



# S&T NEWS BULLETIN

THE LATEST IN SCIENCE AND TECHNOLOGY RESEARCH NEWS

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## FEATURE ARTICLES

### [New research on Northern Lights will improve satellite navigation accuracy](#)

Science Daily, 13MAR2017



Northern Lights  
Credit: University of Bath

The latest research by an international team of researchers (UK, Australia, Canada, Sweden, USA - Johns Hopkins University) found that within the Northern Lights plasma, turbulence does not exist. They identified particle precipitation as responsible for enhanced phase scintillation at L band at the onset of a substorm which is responsible for outages on Global Navigation Satellite Systems (GNSS). However, the large-scale structures did not cascade into smaller-scale structures, leading to enhanced phase scintillation without amplitude scintillation. New insights from this experiment allow a better characterization of the impact that space weather can have on satellite telecommunications and navigation services. [OPEN ACCESS TECHNICAL ARTICLE](#)

Tags: [Environmental science](#), [Featured Article](#)

### [Toward “valleytronic” devices for data storage or computer logic systems](#)

MIT News, 09MAR2017

An international team of researchers (USA - MIT, UC Riverside, Taiwan) has developed a new technique to harness the valley index to tune electronic energy levels in two-dimensional films of crystal. They use laser light to control the electrons in both valleys independently within atomically thin crystals of tungsten disulfide. By tuning the laser frequency to even further below resonance, and increasing its intensity, they were able to simultaneously shift the energy levels of both valleys and reveal a very rare physical phenomenon. The discovery could ultimately pave the way for the development of so-called “valleytronic” devices. [TECHNICAL ARTICLE](#)

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

## S&T NEWS ARTICLES

### ADVANCED MATERIALS

#### [New ‘biomimetic’ glue shows high-strength bonding under water](#)

Physorg.com, 10MAR2017

Mussels extend hair-like fibers that attach to surfaces using plaques of adhesive which contain the amino acid DOPA needed to provide strength and adhesion. Researchers at Purdue University have inserted this chemistry of mussel proteins into a biomimetic polymer called poly(catechol-styrene), creating an adhesive by harnessing the chemistry of compounds called catechols contained in DOPA. The catechol groups may have a special talent for “drilling down” through surface waters to bind to surfaces. The bio-based glue performed better than 10 commercial adhesives when used to bond polished aluminum. [TECHNICAL ARTICLE](#)

Tags: [Advanced materials](#)

#### [New nanofiber marks important step in next generation battery development](#)

Nanowerk, 10MAR2017

An international team of researchers (USA - Georgia Institute of Technology, China) synthesized double perovskite nanofiber using composition tuning - or “co-doping” to improve the intrinsic activity of the catalyst. With enhanced oxygen evolution reaction capability, its catalytic activity was about 72 times greater than the initial powder catalyst. Beyond its applicability in the development of rechargeable metal air batteries, the new catalyst could also represent the next step in creating more efficient fuel cell technologies. [OPEN ACCESS TECHNICAL ARTICLE](#)

Tags: [Advanced materials](#), [Battery](#), [Energy](#)

#### [Physicists predict the existence of unusual optical composites](#)

Physorg.com, 10MAR2017

Researchers in Russia have demonstrated uncommon manifestation of spatial dispersion in low refractive index contrast 3D periodic dielectric composites with periods of about one tenth of the wavelength. They

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bridge the gap between natural crystals and artificial photonic materials. They describe optical composites which on the one hand cannot be described within the scope of classical crystallography, and on the other hand they are not traditional photonic crystals or metamaterials. These findings may enable scientists to develop new types of optical polarization control elements. [OPEN ACCESS TECHNICAL ARTICLE](#)

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

### [Scientists develop novel nanomaterial with controllable optical properties](#)

[Nanowerk](#), 10MAR2017

An international team of researchers (Germany, China, Russia) has produced a new optical nanomaterial based on nanoporous gold, which facilitates changes, of up to thirty percent, in the optical transmission by applying an electrical voltage. The wavelength range at which the nanomaterial absorbs and reflects can be set by manipulating the density of the pore. The enormous inner surface enables electron density variations in the interconnected metallic wires allowing optical transmission to be altered reversibly and on broad bands. The finding has great potential for splitting water into oxygen and hydrogen by absorbing sunlight. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Advanced materials*

### [Semiconductor nanowire on silicon covers the entire mid-infrared](#)

[Nanotechweb](#), 10MAR2017

The difficulty in making nanowires operating in mid- and far-infrared wavelength bands remains a challenge that impedes progress. An international team of researchers (UK, China) successfully increased antimony incorporation in the nanowires with high optical properties. Their nanowires exhibit photoluminescence up to room temperature, with the longest wavelength being 5.1  $\mu\text{m}$ , and show a complete pure zinc-blende crystalline phase. They are exploring the advantages of the high mobility and photovoltaic features for device applications in silicon-based high-mobility transistors and sustainable energy generation including cost-effective thermoelectric and thermophotovoltaic cells. [TECHNICAL ARTICLE](#)

*Tags: Advanced materials*

### [Guiding light: 3-D metasurfaces with optical possibilities created](#)

[Science Daily](#), 09MAR2017

Extensive commercial use of metamaterials has been restrained by the limitations imposed by the materials comprising them. An international team of researchers (USA - Sandia National Laboratory, Germany) is using III-V semiconductors as the building blocks of metamaterials. The new materials can be fabricated in multiple layers to form complex, three-dimensional meta-atoms that reflect more light than shiny gold surfaces. They emit

photons when excited, and have highly variable outputs across the color spectrum so they might be used to extend the wavelength range of lasers or for generating “entangled photons” for quantum computing. [TECHNICAL ARTICLE 1, 2](#)  
*Tags: Advanced materials, Government S&T*

### [MIT physicists predict the existence of unusual optical composites](#)

[Eurekalert](#), 09MAR2017

Researchers in Russia demonstrated uncommon manifestation of spatial dispersion in low refractive index contrast 3D periodic dielectric composites with periods of about one tenth of the wavelength. The splitting of a beam in two in birefringent materials is due to the dependence of the properties of a crystal on the direction of light wave propagation, and the presence of polarization of light waves. The research may enable scientists to develop new types of optical polarization control elements. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Advanced materials*

### [Novel laminated nanostructure gives steel bone-like resistance to fracturing under repeated stress](#)

[Physorg.com](#), 09MAR2017

An international team of researchers (Japan, Germany, USA - MIT) has shown that when steel microstructures are hierarchical and laminated, similar to the substructure of bone, superior crack resistance can be realized. Their results reveal that tuning the interface structure, distribution, and phase stability to simultaneously activate multiple micro-mechanisms that resist crack propagation is key for the observed leap in mechanical response. The exceptional properties enabled by this strategy provide guidance for all fatigue-resistant alloy design efforts. Although this alloy would be more expensive than a basic low-carbon steel, the property benefits have been shown to be quite exceptional, and it's with much lower amounts of alloying metals. [TECHNICAL ARTICLE](#)

*Tags: Advanced materials*

### [Perovskite edges can be tuned for optoelectronic performance](#)

[Physorg.com](#), 09MAR2017

An international team of researchers (USA - Los Alamos National Laboratory, Rice University, Northwestern University, Brookhaven National Laboratory, France) investigated both photophysical and optoelectronic properties of phase-pure homogenous 2D perovskites and showed that thin films have an intrinsic mechanism for dissociation of the strongly bound excitons to free-carriers provided by lower energy states at the edges of the layered perovskites. They can contribute to photocurrent in a PV device or radiatively recombine efficiently for light-emission applications. These results show that edges and surface can be

“Fear cannot be banished, but it can be calm and without panic; it can be mitigated by reason and evaluation.” VANNEVAR BUSH

chemically designed and engineered to achieve efficient flow of charge and energy leading to high-efficiency optoelectronic devices. [TECHNICAL ARTICLE](#)

*Tags: Advanced materials, Materials science*

### [‘Photonic doping’ makes class of metamaterials easier to fabricate](#)

[Nanowerk, 09MAR2017](#)

An international team of researchers (USA - University of Pennsylvania, Egypt, China) transplanted the concept of doping to macroscopic photonics, demonstrating that two-dimensional dielectric particles immersed in a two-dimensional epsilon-near-zero medium act as dopants that modify the medium’s effective permeability while keeping its effective permittivity near zero, independently of their positions within the host. The response of a large body can be tuned with a single impurity. They demonstrated the effect at microwave frequencies. This methodology might provide a new pathway for engineering electromagnetic metamaterials and reconfigurable optical systems. [TECHNICAL ARTICLE](#)

*Tags: Advanced materials, Photonics*

### [NRL Develops Lighter, Field Repairable Transparent Armor](#)

[Naval Research Laboratory, 08MAR2017](#)

According to researchers at NRL, heating thermoplastic elastomers above the softening point, around 100 degrees Celsius, melts the small crystallites, enabling the fracture surfaces to meld together and reform via diffusion. Using this technique, they have recreated superior ballistic properties of polyurea and polyisobutylene coatings, with the added benefit of the material being transparent, lighter than conventional bullet-resistant glass and repairable. Because of the dissipative properties of the elastomer, the damage due to a projectile strike is limited to the impact locus.

*Tags: Advanced materials, Government S&T*

## AUTONOMOUS SYSTEMS & ROBOTICS

### [Songs that make robots cry](#)

[Medical Express, 09MAR2017](#)

An international team of researchers (Japan, Belgium) has released a new machine-learning device that detects the emotional state of its listeners to produce new songs that elicit new feelings. They preprogrammed the robot with songs, but added the brain waves of the listener to make new music. They found that users were more engaged with the music when the system could detect their brain patterns. The technology may have applications in health care.

*Tags: Autonomous systems & robotics, Artificial intelligence*

### [This Hard-to-Destroy Drone Goes From Rigid to Flexible When It Crashes](#)

[IEEE Spectrum, 09MAR2017](#)

Researchers in Switzerland present a bioinspired strategy for the design of quadcopters resilient to collisions. Abstracting the biomechanical strategy of collision resilient insects’ wings, the quadcopter has a dual-stiffness frame that rigidly withstands aerodynamic loads within the flight envelope, but can soften and fold during a collision to avoid damage. The dual-stiffness frame works in synergy with specific energy absorbing materials that protect the sensitive components of the drone hosted in the central case. The proposed approach is compared to other state-of-the-art collision-tolerance strategies and is validated in a 50g quadcopter that can withstand high speed collisions.

[TECHNICAL ARTICLE](#)

*Tags: Autonomous systems & robotics, S&T Switzerland*

### [Baidu’s Artificial Intelligence Lab Unveils Synthetic Speech System](#)

[MIT Technology Review, 08MAR2017](#)

One of the challenges in speech synthesis is to reduce the amount of fine-tuning that goes on behind the scenes. Baidu’s big breakthrough is to create a deep-learning machine that largely does away with this kind of meddling. The result is a text-to-speech system called Deep Voice that can learn to talk in just a few hours with little or no human interference. The only variables that the new system does not control are the stresses on the phonemes, their duration, and the natural frequency of the sound. This allows Baidu to change the voice of the speaker and the emotion the word conveys. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Autonomous systems & robotics, Artificial intelligence*

### [Computer linguists are developing an intelligent system aid for air traffic controllers](#)

[Science Daily, 08MAR2017](#)

The current technical support systems typically lack the ability to understand and process brief radio exchanges between the pilot and air traffic controllers. Researchers in Germany developed a software system named “AcListant,” which listens in to air controllers’ radio conversations and makes more informed suggestions for their current situation. Data from the radar is used to generate probable word sequences and filtered items as suggested instructions for the pilot are shown. In tests the software has reduced the number of incorrect commands and the controllers were able to communicate a lot better with pilots who talk very fast or with an accent.

*Tags: Autonomous systems & robotics, Artificial intelligence*

*continued...*

**Hacked Drones Become the Ultimate IEDs**

Defense Update, 06MAR2017

Past uses of drones by terrorists focused primarily on situational awareness and documentation of offensive actions. Availability of high-resolution HD or 4K cameras and infrared sensors, low-cost, high precision gimbals, higher frequency datalinks and online 'do-it-yourself' (DIY) drones have transformed drones into rudimentary though capable offensive platforms that can drop weapons on target with impressive accuracy and surprise.

*Tags: Autonomous systems & robotics, Military technology*

**FEATURED RESOURCE****Live Science**

Live Science offers a fascinating window into the natural and technological world, delivering comprehensive and compelling news and analysis. [RSS](#)

**BIOTECHNOLOGY****On the path toward molecular robots**

Physorg.com, 10MAR2017

Researchers in Japan have successfully created a chemical compound, called a crystalline assembly, which repeatedly flips under a blue light. They made crystals composed of azobenzene which takes two structurally different forms: cis and trans. They observed repetitive bending-unbending motion of the thin crystals under blue light, which suggests the existence of two stable structures, bent or unbent, depending on the cis/trans ratio. The frequency of the motion increased with the intensity of light. This mechanism can be used in bio-inspired molecular motors and drug delivery.

*Tags: Biotechnology, S&T Japan*

**This small molecule could have a big future in global food security**

Science Daily, 10MAR2017

Aflatoxin contamination is responsible for a global loss of millions of tons of crops each year. Researchers at the University of Arizona transformed maize plants with a kernel-specific RNA interference (RNAi) gene cassette targeting the aflC gene, which encodes an enzyme in the Aspergillus aflatoxin biosynthetic pathway. After pathogen infection, aflatoxin could not be detected in kernels from these RNAi transgenic maize plants. The research provides an attractive and precise engineering strategy that could also be extended to other crops to improve food security. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Biotechnology, Synthetic biology*

**COMMUNICATIONS TECHNOLOGY****Two radio signals, one chip, open a new world for wireless communication**

Science Daily, 13MAR2017

A team of researchers in the US (Cornell University, industry partner) connected a series of six subtransmitters to an artificial transmission line. Each of the subtransmitters sends signals at regular intervals, and their individually weighted outputs are programmed so that they combine to produce a radio frequency signal in the forward direction at the antenna port, while canceling out at the receive port. Summation and cancellation can be tuned across a wide range of frequencies and signal strength at the antenna can be adjusted. In one direction, it's a filter and in the other direction, it's an amplifier. [TECHNICAL ARTICLE](#)

*Tags: Communications technology*

**FOREIGN S&T****China developing reusable rocket that will be able to send manned missions to the moon**

Next Big Future, 09MAR2017

The spaceship is expected to be operable in the lower orbit of Earth, as well as capable of landing humans on the moon. The next-gen rocket from China will not only be reusable, but also offer a higher carrying capacity when compared to its foreign counterparts. This craft will apparently be able to carry up to six members in the lower orbit of Earth and nearly three or four astronauts during a moon landing operation.

*Tags: Foreign S&T, S&T China*

**GOVERNMENT S&T****ARPA-E Energy Innovation Summit: Self-Fluffing Fabrics and the World's Coolest Paint**

IEEE Spectrum, 10MAR2017

Two of the technologies funded by ARPA-E are highlighted in the article. A company in California used a combination of common synthetic fibers, each of which has different thermal expansion characteristics. The fibers are structurally layered so that when one fiber expands in response to temperature more than another, it causes the fabric to change significantly. It dynamically changes its insulation in response to temperature by varying the amount of air trapped. It operates completely passively. Another company has developed a paint brimming with two different kinds of nanoparticles, one reflects broadband sunlight, the other emits infrared radiation dropping the paint's temperature below ambient temperature. In demonstration, the tent with a painted fabric roof was reliably 8 °C to 12 °C cooler than the unpainted tent.

*Tags: Government S&T*

**DHS wants a look at anti-drone tech**

Federal Computer Week, 08MAR2017

The Science and Technology Directorate at DHS is looking to identify and prove out technology that can detect, identify and track small UAS that are perceived as threats to people or critical infrastructure. Testing will be done “under urban clutter conditions,” in which spectrum availability and line-of-sight issues will challenge operators. The program will be conducted in two parts. The first will be this summer when it will bring in technology developers in a “familiarization assessment.” The second part, held in the fall of 2017, will be an assessment to quantify system performance. [Solicitation](#)

Tags: Government S&amp;T

## INFORMATION TECHNOLOGY

**The prototype of a chemical computer detects a sphere**

Science Daily, 09MAR2017

Researchers in Poland are using chemical signals instead of electronic signals for their calculations. They investigated a system of a dozen-or-so to a few dozen drops in which chemical signals propagate. The system works by mutual communication between droplets: when the droplets are in contact, the chemical excitation can be transmitted from droplet to droplet. Using evolutionary algorithms, they taught the system of droplets to detect the shape of a sphere. It showed the greatest accuracy in detecting the shape of a sphere, at a level of 85% and it acquired this ability in 150 generations. Droplet systems do not interpret the incoming data, they just look for correlations (‘shapes’) among them similar to the one they have been taught to find. [OPEN ACCESS TECHNICAL ARTICLE](#)

Tags: Information technology

## MICROELECTRONICS

**Single molecule switch**

Nanowerk, 10MAR2017

An international team of researchers (Germany, Switzerland, China) presents a tripodal platform with a cantilever arm and a nitrile group at its end that is lifted from the surface. The formation of a bond between the nitrile nitrogen and the gold tip of a scanning tunnelling microscope can be controlled by both electrical and mechanical means. The well-defined on and off state can be actuated with high reproducibility. The research is an important step towards realising fundamental ideas of molecular electronics. [OPEN ACCESS TECHNICAL ARTICLE](#)

Tags: Microelectronics

**Researchers flip magnetic memory cell with light pulse at record speed**

Science Daily, 09MAR2017

Researchers at the University of Minnesota used GdFeCo alloy to replace the upper magnetic layer of a conventional magnetic tunnel junction and used transparent indium tin oxide for the electrode to allow light to pass through it. The layers are stacked into a pillar. Every time a pulse hit the magnetic tunnel junction pillar, the change in voltage confirms that the resistance of the magnetic tunnel junction “sandwich” changes each time the magnetization of the GdFeCo layer is switched. Because each laser pulse lasts less than 1 picosecond, the device can receive data at a rate of 1 terabit per second. The ultimate goal for the research team is to shrink the size of the magnetic tunnel junction to less than 100 nanometers and reduce the required optical energy. The research may lead to new spintronics. [TECHNICAL ARTICLE](#)

Tags: Microelectronics

## NEUROSCIENCE

**Brainlike computers are a black box. Scientists are finally peering inside**

Science Magazine, 07MAR2017

To unlock the neural network black box, an international team of researchers (Germany, Singapore, South Korea) created software that can go through such networks backward to see where a certain decision was made, and how strongly this decision influenced the results. The method enables researchers to measure how much individual inputs, like pixels of an image, contribute to the overall conclusion. With that information, researchers can create visualizations that impose a mask over the image. The mask is most bright where the pixels are important and darkest in regions that have little or no effect on the neural net’s output. This work could improve neural networks, reduce the amount of data needed and help investigate errors when they occur in results, like misclassifying objects in an image. [OPEN ACCESS TECHNICAL ARTICLE](#)

Tags: Neuroscience, Artificial intelligence

## PHOTONICS

**New material helps record data with light**

Physorg.com, 10MAR2017

An international team of researchers (Russia, Germany, the Netherlands) synthesized MOFs that have a layered structure. To prevent the plates from uncontrollably coming together through van der Waals force, the interlayer space is filled with an organic liquid. They brought together intralayer and interlayer excitons. Interlayer excitons are more stable, but slow moving, so the researchers propose they be used for the data recording.

Both types of excitons are suitable for processing of optical signals. [TECHNICAL ARTICLE](#)

*Tags: Photonics, Advanced materials, Information technology*

## QUANTUM SCIENCE

### [Simultaneous detection of multiple spin states in a single quantum dot](#)

[Science Daily](#), 13MAR2017

Readout of the electron spin of quantum dots is necessary to realize quantum computing. Researchers in Japan used a quantum point contact charge sensor positioned near a gallium arsenide quantum dot. The change in current of the charge sensor depended on the spin state of the quantum dot and was used to distinguish between singlet and two types of triplet spin states. They identified one ground state and two excited states in the quantum dot using their setup. Their findings represent a step forward on the path to realizing quantum computing. [TECHNICAL ARTICLE](#)

*Tags: Quantum science, S&T Japan*

## SENSORS

### [How Metamaterials Are Reinventing 3-D Radar Imaging](#)

[MIT Technology Review](#), 10MAR2017

A team of researchers in the US (Duke University, University of Washington University) built a synthetic aperture radar using metamaterials. The flexibility offered by dynamic metasurfaces may be used to steer directive beams for enhanced signal strength, create nulls in the pattern to avoid jamming, probe a large region of interest with a wide beam, or even interrogate multiple positions at once with a collection of beams. Because they vary in direction at random, they cover a much wider area than a conventional beam, which points in just one direction. Dynamic metasurface aperture is poised to make important contributions across the entire field of microwave sensing. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Sensors, Advanced materials*

### [Physicists design a device inspired by sonic screwdriver](#)

[Eurekalert](#), 08MAR2017

Nanomechanical sensors and quantum nanosensors are two rapidly developing technologies that have diverse interdisciplinary applications in biological and chemical analysis and microscopy. An international team of researchers (Australia, Germany, USA - UC Santa Barbara, Japan) have taken the first step toward combining these two complementary technologies in the form of diamond nanomechanical structures containing nitrogen-vacancy centers. They established the principles for nanomechanical sensing using nanospin-mechanical sensors (NSMS). When combined with the other nanometrology modes of the NV center, NSMS potentially offer unparalleled analytical power at nanoscale. [OPEN ACCESS](#)

[TECHNICAL ARTICLE](#)

*Tags: Sensors* ■

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