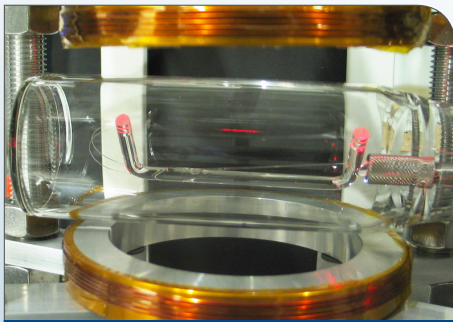
[Science without borders \(1\)](#)

[Sensors \(1\)](#)

## FEATURE ARTICLES

### [Strong Light Reflection from Few Atoms](#)

[American Physical Society Focus, 23SEP2016](#)



Atomic mirror. Red light sent through an optical fiber is visible in the fiber segment that is just a few hundred nanometers in diameter. (The red segment is between 1 and 2 cm long.)  
Credit: J. Appel/Univ. of Copenhagen

Two independent research teams (France, Denmark) report what must surely be the lightest, most insubstantial mirrors ever made. They have both reflected a significant amount of laser light from just one or two

thousand atoms. The atomic mirrors might be useful for controlling light signals in photonic circuits. And because the mirror atoms interact strongly with one another, they might serve as an analog system for simulating the behavior of solids at the quantum-mechanical level. [TECHNICAL ARTICLE](#)

Tags: [Photonics](#), [Featured Article](#)

### [Freeze-Dried Molecules Can Be Used to Whip Up Medicines Anywhere](#)

[MIT Technology Review, 22SEP2016](#)

A team of researchers in the US (MIT, Harvard University) has demonstrated that a freeze-dry method can be used to manufacture antimicrobial compounds, vaccines, and antibodies that are just as effective as traditionally made drugs. They found that the pellet-made vaccine elicited a protective response in mice that was comparable to a traditional diphtheria vaccine. The researchers also used their system to create a small, modular toolbox for making designer antibodies for a variety of diseases. [OPEN ACCESS TECHNICAL ARTICLE](#)

Tags: [Biotechnology](#), [Medical sciences](#), [Featured Article](#)

### [With great power comes great laser science](#)

[Science Daily, 22SEP2016](#)

An international team of researchers (Austria, Russia, USA - Texas A&M University, UK, Germany, Lithuania) sent a laser pulse through an Yttrium aluminium garnet crystal. The duration of the pulse decreased from 94 femtoseconds to a mere 30 femtoseconds. Its energy stays almost the same, and the power increases by a factor three, to almost half a terawatt. As the pulse is very short, its extremely high power opens the door to many exciting experiments and maybe even to new technologies in laser science.

[OPEN ACCESS TECHNICAL ARTICLE](#)

Tags: [Photonics](#), [Featured Article](#)

## S&T NEWS ARTICLES

### ADVANCED MATERIALS

#### [Engineers create room-temperature multiferroic material](#)

[Science Daily, 23SEP2016](#)

Multiferroics are of interest for next-generation computing. A team of international researchers (US - Cornell University, University of Illinois at Urbana-Champaign, University of Michigan, UC Berkeley, NIST, Lawrence Berkeley National Laboratory, Pennsylvania State University, Switzerland) engineered thin films of hexagonal lutetium iron oxide with double monolayers of iron oxide. They combined these two materials at the atomic-scale to create a new compound that was not only multiferroic but had better properties than either of the individual constituents. The research shows that an entirely different mechanism is active in this new material. [TECHNICAL ARTICLE 1, 2](#)

Tags: [Advanced materials](#)

[continued...](#)

[BACK TO TOP](#)

## **Stronger turbine blades with molybdenum silicides**

Science Daily, 23SEP2016

Researchers in Japan fabricated molybdenum silicide-based materials using a method known as “directional solidification,” in which molten metal progressively solidifies in a certain direction. They found that a homogeneous material could be formed by controlling the solidification rate of the molybdenum silicide-based composite during fabrication and by adjusting the amount of the ternary element added to the composite. The resulting material starts deforming plastically under uniaxial compression above 1000° C. [OPEN ACCESS TECHNICAL ARTICLE](#)

Tags: *Advanced materials, S&T Japan*

## **Nanotechnology may revolutionize future engines (w/video)**

Nanowerk, 22SEP2016

Researchers at the Army Research Laboratory stabilized a copper alloy microstructure and found it to be strong at very high temperatures. They report a six to eight orders of magnitude increase in creep response relative to what conventional nanocrystal materials can do. Jet turbine engines require just this combination of high-structural strength coupled with high thermal stability. Researchers hope to recreate the combination of properties within other types of materials like nickel, cobalt or tantalum, which would have the potential to revolutionize engine technology. [TECHNICAL ARTICLE](#)

Tags: *Advanced materials, Government S&T, Materials science*

## **Color-changing water reflects a rainbow of colors and beyond**

PhysOrg.com, 21SEP2016

Researchers in Japan have created “photonic water,” which is more than 99.5% water by volume. The remaining 0.5% contains the active ingredients which are titanate nanosheets and quaternary ammonium (Q<sup>+</sup> ions). Photonic water changes color when exposed to a variety of stimuli, such as a change in magnetic field, temperature, or pH. It displays both fluidity and order. It can reflect light across the entire visible spectrum extending the ultra-violet region. In general, photonic materials that reflect light in the near-infrared range have important applications in telecommunications and smart optical devices, including optical sensors and displays and variable photonic lasers. [OPEN ACCESS TECHNICAL ARTICLE](#)

Tags: *Advanced materials, Materials science, S&T Japan*

## **AUTONOMOUS SYSTEMS & ROBOTICS**

### **Video Friday: LEGO Drone Kits, Robots in the Desert, and Pepper Learns**

IEEE Spectrum, 23SEP2016

This video shows a quadrotor being powered completely wirelessly via magnetic induction. The quadrotor’s battery

has been removed. The transmitter was implemented on a two layer PCB and was driven by a load independent Class EF inverter.

Tags: *Autonomous systems & robotics*

## **BIG DATA**

### **Next generation of statistical tools to be developed for the big data age**

Science Daily, 21SEP2016

Researchers working under the StatScale project sponsored by the EU are developing new ways to interpret the unprecedented amounts of data being generated continuously all around us. According to the researchers, the volume, scale and structure of this contemporary data poses fundamentally new and exciting statistical challenges that cannot be tackled with traditional methods. Their aim is to develop a paradigm-shift in statistics, providing a new statistical toolbox to tackle, and capitalise on, these huge data streams.

Tags: *Big data, S&T EU, S&T Policy*

## **BIOTECHNOLOGY**

### **Shape-programmable miniscule robots**

Nanowerk, 27SEP2016

Microrobots may be able to swim through the human body to carry out medical functions in specific locations. An international team of researchers (Germany, USA - Carnegie Mellon University, Arizona State University, Singapore) has developed functional elastomers, which can be activated by magnetic fields to imitate the swimming gaits of natural flagella, cilia and jellyfish. Using a specially developed computer algorithm, the researchers can now automatically generate the optimal magnetic conditions for each gait for the first time. To enable different magnetic responses, the researchers varied the density of the magnetizable particles along the elastomer and controlled the magnetization orientation of the particles. [OPEN ACCESS TECHNICAL ARTICLE](#)

Tags: *Biotechnology*

### **The world’s smallest artificial virus**

Nanowerk, 27SEP2016

Researchers in the UK are developing physical biology with an ultimate goal of producing reference standards, practices, methods and materials to ensure safe and reliable use of synthetic biology. They designed very short protein fragments that assembled into the world’s smallest virus, just 12 nm in diameter. The virus was shown to be structurally plastic with the ability to adapt its size to the size of genes it encapsulates. With their uniform sizes and morphology, the virus shells provide a solid platform for developing candidate reference materials as suitable standards for gene transfer products. [TECHNICAL ARTICLE](#)

Tags: *Biotechnology, S&T UK, Synthetic biology*

“I want to put a ding in the universe.”

STEVE JOBS

### **Evolving Efficient Networks**

American Physical Society Focus, 22SEP2016

Highly optimized complex transport networks serve crucial functions in many man-made and natural systems such as power grids and plants or animal vasculature. In general, finding the global or nearly global optimum is difficult. In biological systems, it is believed that such an optimal state is slowly achieved through natural selection. Researchers at the University of Pennsylvania have developed a new model that accounts for the growth of the underlying tissue in tandem with the development of the network it contains. This coupling drives the network to optimize for efficient fluid flow without the need for complex chemical cues or any pre-encoded guiding pattern. [TECHNICAL ARTICLE](#)

Tags: *Biotechnology*

### **Computers learn to spot deadly bacteria**

Science Daily, 21SEP2016

An international team of researchers (UK, USA - FDA, Nebraska) trained the software on DNA sequences from strains isolated from cattle herds and human infections in the UK and the US. Once trained, the computer is able to predict whether an E. coli strain is likely to have come from a cow or a person. Using this approach, the team predicts that less than ten percent of the E. coli O157 cattle strains are likely to have the potential to cause human disease. Researchers say their approach could be adapted to test samples of other types of bacteria isolated from animals—such as salmonella and campylobacter—to identify strains with the potential to cause human disease. [OPEN ACCESS](#)

[TECHNICAL ARTICLE](#)

Tags: *Biotechnology*

### **Designing Synthetic Flexible Gene Regulation Networks Using RNA Devices in Cyanobacteria**

ACS Synthetic Biology, 16SEP2016

In recent years, studies on the development of gene regulation tools in cyanobacteria have been extensively conducted toward efficient production of valuable chemicals. However, there is considerable scope for improving the economic feasibility of production. Researchers in Japan established efficient gene induction systems in Anabaena by designing a gene regulation network using RNA-based tools.

Tags: *Biotechnology, S&T Japan, Synthetic biology*

## CYBER SECURITY

### **Chinese researchers hack car from 12 miles away**

Federal Computer Week, 21SEP2016

Researchers in China manipulated the Tesla's controls while it was in park via a laptop computer. They locked

the car's control screens, moved seats, activated turn signals and opened doors without keys. While the car was driving, they used the laptop to turn on windshield wipers, open the trunk and fold in exterior rearview mirrors. A researcher in an office building 12 miles from the test track was able to slam on the car's brakes while the vehicle was moving. The company said it patched the bugs once the researchers informed the company of the issue.

Tags: *Cyber security, S&T China*

## ENERGY

### **California eyes unusual power source: its gridlocked roads**

PhysOrg.com, 25SEP2016

The California Energy Commission is investing \$2 million to study whether piezoelectric crystals can be used to produce electricity from the mechanical energy created by vehicles driving on roads. Scientists already know the technology works, but the state needs to figure out whether it can produce high returns without costing too much. Similar projects in other parts of the world have been discontinued.

Tags: *Energy*

### **New superconductive material for long-distance energy transmission**

PhysOrg.com, 23SEP2016

Researchers in Germany are taking part in a study on superconductors under the European project Best Paths. They are now planning a demonstration that will test an MgB<sub>2</sub> cable at conditions matching those of future energy transmission systems. At a voltage of 200-320 kV, and a DC current of up to 10,000 amperes, the experiment will demonstrate the transmission of 3.2 gigawatts, the equivalent output of three large power stations, through a superconductive cable 12.5 mm across. The cable will be housed in a tube along with its cooling system that will keep it at an optimal temperature of 20 K.

Tags: *Energy, S&T EU*

### **A marriage made in sunlight: Invention merges solar with liquid battery**

PhysOrg.com, 22SEP2016

An international team of researchers (USA - University of Wisconsin at Madison, Saudi Arabia) has made a single device that eliminates the usual intermediate step of making electricity, instead it transfers light energy directly to the battery's liquid electrolyte. They used a redox flow battery which stores energy in a tank of liquid electrolyte for their experiment.

Tags: *Energy, Solar energy*

*continued...*

## INFORMATION TECHNOLOGY

**Feynman Machine: The Universal Dynamical Systems Computer**

arXiv, 13SEP2016

Researchers in Ireland propose a simple new model which draws on recent findings in Neuroscience and the Applied Mathematics of interacting Dynamical Systems. The Feynman Machine is a Universal Computer for Dynamical Systems, analogous to the Turing Machine for symbolic computing, but with several important differences. They demonstrate that networks and hierarchies of simple interacting Dynamical Systems, each adaptively learning to forecast its evolution, are capable of automatically building sensorimotor models of the external and internal world. These findings lead directly to new architectures for machine intelligence. [OPEN ACCESS TECHNICAL ARTICLE](#)

Tags: Information technology

## FEATURED RESOURCE

**Digital Trends**

Digital Trends helps their audience make informed decisions that allow them to maximize the potential of technology and help integrate it into everyday life. [RSS](#)

## MATERIALS SCIENCE

**Materials scientists prove 70-year-old tensile deformation prediction**

PhysOrg.com, 23SEP2016

Using tensile forces, an international team of researchers (USA- MIT, Harvard University, the Netherlands) triggered instability in a centimeters-thick elastomer block, deforming it into a flat surface. The research uncovers a type of instability that can be triggered in soft, elastic bodies, and widens the design space for new architected materials that use instabilities to change or enhance their functionality. With this instability, we can create materials that can suddenly switch between behaviors by using simple triggers to change their geometry. [TECHNICAL ARTICLE](#)

Tags: Materials science

**Strongest magnetic field trapped in a superconductor is a world record**

PhysOrg.com, 23SEP2016

An international team of researchers (UK, USA - Industries) used gadolinium boron carbon oxide which is typically very brittle, doped the structure with silver, 'shrink wrapped' steel around the thumb-sized

object to increase its strength and trapped 17.6 tesla in it. The research demonstrates the potential of high-temperature superconductors for applications in a range of fields, including flywheels for energy storage, 'magnetic separators', which can be used in mineral refinement and pollution control, and in high-speed levitating monorail trains.

Tags: Materials science

**Defects at the spinterface disrupt transmission**  
Science Daily, 21SEP2016

Magnets made of organic materials are chemically more flexible, cheaper to make, and can be better adapted to various purposes and varying designs. An international team of researchers (Germany, Italy) investigated just such a magnetic interface between the titanium oxide crystals in rutile form and a purely organic magnet. They found that the transition area where the materials met was highly sensitive to minimal defects in the surfaces. When there was a tiny defect on the relevant surface of the rutile the magnetic momentum was wiped out. The finding advances the understanding of the mechanisms at this complex interface.

[TECHNICAL ARTICLE](#)

Tags: Materials science

**Mysterious quantum properties in material crafted by scientists point to new applications in electronics**

Nanowerk, 13SEP2016

An international team of researchers (USA - UC Berkeley, Lawrence Berkeley National Laboratory, Germany) created an exotic 3-D racetrack for electrons in ultrathin slices of a nanomaterial they fabricated. They observed, for the first time, a unique behavior in which electrons rotate around one surface, then through the bulk of the material to its opposite surface and back. Their observations provide evidence for direct access to the topological properties of charge in a transport experiment, a first step towards their potential application. [TECHNICAL ARTICLE](#)

Tags: Materials science

**Team ahead of the 'curve' in magnetic study**  
PhysOrg.com, 12SEP2016

An international team of researchers (USA - Argonne National Laboratory, UCLA, Oakland University, Bryn Mawr College, China) found that the topological charge in magnetic skyrmions causes their deflection when current is applied. Being able to manipulate the motion of skyrmions is of interest because the magnetic textures of the structures could serve as a method to encode data with low power. With the ability to control the motion of skyrmions with a small current, researchers could manipulate them in memory devices that form the basis of spintronics.

[TECHNICAL ARTICLE](#)

Tags: Materials science, Government S&amp;T

## MICROELECTRONICS

**[Flexible Non-Volatile Memory Just Got A Lot Closer](#)**[IEEE Spectrum](#), 23SEP2016

An international team of researchers (France, Germany, Slovenia) fabricated a flexible non-volatile optical memory thin-film transistor device from molecules known as diarylethenes (DAEs), which can be switched between two states. Switching from writing to erasing was as simple as adjusting the wavelength of the light hitting the material (blue light for writing, green for erasing). The DAEs used are particularly suited for non-volatile data storage, since their two forms are stable at ambient conditions. They can be switched even when embedded within a semiconducting polymer matrix, making them an ideal candidate for flexible films. The team will be examining fabrication processes compatible with industrial output, such as roll-to-roll manufacturing and ink-jet printing. [TECHNICAL](#)

[ARTICLE](#)

*Tags: Microelectronics, Flexible electronics, Information technology*

## QUANTUM SCIENCE

**[Single Photon Carries 10 Bits of Information](#)**[MIT Technology Review](#), 23SEP2016

Researchers in the Netherlands used a straightforward method, in theory, to pack more than 10 bits into a single photon. They created an alphabet with 9,072 symbols. Their approach was to associate a single photon with a unique member of an alphabet. When the alphabet contains lots of members, the photon carries lots of information. The work has immediate applications in quantum cryptography. [OPEN ACCESS](#) [TECHNICAL](#)

[ARTICLE](#)

*Tags: Quantum science*

**[Beam me up Scotty! Quantum teleportation of a particle of light six kilometers](#)**[Science Daily](#), 21SEP2016

The City of Calgary is building and provisioning dark fibre to enable next-generation municipal services today and for the future. Dark fibre is a single optical cable with no electronics or network equipment on the alignment. An international team of researchers (Canada, USA - NIST, Cal Tech, China, Japan) demonstrated teleportation of a photon over a straight-line distance of six kilometres using the City of Calgary's fibre optic cable infrastructure. The demonstration opens the path to building a future quantum internet. [TECHNICAL ARTICLE 1, 2](#)

[ARTICLE](#)

*Tags: Quantum science, Communications technology*

## S&amp;T POLICY

**[China begins operating world's largest radio telescope](#)**[PhysOrg.com](#), 25SEP2016

Measuring 500 meters in diameter, the radio telescope is nestled in a natural basin in southern Guizhou province. It took five years and \$180 million to complete and surpasses the 300-meter Arecibo Observatory in Puerto Rico. The radio telescope has double the sensitivity of the Arecibo Observatory, and five to 10 times the surveying speed.

*Tags: S&T policy, S&T China, Space technology*

**[China claims to have successfully developed quantum radar and can easily detect stealth planes](#)**[Next Big Future](#), 22SEP2013

According to Chinese reports, researchers in China have developed the first quantum radar system which is based on the technology of single photon detection. The theoretical basis of the quantum radar is that an object will change its quantum properties after receiving photonic signals. The quantum radar can easily detect stealth aircraft and is highly resistant to becoming jammed. The radar can allegedly detect objects at range of up to 62 miles.

*Tags: S&T policy, Military technology, S&T China*

## SCIENCE WITHOUT BORDERS

**[Hyperloop pushes dream of low-cost futuristic transport](#)**[PhysOrg.com](#), 23SEP2016

California-based Hyperloop One has carried out preliminary tests of its propulsion system in the Nevada desert, and plans to bring its project to market in "2020-2021". Hyperloop systems could change modern life dramatically, as there would be no need to live in densely packed cities. It's too early to say whether Hyperloop will remain a shimmering dream consigned to the footnotes of history or become a breakthrough technology that changes our world.

*Tags: Science without borders*

## SENSORS

**[Turning particle detectors into weapons detectors](#)**[MIT News](#), 26SEP2016

Researchers at MIT are developing a system called physical cryptography which is designed to precisely identify a nuclear warhead, but without revealing the weapon's inner-workings. The goal is to allow inspectors to verify that actual nuclear weapons are being marked for disposal during a disarmament process. The concept involves

shooting beams of photons through a weapon, producing a signal that is highly sensitive to the weapon's makeup. The signal undergoes physical encryption first. The transmitted beam interacts with special materials called encrypting foils that produce a secondary, encrypted signal for detectors to measure.

*Tags: Sensors* ■

---

## ABOUT THIS PUBLICATION

The appearance of external hyperlinks in this publication does not constitute endorsement by the United States Department of Defense (DoD) of the linked web sites, nor the information, products or services contained therein. In addition, the content featured does not necessarily reflect DoD's views or priorities.

To **SUBSCRIBE** or **UNSUBSCRIBE**, visit <https://tin-ly.sainc.com/ASDRE>. To provide feedback or ask questions, contact us at [asdrest-bulletin-reply@sainc.com](mailto:asdrest-bulletin-reply@sainc.com). This publication is authored and distributed by:

**Ryan Zelnio, Ph.D.**, Associate Director - Tech Watch / Horizon Scans, Office of Net Technical Assessments, OSD AT&L/OASD(R&E)

**Ms. Hema Viswanath**, TW/HS, ONTA Corporate Librarian