



# S&T NEWS BULLETIN

THE LATEST IN SCIENCE AND TECHNOLOGY RESEARCH NEWS

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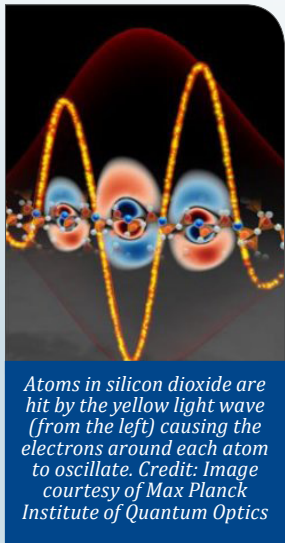
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## FEATURE ARTICLES

### [A switch for light wave electronics](#)

[Science Daily, 23MAY2016](#)



Atoms in silicon dioxide are hit by the yellow light wave (from the left) causing the electrons around each atom to oscillate. Credit: Image courtesy of Max Planck Institute of Quantum Optics

In principle, future electronics could reach petahertz speed and become 100,000 times faster than current digital electronics. This requires a better understanding of the sub-atomic electron motion induced by the ultrafast electric field of light. An international team of researchers (Germany, USA - Georgia State University, Canada, Japan) combined novel experimental and theoretical techniques which provide direct access to this motion for the first time. [TECHNICAL ARTICLE 1, 2, 3](#)

*Tags: Microelectronics, Featured Article*

### [Researchers design six-state magnetic memory](#)

[PhysOrg.com, 18MAY2016](#)

An international team of researchers (Israel, USA - New York University) has shown that realizing the six-state magnetic element does not require any significant increase in complexity, but rather involves simply structuring one of the magnetic layers differently—specifically, arranging the magnetic film into a pattern of three crossing ellipses. In the middle region where all three ellipses overlap, the researchers found that there are six different stable magnetic orientations. Going to six states would triple the density, decrease the cost of memory, and increase reading speed. [TECHNICAL ARTICLE](#)

*Tags: Advanced materials, Featured Article*

## S&T NEWS ARTICLES

### ADVANCED MATERIALS

#### [Dual-function, graphene-based material good for aircraft, extreme environments](#)

[Nanowerk, 24MAY2016](#)

Researchers at Rice University use graphene nanoribbons modified with a fluorine compound to enhance their hydrophobicity. They found that nanoribbons modified with longer perfluorinated chains resulted in films with a higher contact angle, suggesting that the films are tunable for particular conditions. The material can be spray-coated, making it suitable for large applications like aircraft, power lines, radar domes and ships. The material can also be heated with electricity to melt ice and snow in colder conditions because it is conductive. [TECHNICAL ARTICLE](#)

*Tags: Advanced materials*

#### [Gigantic ultrafast spin currents](#)

[Nanowerk, 24MAY2016](#)

It is difficult to create a spin current required in spintronics. Through computer simulations, researchers in Austria analysed the behaviour of electrons in a thin layer of nickel when it is attached to silicon and hit with ultra short laser pulses. An electric field builds up at the interface between nickel and silicon, which stops the current. But even when no electric charge is transported, it is still possible to transport spin. Their calculations show that this spin-polarization is extremely strong—much stronger than we could create with other methods. [TECHNICAL ARTICLE](#)

*Tags: Advanced materials*

#### [Light can 'heal' defects in new solar cell materials](#)

[Science Daily, 24MAY2016](#)

The tiny defects, called traps, can cause electrons to recombine with atoms before the electrons can reach a place in the crystal where their motion can be harnessed. An international team of researchers (UK, USA - University of Washington, MIT) found that under intense illumination the iodide ions migrated away

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from the illuminated region, and in the process apparently swept away most of the defects in that region along with them. Their ultimate aim is to make defect-free films. The resulting improvements in efficiency could also be useful for applications in light emission as well as light capture.

#### TECHNICAL ARTICLE

*Tags: Advanced materials, Materials science*

### **Ultra-fast method to create terahertz radiation advances materials science**

[PhysOrg.com, 24MAY2016](#)

Although the THz range has become increasingly important to science and engineering it has been difficult to realise THz sources which cover the entire frequency domain and supply ultra-short pulses of sufficient intensity. An international team of researchers (Germany, USA - University of Maryland, Sweden, France) synthesised more than 70 different thin metallic layer systems and found that the best emitter consisted of three different metal layers which together are less than six nanometres thick. TECHNICAL ARTICLE

*Tags: Advanced materials, Terahertz technology*

### **Artificial optical nanostructure outperforms butterfly wings**

[Physics World, 18MAY2016](#)

Researchers in Australia used optical two-beam super-resolution lithography to create 3D gyroid structures with lattice constants of 360 nm. The artificial structures are mechanically stronger than natural gyroids, and have long-range periodicities and well-defined crystalline boundaries. They have chiral properties that are lacking in the imperfect natural structures. Apart from applications in photonics, the new gyroid structures could help make more compact optoelectronics because of their smaller size. TECHNICAL ARTICLE

*Tags: Advanced materials, S&T Australia*

## AUTONOMOUS SYSTEMS & ROBOTICS

### **Robots get creative to cut through clutter**

[Science Daily, 18MAY2016](#)

Clutter is a special challenge for robots, but new software developed by researchers at Carnegie Mellon University not only helped a robot deal efficiently with clutter, it surprisingly revealed the robot's creativity in solving problems. One limitation of this system is that once the robot has evaluated a situation and developed a plan to move an object, it effectively closes its eyes to execute the plan. Work is underway to provide tactile and other feedback that can alert the robot to changes and miscalculations and can help it make corrections when necessary.

*Tags: Autonomous systems & robotics*

### **Undersea warfare gamechangers - China building upgraded SOSUS and US upgrading sensor and fielding network of undersea robots**

[Next Big Future, 18MAY2016](#)

The China State Shipbuilding Corporation is proposing an improved Chinese version of the Sound Surveillance System, which is a chain of high-gain long fixed arrays in the deep ocean basins listening posts located around the world in places such as the Atlantic Ocean near Greenland, Iceland, the United Kingdom and at various locations in the Pacific Ocean. BEAM accesses form beams from multiple hydrophone arrays trained on the seafloor to provide signal gain obtained through beam forming. PHONE accesses individual hydrophones from arrays throughout the oceans and provides omni-directional coverage.

*Tags: Autonomous systems & robotics, Military technology, S&T China, S&T Policy*

## BIOTECHNOLOGY

### **Developing biological micro-factories with LED**

[Nanowerk, 24MAY2016](#)

Micro-organisms that convert light energy to chemical energy respond differently, depending on the type and amount of light to which they are exposed. Researchers in Norway are using LEDs which can be controlled much more precisely than other types of light sources. By tailoring the light's spectrum, intensity and duration, they are working to synthesise raw materials for biofuels, cosmetics and health food, and ingredients. This technology can provide us with a number of raw materials which can be used in everything from medicines to fuel.

*Tags: Biotechnology*

### **Traveling wave drives magnetic particles**

[EurekAlert, 23MAY2016](#)

Researchers in Spain have developed a new method for selectively controlling, via a change in magnetic field, the aggregation or disaggregation of magnetically interacting particles of two distinct sizes in suspension in a liquid. They show that it is possible to build long chains of large particles suspended in a liquid, forming channels that drive the small particles to move along. This could be helpful, for example, when sorting magnetic beads by size, separating biological or chemical entities in lab-on-a-chip devices or transporting biological species to analyse them. TECHNICAL ARTICLE

*Tags: Biotechnology*

## COMMUNICATIONS TECHNOLOGY

### **World record in terrestrial radio transmission: Multi-Gigabit wireless communication**

[Science Daily, 23MAY2016](#)

Researchers in Germany achieved extremely high data rates of 6 Gbit/s through efficient transmitters and receivers in the form of MMICs, at a radio frequency of 71-76 GHz in



“Science can only ascertain what is, but not what should be.” ALBERT EINSTEIN

the E band. In the transmitter the broadband signals are amplified to a comparatively high transmission power of up to 1 W with the help of power amplifiers. A highly directive parabolic antenna emits the signals. Terrestrial radio transmissions in E-band are suitable as a cost-effective replacement for deployment of optical fiber or as ad-hoc networks in the case of crises and catastrophe, and for connecting base stations in the backhaul of mobile communication systems.

*Tags: Communications technology, S&T Germany*

## CYBER SECURITY

### **Beware of ransomware, the latest cybercrime epidemic**

[PhysOrg.com](#), 20MAY2016

Unlike other types of malware, ransomware uses encryption to scramble users' files. Windows users are the most at risk; the vast majority of ransomware targets PCs. But users of other devices aren't immune. Researchers have seen ransomware circulating on the Internet that targets Mac computers and Android smartphones and tablets. By the end of 2014, there were only 16 main families, or types, of ransomware in the wild, according to Malwarebytes. Last year, there were 27 new ones. In the first quarter of this year alone there were 15 new families added.

*Tags: Cyber security*

### **New tools and methods to protect Europe's Critical Infrastructure**

[PhysOrg.com](#), 20MAY2016

The EU CIPRNET (Critical Infrastructure Preparedness and Resilience Research Network) project has contributed to the maintenance of European safety and security, through enhanced protection of its essential infrastructure. CIPRNET builds capacity through ongoing education and training, makes available modelling, and simulation and analysis that can explore the interactions and dependencies across CI systems.

*Tags: Cyber security, S&T EU*

### **The complexity and security of a widely-used cryptography scheme are lower than previously thought**

[PhysOrg.com](#), 18MAY2016

Hidden field equation (HFE) is a computer cryptography scheme that uses a set of polynomial equations to generate encrypted values that only the holder of a private key can decrypt. It was previously thought that as the number of terms in the polynomial equation used to construct the HFE system increased, the complexity of the solution would increase exponentially. An international team of

researchers (USA - University of Southern California, Singapore) has shown that because the HFE system is not composed of random polynomials, but instead uses rules for their construction, it can be solved by common mathematical methods without exponential complexity.

**TECHNICAL ARTICLE**

*Tags: Cyber security*

## ENERGY

### **Discovery could energize development of longer-lasting batteries**

[Science Alert](#), 23MAY2016

An international team of researchers (USA - UT Dallas, South Korea) created a new catalyst for the lithium-air battery called dimethylphenazine, which possesses higher stability and increased voltage efficiency. They said soluble-type catalysts possess significant advantages over conventional solid catalysts, generally exhibiting much higher efficiency. The new catalyst materials may jumpstart efforts at expanding battery capacity.

*Tags: Energy, Battery*

### **Electricity from seawater: New method efficiently produces hydrogen peroxide for fuel cells**

[PhysOrg.com](#), 20MAY2016

An international team of researchers (Japan, South Korea) developed a new photoelectrochemical cell which is basically a solar cell that produces H<sub>2</sub>O<sub>2</sub>. When sunlight illuminates the photocatalyst, it absorbs photons and uses the energy to initiate chemical reactions (seawater oxidation and the reduction of O<sub>2</sub>) in a way that ultimately produces H<sub>2</sub>O<sub>2</sub>. They found that the negatively charged chlorine in seawater is mainly responsible for enhanced photocatalytic activity and high yield of H<sub>2</sub>O<sub>2</sub>. **TECHNICAL ARTICLE**

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

### **Researchers nudge closer to physical limits of solar cells**

[Nanowerk](#), 17MAY2016

Researchers in Australia pushed sunlight-to-electricity conversion efficiency to 34.5%—establishing a new world record for unfocused sunlight and nudging closer to the theoretical limits by using a 28 cm<sup>2</sup> four-junction mini-module—embedded in a prism—that extracts the maximum energy from sunlight. It does this by splitting the incoming rays into four bands, using a hybrid four-junction receiver to squeeze even more electricity from each beam of sunlight.

*Tags: Energy, S&T Australia, Solar energy*

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## FORECASTING

**Complex inter-dependent data: Looking beyond conventional networks can lead to better predictions**

Science Daily, 20MAY2016

Researchers at the University of Notre Dame suggest that current algorithms to represent networks have not truly considered the complex inter-dependencies in data, which can lead to erroneous analysis or predictions. They have developed a new algorithm that offers the promise of more precise network representation and accurate analysis. The new method is a general approach that can potentially influence a broad range of fields. [TECHNICAL ARTICLE](#)

Tags: Forecasting, Big data

## FEATURED RESOURCE

**Science magazine**

Science has been at the center of important scientific discovery since its founding in 1880—with seed money from Thomas Edison. Today, Science continues to publish the very best in research across the sciences. [RSS](#)

## GOVERNMENT S&amp;T

**Slimming down supercomputers**

PhysOrg.com, 19MAY2016

Titan, the supercomputer at Oak Ridge National Laboratory solves quadrillions of calculations a second. But it's not enough according to a [report](#) by the Secretary of Energy Advisory Board. An exascale system, a radical leap that could solve a quintillion calculations a second, is vital to tackle the remaining massive yet nuanced problems that face the world. New predictions are for around 20 megawatts, leading to supercomputers that are 100 times faster, but only use 1.5 times more power.

Tags: Government S&T, Information technology

## MATERIALS SCIENCE

**Scientists unravel the quantum properties of graphene**

Nanowerk, 20MAY2016

An international team of researchers (Germany, Austria, Japan, USA - Lehigh University, Hungary) reports that when electrons are squeezing through a narrow constriction in a graphene sheet the relationship between the width of the constriction, the energy of the electrons and the electric current is quite complex. When the energy of the electron is increased, its wavelength

decreases. At some point, one wavelength fits through the constriction, then two wavelengths, then three—this way the electron flux increases in characteristic steps. The electric current is not a continuous quantity, it is quantized.

[TECHNICAL ARTICLE](#)

Tags: Materials science, Quantum science

**Solar cells of the future could be based on iron molecules**

Science Daily, 18MAY2016

Researchers in Sweden have successfully explained how iron-based dyes work on a molecular level in solar cells. The researchers were able to further improve these iron complexes so that they become even better at absorbing and storing solar energy. The new findings will accelerate the development of inexpensive and environmentally friendly solar cells. [TECHNICAL ARTICLE](#)

Tags: Materials science, Energy, S&T Sweden, Solar energy

**Bending hot molecules**

Nanowerk, 17MAY2016

Researchers in Japan have developed a method for controlling the likelihood that the reactions between electrons and hot molecules occur, by altering the degree of bending the linear molecules, modulated by reaching precisely defined temperatures. Detailed knowledge of their reactions is not only relevant to modelling nuclear fusion devices, it is also crucial in simulating the reaction that takes place on a spacecraft's heat shield at the moment when it re-enters Earth's atmosphere. [TECHNICAL ARTICLE](#)

Tags: Materials science, S&T Japan

**Understanding a natural cloaking mechanism**

PhysOrg.com, 19JAN2016

An international team of researchers (Sweden, UK, USA - Yale University) expanded on previous work about surface tension to find the limits of natural cloaking. There is a mechanical cloaking, in which the properties of a material do not change no matter how many droplets you put in. Jell-O is just a fun example, but the human body is filled with just this sort of effective medium. According to the team, their theory provides a rigorous framework to look at the mechanical aspects of physiological response. [TECHNICAL ARTICLE](#)

Tags: Materials science

## MICROELECTRONICS

**New type of graphene-based transistor will increase the clock speed of processors**

PhysOrg.com, 19MAY2016

An international team of researchers (Russia, Japan) proposes the use of "electrical doping" to create a tunneling p-n junction. Under optimum conditions, a graphene transistor can change the current in a circuit 10,000 times with a gate voltage swing of only 150 millivolts. This means that the transistor requires less energy for switching, chips

will require less energy, less heat will be generated, less powerful cooling systems will be needed, and clock speeds can be increased without the worry that the excess heat will destroy the chip. [TECHNICAL ARTICLE](#)

*Tags: Microelectronics, Advanced materials*

### [How repeated spot microdischarges damage microdevices](#)

[Nanowerk](#), 18MAY2016

Microdischarges are caused by residual excited atoms and ions, surface charge, and temperature build-up. An international team of researchers (Czech Republic, Slovakia) found that the temperature increase in a single microdischarge reduces the electric field within the device and subsequent breakdown. Their results suggest that considering a quasi-stable background gas temperature could prove helpful when modelling chemical processes within the microdischarge in such devices.

[TECHNICAL ARTICLE](#)

*Tags: Microelectronics, Battery, Energy*

## S&T POLICY

### [California's tech industry is headed toward a new frontier](#)

[PhysOrg.com](#), 24MAY2016

California technology companies are poised to take the lead in developing new anti-drone and gun safety tools for the federal government—adding another layer of complexity to the West Coast industry's relationship with East Coast intelligence agencies.

*Tags: S&T policy*

## SCIENCE WITHOUT BORDERS

### [Between the lines](#)

[Physics World](#), 19MAY2016

The book, "Failure: Why Science is So Successful" by biologist Stuart Firestein, explores the complex role that failure plays (or should play) in how science is done, taught, perceived and funded, focusing on problems that transcend disciplinary boundaries.

*Tags: Science without borders*

### [This AI can recreate Nobel-winning experiments](#)

[Wired \(UK\)](#), 17MAY2016

Researchers in Australia applied an online optimization process based on machine learning to the production of Bose-Einstein condensates. Through repeated machine-controlled scientific experimentation and observations, the 'learner' discovers an optimal evaporation ramp for BEC production. In contrast to previous work, the learner uses a Gaussian process to develop a statistical model of the relationship between the parameters it controls and the quality of the BEC produced.

[TECHNICAL ARTICLE](#)

*Tags: Science without borders, Artificial intelligence, S&T Australia*

## SENSORS

### [Global early warning system for infectious diseases](#)

[Science Daily](#), 20MAY2016

A team of researchers in the US (University of Georgia and collaborators) calls for the creation of a global early warning system for infectious diseases. Such a system would use computer models to tap into environmental, epidemiological and molecular data, gathering the intelligence needed to forecast where disease risk is high and what actions could prevent outbreaks or contain epidemics. An early warning system would shift the infectious disease paradigm from reactive to pre-emptive management of risk. [TECHNICAL ARTICLE](#)

*Tags: Sensors, Medical sciences*

### [Speedy terahertz-based system could detect explosives](#)

[MIT News](#), 20MAY2016

An international team of researchers (USA - MIT, Sandia National Laboratory, the Netherlands) presents a new terahertz spectroscopy system that uses a quantum cascade laser, a source of terahertz radiation that's the size of a computer chip. The system can extract a material's spectroscopic signature in just 100 microseconds, using only very short bursts of terahertz radiation. The device is efficient because it emits terahertz radiation in a frequency comb. [TECHNICAL ARTICLE](#)

*Tags: Sensors, Terahertz technology*

## STEM

### [Close the Talent Gap, Secure the Future](#)

[MIT Technology Review](#), 23MAY2016

In a recent survey conducted by MIT Technology Review and collaborators, nearly 40 percent of the business and IT leaders who participated cited the lack of in-house cybersecurity expertise as their top challenge. Amid the struggle to find cybersecurity talent—and with the situation unlikely to ease in the foreseeable future—many organizations are seeking external partners to buttress their in-house capabilities.

*Tags: STEM ■*



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