



S&T NEWS BULLETIN

THE LATEST IN SCIENCE AND TECHNOLOGY RESEARCH NEWS

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

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

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

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

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

[Energy \(4\)](#)

[Information technology \(3\)](#)

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

[Microelectronics \(2\)](#)

[Photonics \(3\)](#)

[S&T policy \(3\)](#)

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

[Sensors \(3\)](#)

FEATURE ARTICLES

[Making computers explain themselves](#)

MIT News, 27OCT2016



Science and Artificial Intelligence Laboratory (CSAIL) have devised a way to train neural networks so that they provide not only predictions and classifications but rationales for their decisions. Illustration: Christine Daniloff/MIT

The best-performing systems in artificial-intelligence research have come courtesy of neural networks. But neural nets are black boxes. After training, a network may be very good at classifying data, but even its creators will have no idea why. Researchers

at MIT will present a new way to train neural networks so that they provide not only predictions and classifications but rationales for their decisions. The researchers specifically address neural nets trained on textual data.

[OPEN ACCESS TECHNICAL ARTICLE](#)

Tags: Information technology, Artificial intelligence, Featured Article

[The quantum sniffer dog](#)

Science Daily, 24OCT2016

Researchers in Austria have fabricated a circular laser with a diameter of less than half a millimetre and concentric quantum cascade rings, which can both emit and detect light, at two slightly different wavelengths. One ring emits the laser light which passes through the gas before being reflected back by a mirror. The second ring then receives the reflected light and measures its strength. The two rings then immediately switch their roles, allowing the next measurement to be carried out. Their geometric properties ensure that the laser only emits light at a very specific wavelength. As many gases absorb only very specific amounts of infrared light, it is perfect for chemical analysis of gases. Combining laser and detector allows for the production of extremely

compact sensors, and conceivably, even an entire cluster of microsensors housed on a single chip and able to operate on several different wavelengths simultaneously. [OPEN ACCESS TECHNICAL ARTICLE](#)

Tags: Sensors, Quantum science, Featured Article

S&T NEWS ARTICLES

ADVANCED MATERIALS

[Team heats up exotic topological insulators](#) Physorg.com, 31OCT2016

The special properties that make topological insulators (TIs) so exciting are usually observed only at very low temperature, typically requiring liquid helium to cool the materials. To get around this problem, an international team of researchers (UCLA, NIST, China) tried an antiferromagnet for the alternating layers. They found that the outermost layer's influence magnetizes the TI, but without the overwhelming force. The new approach allowed the TIs to become magnetic and demonstrate the TI's hallmarks at temperatures far above 77 Kelvin, still too cold for use as consumer electronics components, but warm enough that scientists can use nitrogen to cool them instead. Suddenly, room temperature TIs don't look as far out of reach. [TECHNICAL ARTICLE](#)

Tags: Advanced materials, Materials science

[New surfaces repel water in oil as well as oil in water](#)

Science Daily, 28OCT2016

An international team of researchers (Finland, China) proposes two design criteria for new surfaces: the liquid filling criterion and the steady composite interface criterion. The design criteria lead to steady trapping of airless oil and water films within surface texture. Such liquid films enable both underoil superhydrophobicity and underwater superoleophobicity. [TECHNICAL ARTICLE](#)

Tags: Advanced materials, Materials science

continued...

[BACK TO TOP](#)

New technique reveals powerful, ‘patchy’ approach to nanoparticle synthesis

Science Daily, 28OCT2016

Patches of chain-like molecules placed across nanoscale particles can radically transform the optical, electronic, and magnetic properties of particle-based materials. An international team of researchers (Canada, USA - Brookhaven National Laboratory, University of North Carolina, Russia) have demonstrated that the interactions between polymer chains, solvents, and the high curvature of the nanoparticles drive self-assembly. The findings lay the foundation for new nanoscale architectures that could potentially enhance technologies such as self-assembled solar cells and catalysts. [TECHNICAL ARTICLE](#)

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

Metamaterial device allows chameleon-like behavior in the infrared

Science Daily, 27OCT2016

Researchers at Pennsylvania State University made a metadvice with metamaterial composed of layers of gold, aluminum dioxide, active vanadium dioxide and a gold-patterned layer that is attached to an external electric source. The geometry of the patterned mesh screen controls the functional wavelength range. The amount of current flowing through the device controls the Joule heating effect. They found that a current of 2.03 amps fades the pattern on the mesh into the background and becomes invisible, while at 2.20 amps, it is clearly visible but the background has become highly reflective. According to the researchers, vanadium dioxide can change state very rapidly and it is the device configuration that limits the tuning. [OPEN ACCESS TECHNICAL ARTICLE](#)

Tags: *Advanced materials*

AUTONOMOUS SYSTEMS & ROBOTICS

Video Friday: Russian Android, Swarm User Interface, and Robot Drone Man

IEEE Spectrum, 28OCT2016

Rovables are miniature robots that can move freely on unmodified clothing. Applications of the device include on-body sensing, modular displays, tactile feedback and interactive clothing and jewelry.

Tags: *Autonomous systems & robotics*

BIG DATA

Automated method allows rapid analysis of disaster damage to structures

Physorg.com, 28OCT2016

In the aftermath of a disaster, teams of engineers take a lot of photos and spend an enormous amount of time to analyze and put a description on it so that others can use it. Researchers at Purdue University are developing a computerized system using advanced computer vision algorithms that could exponentially speed the process. To

train algorithms, they have gathered about 90,000 digital images from recent earthquakes in Nepal, Chile, Taiwan and Turkey, including images from Santiago Pujol.

Tags: *Big data, Artificial intelligence*

COMMUNICATIONS TECHNOLOGY

Researchers nearly reached quantum limit with nanodrums

Nanowerk, 31OCT2016

Extremely accurate measurements of microwave signals can potentially be used for data encryption based on quantum cryptography and other purposes. Researchers in Finland combined a nanomechanical resonator with two cavities. In addition to the microwave measurement, this device enables transforming quantum information from one frequency to another while simultaneously amplifying it. Therefore, the method has potential for data encryption based on quantum mechanics, i.e. quantum cryptography.

[OPEN ACCESS TECHNICAL ARTICLE](#)

Tags: *Communications technology, Cyber security, Quantum science*

Precise quantum cloning: Possible pathway to secure communication

Science Daily, 24OCT2016

Researchers in Australia use a ‘noiseless optical amplifier’ to demonstrate that they can split a light beam into clones when the amplification is good enough. ‘Amplify-then-split’ allows cloning the light beam with minimal distortion so it can still be read with exquisite precision. They hope this technology could be used to extend the range of communication. It is possible this technique could allow quantum encryption to be implemented with existing fibre optic infrastructure. Quantum cloning opens up important experimental possibilities as well as having applications in ultra-secure long distance quantum networks. [OPEN ACCESS TECHNICAL ARTICLE](#)

Tags: *Communications technology, Quantum science*

CYBER SECURITY

New tool detects malicious websites before they cause harm

Science Daily, 27OCT2016

Researchers at Princeton University describe a system called PREDATOR (Proactive Recognition and Elimination of Domain Abuse at Time-Of-Registration) based on the assumption that malicious users will exhibit registration behavior that differs from those of normal users. By identifying such patterns, they were able to start sifting through the more than 80,000 new domains registered every day to preemptively identify which ones were most likely to be used for harm. Testing their results against known black-listed websites, they found that PREDATOR detected 70 percent of malicious websites based solely on information known at the time those domains were first registered. The

continued...

“If we were not constantly striving for that which we could only imagine, we were not fulfilling our obligations to society as scientists.” **SUSAN LEE LINDQUIST**

false positive rate of the PREDATOR system was only 0.35 percent. PREDATOR can achieve early detection, often days or weeks before existing blacklists.

Tags: Cyber security

ENERGY

Flexible cells on roofs to windows to cars to even clothing could provide another energy source

[Physorg.com, 31OCT2016](#)

Researchers in Australia have developed organic solar cells from simple commercial chemicals that have yielded great results in the lab. The material, with unusual crystallisation, aligns its molecules to improve performance. They can be produced en masse at low cost, simply by being printed on large plastic sheets, using standard commercial printers. They are so pliable they can effectively turn any surface into a solar array—from buildings, to vehicles or even clothing, awnings, shade cloths or umbrellas.

Tags: Energy, S&T Australia, Solar energy

Self-powered textile could be woven into smart clothes

[Nanotechweb, 28OCT2016](#)

An international team of researchers (USA - Georgia Institute of Technology, China, Taiwan) has developed a self-charging hybrid system that can harvest both solar energy and the mechanical energy from a person's movements. The first component in the device harvests solar energy from ambient light and the second harvests the mechanical energy that a person creates as he moves about during normal everyday activities. Both of these energies can easily be converted into electricity in fibre-shaped dye-synthesised solar cells and fibre-shaped triboelectric nanogenerators. The combined energy is then stored as chemical energy in a third component, fibre-shaped supercapacitors. **TECHNICAL ARTICLE**

Tags: Energy, Flexible electronics

Next-generation smartphone battery inspired by the gut

[Science Daily, 26OCT2016](#)

An international team of researchers (UK, China) has developed a new lithium-sulphur battery with a layer of material that resembles a villi-like structure (finger-like protrusions which line the small intestine) made from tiny zinc oxide wires. The material is placed on the surface of one of the battery's electrodes. They created a functional layer which lies on top of the cathode and fixes the active material to a conductive framework so the active material can be reused. The layer is made up of tiny,

one-dimensional zinc oxide nanowires grown on a scaffold. Changing from stiff nickel foam to a flexible carbon fibre mat makes the layer mimic the way the small intestine works even further. The new battery could have five times the energy density of a typical lithium-ion battery.

TECHNICAL ARTICLE

Tags: Energy, Battery

Two-dimensional anodes for advanced sodium ion batteries

[Nanowerk, 26OCT2016](#)

Two-dimensional materials are potentially attractive anodes for sodium ion batteries due to their large surface area and ability to minimize volume changes during battery operation. To better understand the sodium ion storage mechanism in this new class of anodes, researchers in Saudi Arabia developed a process for two-dimensional anodes for sodium ion batteries made from tin selenide. In-situ spectral studies during battery operation showed that tin selenide stores sodium ions by a two-step process involving both conversion and alloying reactions. This dual mechanism explains the high capacity the team could achieve using SnSe₂ anodes. The new synthesis process resulted in 515 milliampere-hours per gram after 500 charge-discharge cycles.

Tags: Energy, Battery

INFORMATION TECHNOLOGY

Breaking the Multicore Bottleneck

[IEEE Spectrum, 28OCT2016](#)

A team of researchers in the US (North Carolina State University, industry partner) has come up with a solution to one of the modern microprocessor's most persistent problems: communication among the processor's many cores. Their answer is a dedicated set of logic circuits they call the Queue Management Device, or QMD. In simulations, integrating the QMD with the processor's on-chip network at a minimum doubled core-to-core communication speed and, in some cases, boosted it much further. As the number of cores was increased, the speedup became more pronounced.

Tags: Information technology

Making energy-harvesting computers reliable

[Physorg.com, 28OCT2016](#)

A team of researchers in the US (Carnegie Mellon University, industry partner) created the first programming language designed to build reliable software for intermittent, energy-harvesting computers. The programming language, called Chain, asks an application developer to define a set of computational tasks

continued...

that compute and exchange data through a novel way of manipulating the computer's memory, called a channel. Chain guarantees that tasks execute correctly despite arbitrary power failures. They plan to run the program on-board two tiny, postage stamp-sized satellites in a low-earth orbit of Earth.

Tags: Information technology

FEATURED RESOURCE

[Forecasting Principles](#)

The Forecasting Principles site summarizes all useful knowledge about forecasting so that it can be used by researchers, practitioners, and educators. The site describes all evidenced-based principles on forecasting and provides sources to support the principles.

MATERIALS SCIENCE

[Changing semiconductor properties at room temperature](#)

[Physorg.com](#), 28OCT2016

Researchers at Rensselaer Polytechnic Institute have developed a method that uses a one-degree change in temperature to alter the color of light that a semiconductor emits. The method, which uses a thin-film semiconductor layered on top of a heat-sensitive substrate material, offers a path to electronically triggering changes in the properties of semiconductor materials. [TECHNICAL ARTICLE](#)

Tags: Materials science

[Raising temperature changes an element's electronic 'topology'](#)

[Physorg.com](#), 28OCT2016

Experimenting with an alloy of iron and titanium, a team of researchers at Caltech found that increasing heat alters the topology of the material's Fermi surface. In practical terms, altering the topology of the Fermi surface alters the chemical properties of a metal or alloy, which in turn alters its electrical conductivity. [TECHNICAL ARTICLE](#)

Tags: Materials science

[Researchers surprised at the unexpected hardness of gallium nitride](#)

[Nanowerk](#), 28OCT2016

Researchers at Lehigh University measured the wear rate and friction coefficients of GaN using a custom microtribometer to perform dry sliding wear experiments. They found that its wear rate approaches that of diamonds. GaN also has a favorable radiation hardness. They observed that an increase in humidity inside the glove box increases the wear rate of GaN. The findings could

have a dramatic effect on the electronic and digital device industries. Multiple layers in a typical semiconductor device can be replaced with one layer made of a material that has excellent optical and electrical properties and is wear-resistant. Electronics, light sensors and light emitters can be integrated and still have a mechanically robust device.

[TECHNICAL ARTICLE](#)

Tags: Materials science

[Controlling the properties of matter in two-dimensional crystals](#)

[Nanowerk](#), 27OCT2016

Researchers at Pennsylvania State University have found a mechanism to give order to the atoms, which in turn introduces control of the properties, not only heat transport but also electronic, chemical or magnetic properties in some alloys. They showed that in the case of the molybdenum, tungsten and sulfur alloy, the electronic properties were the same in every direction, but using simulations they predict that the thermal transport properties are smaller perpendicular to the chains or stripes. Controlling the direction of materials properties in two and three dimensional crystals has implications in sensing, optoelectronics and next-generation electronics applications. [TECHNICAL ARTICLE](#)

Tags: Materials science

[Supersonic phenomena, the key to extremely low heat loss nano-electronics](#)

[Science Daily](#), 25OCT2016

Spontaneously localised excitations may either be discrete breathers or solitons. Using computer simulation, an international team of researchers (Spain, Russia) confirmed that under certain conditions, the discrete breathers evolve into a genuine soliton moving at supersonic speed within the lattice. These findings confirm that solitons can be used as natural carriers of energy, matter and electric charge carriers under certain conditions. [TECHNICAL ARTICLE](#)

Tags: Materials science

MICROELECTRONICS

[Electrical currents can be now be switched on and off at the smallest conceivable scale](#)

[PhysOrg.com](#), 28OCT2016

An international team of researchers (Canada, Germany) have just released findings that detail how to create atomic switches for electricity, many times smaller than what is currently used. They used atomically resolved, electronic pump-probe scanning tunneling microscopy that permits unprecedented, quantitative measurement of time-resolved single dopant ionization dynamics. Distinct ionization and neutralization rates of a single dopant were measured and the physical process controlling those were identified. [OPEN ACCESS TECHNICAL ARTICLE](#)

[TECHNICAL ARTICLE](#)

Tags: Microelectronics

continued...

[Nanotechnology engineers design an infinitesimal computing device](#)

Nanowerk, 27OCT2016

Researchers at UC Santa Barbara have developed a design for a functional nanoscale computing device using material implication logic combined with memristors. Unlike the conventional computing logic and circuitry, in this form of computing, logic operation and information storage happen simultaneously and locally reducing the need for components and space typically used to perform logic operations. The result of the computation is immediately stored in a memory element, which prevents data loss in the event of power outages. They reconfigured the traditionally two-dimensional architecture of the memristor into a three-dimensional block saving space. [TECHNICAL ARTICLE](#)

Tags: *Microelectronics*

PHOTONICS

[Weakness is good... when controlling light](#)

Physorg.com, 31OCT2016

A team of researchers in the US (The State University of New York at Buffalo, Caltech, College of Staten Island) has developed an asymmetric metawaveguide, a tiny rectangular box made of silicon, which creates asymmetric reflections of two beams of light, which enables the weaker beam to control the other beam. The advancement, coupled with other developments, could ultimately lead to more powerful, energy-efficient computer chips and other optics-based technologies.

[TECHNICAL ARTICLE](#)

Tags: *Photonics*

[Novel light sources made of two-dimensional materials](#)

Nanowerk, 28OCT2016

An international team of researchers (UK, Germany) cooled a monolayer of transition metal dichalcogenides (TMDC) down to a temperature of just above absolute zero and excited it with a laser. They showed that a specific type of excitement produces not one but exactly two photons which can be used to transfer information 100% tap-proof. The "cloned" photons have similar properties to laser light, but are manufactured in completely different ways: Ideally, the production of new light particles is self-sustaining after the initial excitation without requiring any additional energy supply.

[TECHNICAL ARTICLE](#)

Tags: *Photonics, Quantum science*

[Physicists break record for laser-electron interaction](#)

Physics World, 26OCT2016

An international team of researchers (USA - UCLA, Brookhaven National Laboratory, Israel) has converted the energy of an electron beam into a pulse of coherent light with an efficiency of 30% - much higher than the 10% efficiency of most free-electron lasers. While their demonstration produces only infrared light, the method could lead to efficient, high-power lasers operating over a range of wavelengths, including X-ray. Such X-ray sources could be used to etch circuits on semiconductor chips faster and more efficiently. [TECHNICAL ARTICLE](#)

Tags: *Photonics*

S&T POLICY

[Russian science at the crossroads](#)

Nature News, 01NOV2016

Upheaval in the former superpower is bad for research and the wider world. Russian science is still struggling to recover from decades of neglect and post-Soviet degradation. Its research community is isolated. Foreign students and scientists are a rare commodity at Russian universities and research institutes. But no matter how tense the geopolitical climate, isolationism leads to a dead end in both science and politics.

Tags: *S&T policy, S&T Russia*

[Renewable energy - not always sustainable](#)

Physorg.com, 31OCT2016

According to researchers in Sweden, to assess the feasibility and consequences of a global energy transition, we need to consider material flows and how sustainable emerging industries are with regard to aspects other than climate. Truly sustainable energy systems require the creation of sustainable industries, which not only can produce large amounts of renewable energy technology, but also maintain a working system on a longer time scale, and do so in a resource efficient way. [OPEN ACCESS](#)

[TECHNICAL ARTICLE](#)

Tags: *S&T policy, Energy, S&T Sweden*

[China will create four artificial islands near Mindanao for the Philippines](#)

Next Big Future, 27OCT2016

A Chinese state-owned company, said to have been involved in Beijing's island-building in the South China Sea, signed a deal to construct islands for rival claimant the Philippines. They will create four artificial islands totaling 208 hectares of reclaimed land in Davao, the port city on the southern island of Mindanao. The islands will spread along eight kilometers of coastline and be used for government buildings, commercial spaces, residences, ports and industry in a project to be completed by 2019.

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

SCIENCE WITHOUT BORDERS

Connecting research and policy may improve educational equity.

EurekAlert, 26OCT2016

According to researchers at Rice University, the disconnect between educational research and public policy is a problem. Researchers do not do a good job of informing policymakers about the results of their research and working with them before and throughout a study. Academic researchers generally focus on informing other researchers of their results rather than decision-makers, policymakers generally do not inform researchers about their policy goals and when policymakers and researchers do exchange information, they often do so in a highly political context in which many interests supersede the interests of students. Under the right conditions, research can be an extremely informative tool for policy-making.

Tags: Science without borders

SENSORS

Machine-Vision Algorithm Learns to Judge People by Their Faces

MIT Technology Review, 01NOV2016

A team of researchers in the US (University of Notre Dame, Harvard University, industry partner) created a database using a website that measures various psychological attributes of the people who visit. They had participants rate the images. Their ratings were used to train the machine-vision algorithm. The algorithm reproduced the same behavior that it has learned from humans. By teasing how the machine does this, they could tell which parts of the face the machine is using to make its judgments. These turn out to be similar to the parts of the face that humans rely on. These observations indicate that the algorithm looks in the same places that humans do, replicating the way we judge high-level attributes in each other. [OPEN](#)

[ACCESS TECHNICAL ARTICLE](#)

Tags: Sensors, Artificial intelligence, Cyber security

AI Body Scanners Could Solve the Worst Thing About Airports

MIT Technology Review, 27OCT2016

A company in the US has built a body scanner using the same millimeter-wave imaging frequencies as existing scanners. The company scans its radar beams up and down people as they walk, measuring how the waves scatter off them. The data is not used to create an image like those normally shown to security staff. Instead, it is processed by a machine-learning algorithm that has been trained to spot dangerous items like explosives and weapons. The devices will be tested at Denver International Airport, and train stations in both Washington, D.C. and Los Angeles. The company claims the devices could scan as many as 800 people per hour.

Tags: Sensors ■

ABOUT THIS PUBLICATION

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

To **SUBSCRIBE** or **UNSUBSCRIBE**, visit <https://tin-ly.sainc.com/ASDRE>. To provide feedback or ask questions, contact us at asdrest-bulletin-reply@sainc.com. 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