



# S&T NEWS BULLETIN

THE LATEST IN SCIENCE AND TECHNOLOGY RESEARCH NEWS

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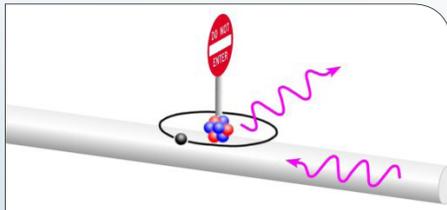
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## FEATURE ARTICLES

### [Nanoscale one-way-street for light](#)

[Science Daily, 14DEC2015](#)



An optical device at nanoscale which allows light to pass in only one direction has been developed at TU Wien (Vienna). It consists of alkali atoms which are coupled to ultrathin glass fibres. Credit: Image courtesy of Vienna University of Technology, TU Vienna

Researchers in Austria coupled alkali atoms to the light field of an ultrathin glass fibre. The direction of propagation and polarization are locked to each other. If the alkali atoms are prepared in the right quantum state and coupled to the light in the ultrathin glass fibre, it is possible to make them react differently to the two senses of light rotation. The one-way-rule holds even if the pulse of light that passes through the fibre consists of only a few photons. Such a one-way-street for light can now be used for optical chips and may thus become important for optical signal processing. [TECHNICAL ARTICLE](#)

*Tags: Photonics, Communications technology, Featured Article*

### [Quantum physics problem proved unsolvable](#)

[Nanowerk, 10DEC2015](#)

A small spectral gap is the central property of semiconductors. When the spectral gap closes it becomes possible for the material to transition to a completely different state. An example of this is when a material becomes superconducting. An international team of researchers (UK, Spain, Germany) has shown that the spectral gap is one of these undecidable problems. This means a general method to determine whether matter described by quantum mechanics has a spectral gap, or not, cannot exist. This limits the extent to which we can predict the behavior of quantum materials, and potentially even fundamental particle physics. [TECHNICAL ARTICLE](#)

*Tags: Quantum science, Featured Article*

## S&T NEWS ARTICLES

### ADVANCED MATERIALS

#### [Spintronics, low-energy electricity take a step closer](#)

[Nanowerk, 14DEC2015](#)

An international team of researchers (Switzerland, Germany, USA - Lawrence Berkeley National Laboratory, UC Berkeley, Russia, South Korea) has identified a material, described as a “crystalline phase” of bismuth iodide, as the first of a new class of topological insulators. What makes this material particularly exciting is the fact that its atomic structure does not resemble any other topological insulator known to date, which makes its properties very different as well. The discovery could propel topological insulators into applications. [TECHNICAL ARTICLE](#)

*Tags: Advanced materials*

#### [Researchers develop nature-mimicking freeze-casting technique for fabricating advanced porous materials](#)

[PhysOrg.com, 11DEC2015](#)

Using their bidirectional freezing technique, an international team of researchers (USA - Lawrence Berkeley National Laboratory, UC Berkeley, Belgium) was able to successfully induce ceramic particles to assemble into scaffolds with centimeter-scale aligned, porous lamellar structures, similar to that of nacre (mother-of-pearl). This ordered hierarchical structure was achieved by covering a laboratory “cold finger” with a polydimethylsiloxane wedge that featured different slopes. The result was controlled nucleation and growth of ice crystals during the freezing process under dual temperature gradients. [TECHNICAL ARTICLE](#)

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

#### [Nanostructured metal coatings let the light through for electronic devices](#)

[Science Daily, 09DEC2015](#)

A team of researchers in the US (University of Illinois, UMass Lowell, Rochester Institute of Technology) has developed a coating which is a specially engraved,

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nanostructured thin film that allows more light through than a flat surface, yet also provides electrical access to the underlying material. The ability to improve both electrical and optical access to a material is an important step towards higher-efficiency optoelectronic devices.

#### TECHNICAL ARTICLE

*Tags: Advanced materials*

### **Basic technology of high thermally-durable all-solid-state lithium ion battery developed**

[Science Daily, 07DEC2015](#)

The upper operating temperature of Li-ion batteries is limited to around 60°C owing to volatility of the organic electrolyte solution. Consequently, it is difficult to use the conventional Li-ion battery in a high temperature environment without a cooling system. Researchers in Japan have developed a solid electrolyte with no volatility which allows Li-ion batteries to be used in high temperature environments. This technology is significant as it allows the thermally durable Li-ion battery to be used in a wider variety of applications, such as large-scale industrial machines with motors, and medical machines.

*Tags: Advanced materials, S&T Japan*

### **How to give a twist to the self-assembly of nanoparticles**

[Nanowerk, 03DEC2015](#)

Researchers in the Netherlands have studied the self-assembly kinetics using computer simulations for a simple model of proteins. They focused on the influence of the rotation of the particles in the self-assembly. In a simulation of cluster formation of four particles, varying the rotational diffusion significantly shifts the preference for the self-assembly routes. The researchers were able to generalise this finding to clusters of any size. Their results provide new opportunities for a better control of the bottom-up synthesis of functional materials. TECHNICAL ARTICLE

*Tags: Advanced materials, Materials science*

## AUTONOMOUS SYSTEMS & ROBOTICS

### **Northrop demonstrates counter UAV technologies**

[Defense Systems, 09DEC2015](#)

The system is capable of tracking small UAVs and providing accurate target coordinates while the UAV is in flight, the company said. Venom is described as a ground based targeting system with Northrop's Lightweight Laser Designator Rangefinder. It can recognize targets in day, night or obscured conditions, range to the target at an eyesafe wavelength, and calculate grid coordinates with the company's GPS/Elevation/Azimuth capability. It operates on a universal stabilized and gimballed mount.

*Tags: Autonomous systems & robotics, Military technology*

### **Here's What Developers Are Doing with Google's AI Brain**

[MIT Technology Review, 08DEC2015](#)

The AI software, called TensorFlow, provides a straightforward way for users to train computers to perform tasks by feeding them large amounts of data. The software incorporates various methods for efficiently building and training simulated "deep learning" neural networks across different computer hardware. Now the software is being used by others to perform some neat tricks, including translating English into Chinese, reading handwritten text, and even generating original artwork.

*Tags: Autonomous systems & robotics, Artificial intelligence*

### **This AI Algorithm Learns Simple Tasks as Fast as We Do**

[MIT Technology Review, 10DEC2015](#)

An international team of researchers (USA - New York University, MIT, Canada) has created an AI software which can recognize a handwritten character about as accurately as a human can, after seeing just a single example. The best existing machine-learning algorithms, which employ deep learning, need to see many thousands of examples of a handwritten character in order to learn the difference between an A and a Z. TECHNICAL ARTICLE

*Tags: Autonomous systems & robotics, Artificial intelligence*

## BIOTECHNOLOGY

### **"Kill switches" shut down engineered bacteria**

[MIT News, 11DEC2015](#)

Many research teams are developing genetically modified bacteria that could one day travel around parts of the human body, diagnosing and even treating infection. However, before such bacteria can be safely let loose, scientists will need to find a way to prevent them from escaping into the wider environment, where they might grow and cause harm. A team of researchers in the US (MIT, Harvard University) is introducing standalone circuits that can be popped in to any number of different organisms, without needing to rewire or change much of the genome in order for it to accommodate the switch. TECHNICAL ARTICLE

*Tags: Biotechnology, Biology, Medical sciences, Synthetic biology*

## CYBER SECURITY

### **There is a way to protect unencrypted data in use**

[Defense Systems, 09DEC2015](#)

While the data is encrypted when it is being stored, and in transit—once it's on a user's computer, laptop or tablet, the user's application has to work on it "in the clear." One method currently under development is the creation of secure memory enclaves on CPUs. Security enclaves carve out a dedicated portion of memory. They create a safe haven that protects data from the rest of memory. They

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“For me, it is far better to grasp the Universe as it really is than to persist in delusion, however satisfying and reassuring” **CARL SAGAN**

do this by isolating data from the rest of the platform. As a result, even in a hostile environment, critical information can be protected.

*Tags: Cyber security*

### **Your broadband router is not as secure as you think it is**

**PhysOrg.com, 09DEC2015**

Researchers analyzed firmware from 37 currently available broadband routers and found that 90% of the components analysed were more than six years old, every firmware had obsolete software with known security issues, regardless of the manufacturer or release date. While alarming, our research does not suggest that consumer routers are being attacked frequently or on a large scale.

*Tags: Cyber security*

## ENERGY

### **Scientists advance understanding of photoelectrodes**

**Science Daily, 08DEC2015**

A team of researchers in the US (National Renewable Energy Laboratory, University of Colorado) developed and used a new probe to uncover the role that a TiO<sub>2</sub>/GaInP<sub>2</sub> interface plays in the photoconversion process. The new measurement tool could lead to improvements in how photoelectrodes are designed to make them more efficient and more stable. [TECHNICAL ARTICLE](#)

*Tags: Energy, Government S&T*

## IMAGING TECHNOLOGY

### **New nanotechnology manufacturing technique advances imaging, biosensing technology**

**Nanowerk, 09DEC2015**

A team of researchers in the US (University of Chicago, Air Force Research Laboratory, University of Florida) invented a novel way to build nanolenses in large arrays using a combination of chemical and lithographic techniques. They aligned three spherical gold nanoparticles of graduated sizes in the string-of-pearls arrangement predicted to produce the focusing effect. The key was placing each individual nanoparticle building block into exactly the position they wanted it to go. The device makes possible extremely high-resolution imaging or biological sensing. [TECHNICAL ARTICLE](#)

*Tags: Imaging technology, Sensors*

### **Toward powerful and compact terahertz spectrometers**

**Science Daily, 08DEC2015**

An international team of researchers (USA - MIT, Sandia National Laboratory, the Netherlands) has fabricated

high-performance quantum cascade lasers and integrated them into a device to demonstrate new, high-power broadband terahertz frequency combs. By canceling out intracavity wavelength dispersion, they formed robust frequency combs covering a frequency range of almost 500 GHz with more than 70 lines at 3.5 terahertz. This suggests that similar techniques can be used to improve frequency combs at wavelengths other than terahertz, such as the mid-infrared. [TECHNICAL ARTICLE](#)

*Tags: Imaging technology, Terahertz technology*

## MATERIALS SCIENCE

### **Doped organic semiconductors explored**

**Nanowerk, 14DEC2015**

An international team of researchers (Germany, Columbia, Austria, China) analyzed doping in organic semiconductor materials and found that the molecules form what are known as co-crystallites. The doped organic semiconductor consists of a matrix of undoped crystallites in which “mixed crystallites” are embedded. The new understanding makes it possible to control the electronic properties of organic semiconductors just as precisely as we customarily do today with inorganic semiconductors. [TECHNICAL ARTICLE](#)

*Tags: Materials science*

### **How nanoparticles give electrons away**

**Nanowerk, 14DEC2015**

An international team of researchers (Germany, Spain, Czech Republic, Italy) prepared an extremely clean and atomically well-defined oxide surface, onto which they placed platinum nanoparticles. Looking at particles with various numbers of atoms, from several to many hundred, they counted the number of electrons transferred and showed that the effect is most pronounced for small nanoparticles with around 50 atoms. The researchers were also able to use theoretical methods to show how the effect can be controlled, allowing the chemical properties to be adapted to better suit their intended application. [TECHNICAL ARTICLE](#)

*Tags: Materials science, Advanced materials*

### **2D superconductor surviving in high magnetic fields over 50 Tesla**

**University of Tokyo, 10DEC2015**

Researchers in Japan have discovered a 2D superconductor, which is realized on the surface of molybdenum disulfide that can survive even in high magnetic fields over 50 Tesla, more than 100 times the power of the strongest commercially available Neodymium magnets. This result opens a new field of research into noncentrosymmetric superconductivity and provides important insights into the

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development of superconductors that are stable in strong magnetic fields. [TECHNICAL ARTICLE](#)

*Tags: Materials science, S&T Japan*

### [Scientists discover that a single layer of tiny diamonds increases electron emission 13,000-fold](#)

[PhysOrg.com](#), 10DEC2015

An international team of researchers (USA - Stanford University, Germany, Ukraine) used tiny nanopillars of germanium wire as stand-ins for electron gun tips. They coated the wires with gold and then with diamondoids of various sizes. When they applied a voltage to the nanowires to stimulate the release of electrons from the tips, they found the best results from tips coated with diamondoids that consist of four “cages.” These released a whopping 13,000 times more electrons than bare gold tips. The technique provides an avenue for designing other types of electron emitters with atom-by-atom precision. [TECHNICAL ARTICLE](#)

*Tags: Materials science*

## FEATURED RESOURCE

### [Scientific Data \(Nature\)](#)

Scientific Data is an open-access, peer-reviewed publication for descriptions of scientifically valuable datasets. The primary article-type, the Data Descriptor, is designed to make your data more discoverable, interpretable and reusable. [RSS](#)

### [Study reveals essential ingredients for nanowire growth](#)

[Nanowerk](#), 10DEC2015

Through the use of real-time infrared spectroscopy, researchers at the Georgia Institute of Technology found that surface species, specifically hydrogen atoms and methyl groups, decorate the nanowire’s surface and are essential for the stable growth of nanowires made from germanium. With these findings it will be possible to better design processes and precursors to choreograph nanowire growth. [TECHNICAL ARTICLE](#)

*Tags: Materials science*

### [Near zero friction from nanoscale lubricants](#)

[Nanowerk](#), 08DEC2015

Researchers at Argonne National Laboratory have developed a system which wraps graphene flakes around nanodiamonds that then roll between a diamond-like carbon-surface and graphene on silica. Such hard ball bearings wrapped in slippery Teflon® tissue paper rolling between two surfaces reduces the friction to almost zero. The coefficient of friction is just 0.004, and contact areas are reduced by more than 65%. [TECHNICAL ARTICLE](#)

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

### [Two-dimensional silica can behave as an auxetic material](#)

[Nanotechweb](#), 07DEC2015

Researchers in Germany have discovered a new ground state of bilayer silica - AAr-stacking  $\alpha$ -silica via first principles calculations. The new ground state structure introduces a new member to the family of two-dimensional auxetic material, like phosphorene and defective graphene, and is expected to facilitate experimental study identifying the related structures and exploring further physical and chemical properties of 2D nanoscale systems. Their computational results can provide a possibility for its promising use in the nanoelectronics and electromechanical devices. [TECHNICAL ARTICLE](#)

*Tags: Materials science, S&T Germany*

## QUANTUM SCIENCE

### [Google Says It Has Proved Its Controversial Quantum Computer Really Works](#)

[MIT Technology Review](#), 08DEC2015

Researchers at Google set up a series of races between the D-Wave computer installed at NASA against a conventional computer with a single processor. Google posted a [research paper](#) describing its results online, but it has not been formally peer-reviewed. They are also working on quantum hardware that would not be limited to optimization problems, as annealers.

*Tags: Quantum science*

## S&T POLICY

### [Billion-Dollar Non-Profit AI Research Lab to Open in San Francisco](#)

[IEEE Spectrum](#), 11DEC2015

A group of Silicon Valley luminaries and companies [in the US] announced that they have committed US\$1 billion to an organization they’ve named [OpenAI](#). This nonprofit is dedicated to advancing “digital intelligence” in the way that is most likely to benefit humanity as a whole, unconstrained by a need to generate financial return. [Investors’ Letter](#)

*Tags: S&T policy, Artificial intelligence*

### [Investing in PhD Research Pays Off](#)

[IEEE Spectrum](#), 10DEC2015

A research team led by economists at the National Bureau of Economic Research found that nearly 40% of federally and non-federally funded PhDs went to work in the industry. These graduates were more likely to get high-paying jobs, jobs in high-tech and professional service industries, and at firms that perform R&D. This shows that doctoral recipients transfer their knowledge out to the economic marketplace, boosting local and national economic growth. Not much is known about where research-funded PhDs go after they graduate and enter the private sector. Even less is known about the traits of businesses that employ them. [TECHNICAL ARTICLE](#)

*Tags: S&T policy*

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## SCIENCE WITHOUT BORDERS

### **Double quantum-teleportation milestone is Physics World 2015 Breakthrough of the Year**

Physics World, 11DEC2015

The Physics World 2015 Breakthrough of the Year goes to the University of Science and Technology of China in Hefei, for being the first to achieve the simultaneous quantum teleportation of two inherent properties of a fundamental particle—the photon. Nine other achievements are highly commended and cover topics ranging from astronomy to medical physics.

*Tags: Science without borders, S&T China*

### **Nature publisher to continue free paper-sharing service**

Science Insider, 11DEC2015

In December 2014, the publisher of Nature and its 48 sister journals launched a 1-year experiment: an online tool called ReadCube that allowed subscribers to share a read-only version of the subscription journal content with anyone, for free. The trial had no adverse implications for subscription-based journals either in terms of institutional business or individual article sales. ReadCube access is now permanent for the Nature journals.

*Tags: Science without borders*

### **Electron lifetime is at least 66,000 yottayears**

Physics World, 09DEC2015

An international team of researchers used the Borexino detector in Italy to look for electron decay. As they did not find any evidence of decay they estimated a minimum value for the average lifetime of the electron to be  $6.6 \times 10^{28}$  yr which is more than 100 times greater than the previous lower limit of  $4.6 \times 10^{26}$  yr. The discovery could help physicists to develop a new and improved model of nature. TECHNICAL ARTICLE

*Tags: Science without borders, Particle physics*

## SENSORS

### **New optical technique able to detect a single radio signal amongst background noise**

PhysOrg.com, 11DEC2015

Researchers at UC San Diego have developed a way to convert radio signals to optical signals that can be processed to filter, separate and identify individual components. They looped the signals so that they could gather enough data for averaging. Next they used two tunable optical frequency combs—when the spectra were overlapped it allowed for alignment of the components which caused the signal to be amplified as compared to other background noise, which then allowed it to be uniquely identified. The team tested

their technique by running 4,720 detection attempts and found it to be better than 99 percent accurate. TECHNICAL ARTICLE

*Tags: Sensors*

### **‘Quasiparticles’ reveal incredibly minute distortions in light waves**

Science Daily, 08DEC2015

Sensor technology developed by researchers in Ireland is based on a curious phenomenon: a quasiparticle that emerges when light waves couple with the electrons' oscillations of certain solid surfaces. By measuring how efficiently incoming light creates these quasiparticles, the researchers are able to derive previously undetectable distortions in the wavefronts. This new technique advances applications in metrology and chemical sensing, and improves adaptive optics for microscopy and biomedicine.

TECHNICAL ARTICLE

*Tags: Sensors*

### **The world's tiniest temperature sensor is powered by radio waves**

Nanowerk, 07DEC2015

The current version of the sensor, made by researchers in the Netherlands, has a range of 2.5 centimeters; the researchers expect to extend this to a meter within a year, and ultimately to 5 meters. The sensor has a specially developed router, with an antenna that sends radio waves to the sensors to power them. Since this energy transfer is accurately targeted at the sensor, the router consumes very little electricity. And the sensors themselves are made such that their energy consumption is extremely low. The sensor also operates beneath a layer of paint, plaster or concrete; it can be painted onto the wall with latex.

*Tags: Sensors* ■

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