



# S&T NEWS BULLETIN

THE LATEST IN SCIENCE AND TECHNOLOGY RESEARCH NEWS

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

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

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

[Biotechnology \(2\)](#)

[Communications technology \(2\)](#)

[Energy \(7\)](#)

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

[Materials science \(4\)](#)

[Microelectronics \(1\)](#)

[Quantum science \(3\)](#)

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

[Science without borders \(2\)](#)

[Sensors \(2\)](#)

## FEATURE ARTICLES

### [Quantum matter - shaken, but not stirred](#)

[Nanowerk, 20FEB2017](#)



Quantum matter is sensitive to perturbation. Therefore, it was assumed that quantum systems should normally be susceptible to mixing. An international team of researchers (Germany, UK) cooled a cloud of potassium atoms to extremely low temperature in a vacuum chamber. They loaded the atoms into an optical lattice with different depths of individual wells so that the potassium atoms were unevenly distributed within the lattice. When the lattice was shaken with varying the intensities of laser light, the system remained stable and the overall distribution of the potassium atoms remained intact. The research could have practical implications for the development of robust quantum computers. [TECHNICAL ARTICLE](#)

*Tags: Quantum science, S&T Japan, Featured article*

### [‘Lossless’ metamaterial could boost efficiency of lasers and other light-based devices](#)

[EurekaAlert, 17FEB2017](#)

Metamaterials typically contain metals that absorb energy from light and convert it into heat, lowering the efficiency. Researchers at UC San Diego demonstrated a way to make up for these losses by incorporating a semiconductor into the metamaterial. They grew indium gallium arsenide phosphide crystal on a substrate, etched narrow trenches into the semiconductor and filled the trenches with silver to create a pattern of alternating nano-sized stripes of semiconductor and silver. When they shined light from an infrared laser onto the metamaterial, they found that depending on which way the light is polarized, the metamaterial either reflects or emits light. This process could result in a ‘lossless’ metamaterial. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Advanced materials, Featured article*

## S&T NEWS ARTICLES

### ADVANCED MATERIALS

#### [Researchers replicate nature’s ability to reflect light to develop innovative materials](#)

[Science Daily, 17FEB2017](#)

The interaction of a material with light is intimately related to its wavelength-scale structure. An international team of researchers (UK, USA - San Francisco State University) has developed a method to characterize the internal structures of natural materials and replicate their interaction with light using 3D printing of ceramics. They developed a new mathematical metric to measure which photonic structures best control the propagation of light, enabling the design of new materials with different functionalities. They demonstrated their theory by developing amorphous gyroid (triamond) structure with band gaps, which is similar to the structuring found in some butterfly wings. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Advanced materials*

#### [New bilayer material could lead to more efficient and versatile light emission, such as bendy LED screens](#)

[Nanowerk, 15FEB2017](#)

Using the “Scotch tape” method, a team of researchers in the US (University of Kansas, University of Nebraska) built a bilayer material combining atomically thin layers of molybdenum disulfide and rhenium disulfide. Both absorb light very well as semiconductors, are very flexible and can be stretched or compressed. As all electrons and holes will be in their original layer, light emission will be a lot stronger. The goal is to develop a method that allows precise control of the location of electrons and holes among different atomic layers so that the electronic and optical properties of the material can be controlled and optimized. [TECHNICAL ARTICLE](#)

*Tags: Advanced materials, Materials science*

*continued...*

[BACK TO TOP](#)

## **Researchers engineer 'thubber,' a stretchable rubber that packs a thermal conductive punch**

Science Daily, 13FEB2017

Researchers at Carnegie Mellon University have developed an electrically insulating composite they call "thubber", whose key ingredient is non-toxic, liquid metal micro-droplets. The liquid state allows the metal to deform with the surrounding rubber at room temperature. When the rubber is pre-stretched, the droplets form elongated pathways that are efficient for heat travel. Despite the amount of metal, the material is also electrically insulating. The research is a breakthrough for creating soft, stretchable machines and electronics. [OPEN ACCESS TECHNICAL ARTICLE](#)

Tags: *Advanced materials, Flexible electronics, Materials science*

## AUTONOMOUS SYSTEMS & ROBOTICS

### **Scaling up the next generation of UAVs**

Physorg.com, 16FEB2017

Researchers at Texas A&M University have developed and demonstrated a flying cyclocopter, a flapping-wing aircraft in the 100-gram weight category. These novel concepts have shown unprecedented performance over conventional helicopters at micro scales. They are upscaling the cyclocopter and flapping wing for larger vertical take-off and landing capable UAVs. The team is looking at the feasibility of upscaling their cycloidal rotor to be used on larger VTOL UAVs weighing hundreds of pounds, and test drones scaled up in size in the tens of pounds.

Tags: *Autonomous systems & robotics*

## BIG DATA

### **Is your big data messy? We're making an app for that**

Physorg.com, 16FEB2017

Malfunctioning computers, data entry errors and other hard-to-spot problems can skew datasets and mislead people. Researchers at the University of Buffalo are developing a software tool called Vizier to proactively catch errors, working unobtrusively making helpful observations. Vizier is intended for much larger datasets; it will be used to examine millions or billions of data points, as opposed to hundreds or thousands typically plugged into spreadsheet software.

Tags: *Big data*

## BIOTECHNOLOGY

### **Switched-on DNA sparks nanoelectronics applications**

Nanowerk, 20FEB2017

A team of researchers in the US (Arizona State University, Pennsylvania State University, Northwestern University) modified just one of DNA's double helix chemical letters (A,C,T,G) with anthraquinone (Aq). Anthraquinone

contains a redox group which converts chemical energy through switches that send all electrical pulses in the human body. The modified Aq-DNA helix could now perform as the switch, slipping comfortably in between the rungs that make up the ladder of the DNA helix. The researchers have demonstrated the ability of the modified DNA to conduct electricity. It provides a unique way for studying important reactions implicated in disease or photosynthesis reactions for novel renewable energy applications. [OPEN ACCESS TECHNICAL ARTICLE](#)

Tags: *Biotechnology*

### **Big improvements to brain-computer interface**

Physorg.com, 16FEB2017

The current state-of-the-art material for electrodes in prosthetic devices is thin-film platinum which can fracture and fall apart over time. An international team of researchers (USA - San Diego State University, a university consortium, Italy) has developed electrodes made of glassy carbon which is about 10 times smoother than granular thin-film platinum. It corrodes less easily under electrical stimulation and lasts much longer than platinum or other metal electrodes. Glassy carbon is much more promising for reading signals directly from neurotransmitters, gets about twice as much signal-to-noise and the signals are clearer and easier to interpret. [OPEN ACCESS TECHNICAL ARTICLE](#)

Tags: *Biotechnology*

## COMMUNICATIONS TECHNOLOGY

### **Research opens door to smaller, cheaper, more agile communications tech**

Science Daily, 16FEB2017

An international team of researchers (Australia, Italy, Finland, Qatar) used a magnetic field to stimulate liquid crystals and steer light beams carrying data, which enables an innovative approach to data processing and switching. The magnetic field effectively controls the direction of propagation and the angular steering of the self-trapped wavepackets. Their approach to the routing of self-localized beams and light-induced waveguides in three dimensions is without the usual limitations imposed by transverse boundary conditions. The system can remotely transfer the tiny optical signal in any desired direction in real time. It has applications in sensors, data storage and liquid crystal displays. [OPEN ACCESS TECHNICAL ARTICLE](#)

Tags: *Communications technology*

### **A new spin on electronics**

Science Daily, 15FEB2017

An international team of researchers (Japan, Germany) has demonstrated the production, transport and detection of electronic spins in the boundary layer between the materials lanthanum-aluminate and strontium-titanate. This material system is an extremely thin, electrically conducting layer. The electron gas, which forms at the

*continued...*

“You’ve got to think about the big things while you’re doing small things, so that the small things go in the right direction.” ALVIN TOFFLER

interface between the two non-conducting materials, transports charge and transfers spin information to a non-magnetic contact located one micrometer next to the contact. They demonstrated the feasibility of bridging distances up to one hundred times larger than the distance of today’s transistors. [TECHNICAL ARTICLE](#)

*Tags: Communications technology*

## ENERGY

### [Looking for the next leap in rechargeable batteries](#)

[Nanowerk](#), 18FEB2017

Lithium-sulfur batteries have a host of advantages over lithium-ion batteries, but have a short cycle life. To counter this, researchers at the University of Southern California fabricated a non-porous membrane called Mixed Conduction Membrane (MCM) sandwiched between two layers of porous separators, soaked in electrolytes and placed between the two electrodes. The membrane works as a barrier in reducing the shuttling of dissolved polysulfides between anode and cathode. The MCM still allows for the necessary movement of lithium ions. The membrane preserves the high-discharge rate capability and energy density without losing capacity over time. Batteries with MCM led to 100 percent capacity retention compared to batteries without the membrane. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Energy, Battery*

### [Advanced silicon solar cells](#)

[MIT News](#), 17FEB2017

It is estimated that the world will need 10 terawatts or more of solar power by 2030—at least 50 times the level deployed today. According to researchers at MIT, to meet the challenge three changes are required: reduce the cost of modules by 50 percent, increase the conversion efficiency of modules by 50 percent, and decrease the cost of building new factories by 70 percent. The researchers addressed the conversion efficiency of the passivated emitter and rear cell (PERC) in which some modules containing PERC solar cells have degraded in the sun. Based on their analysis, the researchers offer manufacturers two recommendations - try to adjust their manufacturing processes so that they can perform the firing step at a lower temperature and make sure that their silicon has sufficiently low concentrations of certain metals they identified as likely sources of the problem. [TECHNICAL ARTICLE](#)

*Tags: Energy, Materials science*

### [Stanford researchers say extracting uranium from seawater could help nuclear power play a larger role in a carbon-free energy future](#)

[Stanford University](#), 17FEB2017

Uranium dissolved in seawater combines chemically with oxygen to form uranyl ions with positive charge. Researchers at Stanford University developed a process for extracting the uranyl ions which involves dipping plastic fibers containing amidoxime into seawater. The uranyl ions stick to the amidoxime. When the strands become saturated, the plastic is chemically treated to free the uranyl, which is refined for use in reactors. They created a conductive hybrid fiber incorporating carbon and amidoxime. By sending pulses of electricity down the fiber, they altered the properties of the hybrid fiber so that more uranyl ions could be collected. They improved capacity, rate and reuse which make extracting practical.

*Tags: Energy*

### [Four-stroke engine cycle produces hydrogen from methane, captures carbon dioxide](#)

[Science Daily](#), 16FEB2017

Using a catalyst, a hydrogen separating membrane and carbon dioxide sorbent, researchers at the Georgia Institute of Technology have built and demonstrated a laboratory-scale hydrogen reforming system called the CO<sub>2</sub>/H<sub>2</sub> Active Membrane Piston (CHAMP) reactor. The device operates at temperatures much lower than conventional steam reforming processes, consumes substantially less water and could also operate on other fuels such as methanol or bio-derived feedstock. It captures and concentrates carbon dioxide emissions. The CHAMP system can be scaled up or down to produce the required amount of hydrogen.

[TECHNICAL ARTICLE](#)

*Tags: Energy*

### [Wireless power transmission safely charges devices anywhere within a room](#)

[Physorg.com](#), 16FEB2017

Today, most wireless power transmission occurs over very short distances, typically involving charging stands or pads. Researchers at Disney Research in the US have developed a method, called quasistatic cavity resonance (QSCR), which involves inducing electrical currents in the metalized walls, floor and ceiling of a room, which in turn generate uniform magnetic fields that permeate the room’s interior. This enables power to be transmitted efficiently to receiving coils that operate at the same resonant frequency as the magnetic fields. According to the researchers, it may be

possible to reduce the need for special rooms. Existing structures may be retrofitted with modular panels or conductive paint. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Energy*

### [UMD Physicist Improves Method for Designing Experimental Fusion Reactors](#)

[University of Maryland, 15FEB2017](#)

Researchers at the University of Maryland propose a new algorithm called REGCOIL for computing the stellarator coil shapes. According to the researchers their algorithm simultaneously achieves lower surface-averaged and maximum values of both current density and normal magnetic field. This approach can simultaneously improve the free-boundary reconstruction of the target plasma shape while substantially increasing the minimum distances between coils, preventing collisions between coils while improving access for ports and maintenance.

[TECHNICAL ARTICLE](#)

*Tags: Energy, Nuclear energy*

## FEATURED RESOURCE

### [Academia.edu](#)

Academia.edu is a platform for academics to share their research and share papers with millions of people across the world for free, monitor deep analytics around the impact of their research and track the research of academics they follow. Free sign up required.

### [Assembly of micro-/meso-/macroporous carbon optimized for Li-S batteries](#)

[Science Daily, 09FEB2017](#)

Li-S batteries are considered promising alternatives for Li-ion batteries. A variety of porous carbon materials have been applied as sulfur host to improve the performances of Li-S batteries. Researchers in China demonstrated that pore size distribution substantially influences the electrochemical performances of cathode rather than specific surface area and total pore volume. The micropore-volume-ratio to the total pore volume dominates cycling stability of batteries, meso/macropore-volume-ratio influences spaces for sulfur loading and channels to ion transfer. [TECHNICAL ARTICLE](#)

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

## IMAGING TECHNOLOGY

### [Ultrafast camera for self-driving vehicles and drones invented](#)

[Science Daily, 16FEB2017](#)

Researchers in Singapore have developed a camera that records the changes in light intensity between individual pixels at its sensor, which reduces the data output. This avoids the need to capture the whole scene like a photograph. With a built-in circuit, the camera can do an instant analysis of the captured scenes, highlighting important objects and details. The camera can be a great safety tool for autonomous vehicles.

*Tags: Imaging technology*

## MATERIALS SCIENCE

### [Controlling friction levels through on/off application of laser light](#)

[Physorg.com, 20FEB2017](#)

Researchers in Japan irradiated a localized area of a cantilever coated with organic molecules with laser light and found the friction force between the coated cantilever and a sapphire substrate increased by 15%. They were able to increase and decrease the friction force repeatedly by switching the laser light on and off. The findings may lead to the development of techniques to control the movement of micromachines and contribute to the identification of basic friction mechanism. The technique also may be applicable to control of friction phenomena at the macro level.

[TECHNICAL ARTICLE](#)

*Tags: Materials science, Photonics, S&T Japan*

### [Designing new materials from 'small' data](#)

[Nanowerk, 17FEB2017](#)

A team of researchers in the US (Los Alamos National Laboratory, Drexel University, Northwestern University) focused on Ruddlesden-Popper oxides which exhibit many technology-enabling properties, such as ferroelectricity and piezoelectricity, and can be interfaced with traditional semiconductor materials. They built a database of known materials and using machine learning they were able to identify chemical compositions that are likely candidates for the desired materials. Of the more than 3,000 possible materials investigated, the data science approach found more than 200 with promising candidates. With further refining they narrowed the possibilities to 19. The technique has the potential to help save enormous amounts of time and resources. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Materials science, Advanced materials*

## **When ultrafast laser pulse meets magnetic materials**

Nanowerk, 17FEB2017

Investigating the optically excited magnetization precession in magnetic oxides may shed light on potential application in spintronics devices. Researchers in China investigated the BiFeO<sub>3</sub> (BFO) and Sr-doped LaMnO<sub>3</sub> (LMSO) heterostructure using the optical pump-probe technique. They found the magnetization precession frequencies of the LSMO thin films with the BFO coating layers to be lower than those of uncoated LSMO films. They attributed the difference to the suppression of the anisotropy field induced by the exchange interaction at the interface between the antiferromagnetic order of BFO and the FM order of LSMO. The technique provides an effective path to fast optical detection, as well as for the control of the magnetic order. [TECHNICAL ARTICLE](#)

*Tags: Materials science, S&T China*

## **Breakthrough in 'wonder' materials paves way for flexible tech**

Physorg.com, 16FEB2017

Multiple stacked layers of 2-D materials, heterostructures, create highly efficient optoelectronic devices with ultrafast electrical charge, which can be used in nano-circuits. An international team of researchers (UK, USA - University of Washington, Italy) has developed a technique that measures the electronic properties of each layer in a stack, allowing researchers to establish the optimal structure for the fastest, most efficient transfer of electrical energy. The ability to create optimal semiconductor structures paves the way for the development of highly efficient nano-circuitry, and smaller, flexible, more wearable gadgets. The heterostructures could also revolutionize solar power with strong absorption and efficient power conversion with a minimal amount of photovoltaic material. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Materials science*

## **MICROELECTRONICS**

### **New resource for optical chips**

MIT News, 20FEB2017

According to the Semiconductor Industry Association, computers' energy requirements will exceed the world's total power output by 2040. Researchers at MIT present a practical way to introduce second-order nonlinearities into silicon photonics to make optical signal processing more efficient and reliable. They developed a modulator and frequency doubler that exploit nonlinearities. The free carriers at the center of a conventional silicon modulator can absorb photons traveling through the waveguide, they diminish the strength of the optical signal; modulators that exploit second-order nonlinearities don't face that problem.

*Tags: Microelectronics*

## **QUANTUM SCIENCE**

### **New technique for creation of entangled photon states**

Physorg.com, 15FEB2017

Spatial states of single photons and spatially entangled photon pairs are becoming an important resource in quantum communication. Researchers in Russia have developed and tested a new technique for creating spatial entanglement. The method does not require postselection of a particular subspace of spatial modes and allows one to use the full photon flux from the nonlinear crystal. Such sources are a prerequisite for emerging applications in free-space quantum communication. The research has application in quantum cryptography. [TECHNICAL ARTICLE](#)

*Tags: Quantum science, Communications technology, S&T Russia*

### **Another hurdle to quantum computers cleared: Sorting machine for atoms**

Science Daily, 09FEB2017

Around the world, scientists are currently looking for methods that enable sorting processes in the microcosm to realizing quantum computers. Making use of spin, which can be influenced with microwaves, researchers in Germany set all atoms in the same direction of rotation, loaded and held the particles in a polarized laser beam. Thus the atoms could be moved. In principle, any number of atoms can be moved at the same time and placed in any pattern. According to the researchers, the method can be used to investigate the behavior of semiconductor crystals under certain conditions. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Quantum science, S&T Germany*

## **S&T POLICY**

### **US military technology superiority is challenged as reaching near parity in some capability areas**

Next Big Future, 20FEB2017

According to [Military Balance 2017](#) published by the International Institute for Strategic Studies, military technological superiority in some capability areas, particularly in the air domain, China appears to be reaching near-parity with the West. Across the globe, advanced military capabilities are spreading. Growing proliferation of lethality, and the increasing sophistication of these systems risks complicating Western states' military options. The USA still spends the most, and retains the world's most powerful military forces. From 2012 to 2016, real-terms defence spending across Asia grew by 5–6% each year. However, total global military spending in 2016 fell by 0.4% in real terms when compared to 2015, largely driven by reductions in the Middle East.

*Tags: S&T policy, Military technology*

## **Russian company working on a lightweight stealth fighter to replace the Mig-29 and Mig35**

Next Big Future, 18FEB2017

According to aviation journalists, the Russian Liogkiy Mnogofunktionalniy Frontovoi Samolyet (LMFS) (or Light Multi-Function Frontal Aircraft in English) will use a canard configuration which was developed in the late 1980s. The aircraft will likely have an empty weight of roughly 33,000lbs, a maximum takeoff weight of 55,000lbs. The new fighter will be equipped with a pair of the Klimov VK-10M afterburning turbofans that should enable the aircraft to reach speeds of between Mach 1.8 and Mach 2.0 with a range of 2485 miles when configured with external droptanks.

Tags: S&T policy, Military technology, S&T Russia

## **SCIENCE WITHOUT BORDERS**

### **Stages of Electronics - Cellphones as a fifth-order elaboration of Maxwell's theory**

IEEE Spectrum, 20FEB2017

Electronic gadgets are nothing but the inevitable fifth-order elaborations of two fundamental ideas: electromagnetic radiation, the theory of which was formulated by James Clerk Maxwell in the 1860s, and miniaturized fabrication, which followed Richard Feynman's 1959 dictum that "there's plenty of room at the bottom"

Tags: Science without borders

### **Separating fact from fiction using a 'fake news' algorithm**

Physorg.com, 16FEB2017

According to researchers in Canada, every brand of 'fake'—whether it is journalistic deception, a hoax or a satirical news piece—would need its own algorithm. They identified five features that serve as a litmus test in determining whether something is legitimate—a high prevalence of absurdity, humour elements, long sentences, negative affect and punctuation indicates a likelihood something is fake. The detector has a relatively high accuracy 80-85 per cent of the time.

Tags: Science without borders

## **SENSORS**

### **Quantum dots help silicon FET see infrared light**

Nanotechweb, 20FEB2017

Researchers in Canada grew a thin epitaxial p-type silicon layer on top of an n-type type silicon substrate contacting the epitaxial layer using source and drain electrodes made from aluminium. They deposited a layer of colloidal quantum on top of the p-type silicon channel. The quantum dots act as an IR photosensitive gate that modulates the p-type silicon channel based on the amount of infrared light absorbed. The device allows for detection of IR light directly on silicon. With a response time of around 10 microseconds, it is five orders of magnitude better than similar phototransistors. [TECHNICAL ARTICLE](#)

Tags: Sensors, Quantum science, S&T Canada

### **Living sensors at your fingertips**

Nanowerk, 16FEB2017

Researchers at MIT have developed a tough, stretchy, biocompatible sheet of hydrogel injected with live cells that are genetically programmed to light up in the presence of certain chemicals. The material made from a mix of polymer contained up to 95 percent water, provides an environment suitable for sustaining living cells. The material also resists cracking even when repeatedly stretched and pulled—a property that could help contain cells within the material. They have demonstrated the material's potential for sensing chemicals, both in the environment and in the human body. [OPEN ACCESS TECHNICAL ARTICLE](#)

Tags: Sensors, Advanced materials ■

## **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/Subscription>. To provide feedback or ask questions, contact us at [asdre-st-bulletin-reply@sainc.com](mailto:asdre-st-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