



# S&T NEWS BULLETIN

THE LATEST IN SCIENCE AND TECHNOLOGY RESEARCH NEWS

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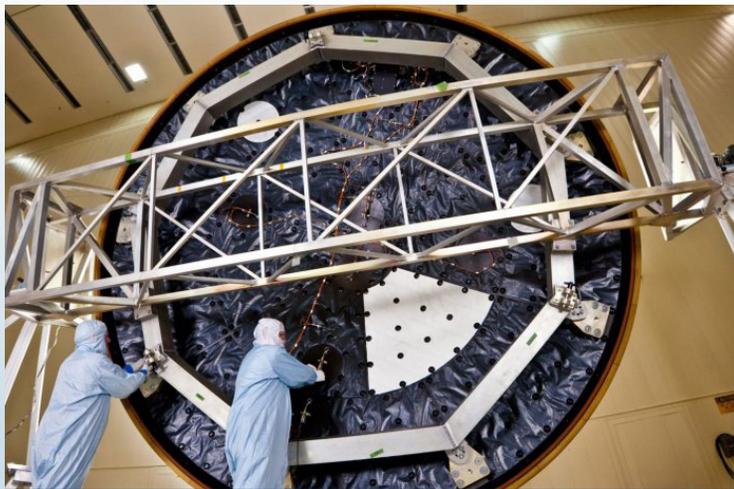
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## FEATURE ARTICLES



Discovery paves the way for new types of heat shields. Credit: NASA

### [New record set for world's most heat resistant material](#)

[PhysOrg.com, 22DEC2016](#)

Tantalum carbide (TaC) and hafnium carbide (HfC) are extraordinarily resistant to heat. However, there hasn't been the technology available to test their melting points. An international team of researchers (UK, Germany, USA-Utah State University) developed a new extreme heating technique using lasers to find the point at which TaC and HfC melted, both separately and as mixed compositions of both. They found that TaC melted at 3768°C and HfC melted at 3958°C. The materials could be used in thermal protection systems on high-speed vehicles, heat resistant shielding for the next generation of hypersonic space vehicles and as fuel cladding in the super-heated environments of nuclear reactors. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Advanced materials, Materials science, Featured Article*

### [Ultra-thin solution to primary obstacle in solid-state battery development](#)

[Nanowerk, 19DEC2016](#)

An international team of researchers (USA - University of Maryland, Canada) inserted a layer of ultra-thin

aluminum oxide between lithium electrodes and a solid non-flammable ceramic electrolyte garnet which decreases the impedance 300 fold. This virtually eliminates the barrier to electricity flow within the battery, allowing for efficient charging and discharging of the stored energy. [TECHNICAL ARTICLE](#)

*Tags: Energy, Battery, Materials science, Featured Article*

## S&T NEWS ARTICLES

### ADVANCED MANUFACTURING

#### [Researchers use world's smallest diamonds to make wires three atoms wide \(Update\)](#)

[PhysOrg.com, 26DEC2016](#)

An international team of researchers (USA - Stanford University, Lawrence Berkeley National Laboratory, Mexico, Germany) created a basic nanowire building block starting with the smallest possible diamondoids—single cages that contain just 10 carbon atoms—and attached a sulfur atom to each. Floating in a solution, each sulfur atom bonded with a single copper ion. The building blocks then drifted toward each other, drawn by the van der Waals attraction between the diamondoids, and attached to the growing tip of the nanowire. The new technique could potentially be used to build tiny wires for a wide range of applications, including fabrics that generate electricity, optoelectronic devices and superconducting materials. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Advanced manufacturing*

#### [Advances in intense pulsed light sintering opens door to improved electronics manufacturing](#)

[PhysOrg.com, 22DEC2016](#)

Densification in intense pulsed light (IPL) increases the density of a nanoparticle thin-film or pattern

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leading to functional improvements such as greater electrical conductivity. Studying the photonic sintering of silver nanoparticle films, researchers at Oregon State University found a temperature turning point in IPL despite no change in pulsing energy, and discovered that this turning point appears because densification during IPL reduces the nanoparticles' ability to absorb further energy from the light. Using IPL, it should be possible to create production processes that are both faster and cheaper, without loss in product quality. Research could benefit flexible electronics, wearable biomedical sensors, and sensing devices for environmental applications.

**TECHNICAL ARTICLE**

*Tags: Advanced manufacturing*

## ADVANCED MATERIALS

### **Engineers create programmable silk-based materials with embedded, pre-designed functions**

[PhysOrg.com](#), 26DEC2016

Using a water-based fabrication method based on protein self-assembly, researchers at Tufts University generated three-dimensional bulk materials out of silk fibroin. Protein gives silk its durability. Then they manipulated the bulk materials with water-soluble molecules to create multiple solid forms, from the nano- to the micro-scale, that have embedded, pre-designed functions. Protein can be preprogrammed with biological, chemical, or optical functions, such as mechanical components that change color with strain, deliver drugs, or respond to light.

**TECHNICAL ARTICLE**

*Tags: Advanced materials*

### **A flexible, stretchable, self-healing ionic conductor (w/video)**

[Nanowerk](#), 22DEC2016

A team of researchers in the US (UC Riverside, University of Colorado) combined a polar, stretchable polymer with a mobile, high-ionic-strength salt to create a material that can be electrically activated. The material can stretch 50 times its original length. After being cut it can completely re-attach or heal in 24 hours at room temperature. It could give robots the ability to self-heal after mechanical failure; extend the lifetime of lithium ion batteries used in electronics and electric cars; and improve biosensors used in the medical field and environmental monitoring.

**TECHNICAL ARTICLE**

*Tags: Advanced materials, Materials science*

## AUTONOMOUS SYSTEMS & ROBOTICS

### **Researcher proposes parallel Intelligence, a move toward the intelligent future**

[PhysOrg.com](#), 22DEC2016

According to an international team of researchers (China, USA - Purdue University) the victory of a computer over

the world's best players at Go was the start of the era of new IT, Intelligent Technology. They propose "ACP approach"—artificial/computational/parallel—to generate big data from small data, then reduce big data to specific laws, where software (artificial intelligence systems) learn from millions of scenarios (computational experiments) to make the best decisions while interacting (in parallel) with real-world physical systems. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Autonomous systems & robotics, Artificial intelligence*

## BIG DATA

### **New data-mining strategy that offers unprecedented pattern search speed could glean new insights from massive datasets**

[PhysOrg.com](#), 28DEC2016

Finding recurring graphs which reveal how objects tend to connect to each other is computationally expensive. Researchers in Saudi Arabia have developed a system called ScaleMine which overcomes the limitations of computation by performing the search in two steps: a first approximation step to determine the search space and the optimal division of tasks and a second computational step in which large tasks are split dynamically into the optimal number of subtasks. This resulted in search speeds up to ten times faster than previously possible.

*Tags: Big data*

### **10 reasons to be excited about data analytics in 2017**

[IBM Big Data Hub](#), 15DEC2016

The exponential growth of data and intelligent things in an environment of ubiquitous Internet connectivity is enabling a fourth industrial revolution—digital business transformation. Information is vital to evolving digital businesses because analytics touches everyone. What, then, should we expect to see in the analytics industry as we head into 2017?

*Tags: Big data*

## BIOTECHNOLOGY

### **Predictive kinetic model paves the way for designing microbial factories**

[PhysOrg.com](#), 23DEC2016

When using microbes as factories for the production of chemicals or biofuels, the key is to find the best candidates out of hundreds of genes in order to harness the subsequent increases in productivity. Researchers at Pennsylvania State University have developed a near genome-scale kinetic model of E.coli's metabolic processes, which will allow scientists to quickly and efficiently use computer modeling to predict the effects that multiple gene interventions have on the microbial

“Science has a simple faith, which transcends utility. It is the faith that it is the privilege of man to learn to understand, and that this is his mission.” **VANNEVAR BUSH**

factories. These advances in designing novel strains aren't limited to E. coli; similar kinetic models could be developed for other microorganisms such as cyanobacterial or clostridia. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Biotechnology*

### **Sensor Sensation**

[Science Newsline, 22DEC2016](#)

With microfluidics, blood or urine samples can be tested at point-of-care provided specific disease-detecting biomolecules are inserted into the microfluidic platform. Researchers in Japan have developed a nano-metal-insulator semiconductor (nMIS) sensor that has a layer of tiny gold metal islands. It measures charge using the same technique as conventional sensors but has the additional function of measuring mass. In a proof-of-concept experiment, by combining information about both the mass and charge of the biomolecule, the scientists were able to show that a common biomolecule survives exposure to ionized gas at a specific energy level. Their research offers great promise in the field of healthcare diagnostics owing to its advantages of portability and point-of-care testing. [TECHNICAL ARTICLE](#)

*Tags: Biotechnology, Medical technology, S&T Japan, Sensors*

### **Scientists can now sniff out 17 diseases from a single breath sample**

[Science Alert, 21DEC2016](#)

An international team of researchers (Israel, France, Latvia, USA) developed an artificially intelligent nanoarray based device on molecularly modified gold nanoparticles. The performance of the device was clinically assessed on breath samples collected from 1404 subjects having one of 17 different disease conditions. Analysis showed that each disease has its own unique breathprint, and that the presence of one disease would not screen out others. Blind experiments showed that 86% accuracy could be achieved with the device, allowing both detection and discrimination between the different disease conditions examined. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Biotechnology, Medical technology, Sensors*

## COMMUNICATIONS TECHNOLOGY

### **Network traffic anomaly detection**

[PhysOrg.com, 27DEC2016](#)

Researchers in Germany describe their system as data flows from origin to destination along courses that cross at various links. They focus on the directly observable but coarse link matrix, for which they then need to identify how they can estimate the unobservable flow matrix for

the full network from the link matrix. They avoid storage issues for large sets of archive data by developing the algorithm to operate online. Extensive numerical evaluations show that the proposed algorithm achieves faster convergence per iteration of model approximation, and better volume anomaly detection performance compared to state-of-the-art algorithms. [TECHNICAL ARTICLE](#)

*Tags: Communications technology*

## COUNTER WMD

### **Early Warning of Biological Threats via Surface-Enhanced Raman Spectroscopy: A Case Study of Bacillus Spores**

[Multidisciplinary Digital Publishing Institute, 25DEC2016](#)

Researchers in Italy propose an automated device where SERS is used as a fast, pre-alarm technique of a two-stage sensor equipped with a real-time PCR. In tests, principal component analysis was applied for discriminating between different strains representing dangerous and harmless spores. The results show that the SERS sensor is capable of detecting a few tenths of spores in a few minutes, and is particularly sensitive and fast for this purpose. Post-process analysis of the spectra allowed for discrimination between the contaminated and uncontaminated SERS sensors and even between different strains of spores, although not as clearly. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Counter WMD, Sensors*

## CYBER SECURITY

### **Hack-proofing our devices**

[Science Daily, 24DEC2016](#)

RFID is a staple for many industries. To protect communications between tags and readers, researchers in Singapore are making the protocol's output unpredictable, making two tags indistinguishable to the hacker, preventing hackers from obtaining useful information even if they manage to interact with the tags and designing improved access control mechanisms that protect RFID information when it is shared on the internet. [TECHNICAL ARTICLE](#)

*Tags: Cyber security*

### **A Chip to Protect the Internet of Things**

[IEEE Spectrum, 22DEC2016](#)

IoT devices can be harnessed to wreak havoc or compromise the privacy of their owners; thus Microchip Technology and Amazon.com have collaborated to create an add-on chip that is designed to make it easier to combat certain types of attack. The AWS-ECC508 is an add-on

chip designed to make devices more secure and provide end-to-end security between the IoT device and the cloud infrastructure.

*Tags: Cyber security*

## ENERGY

### One step closer to reality: Devices that convert heat into electricity

[Science Daily, 22DEC2016](#)

An international team of researchers (USA - Ohio State University, Belgium) distributed a very small amount of platinum nanoparticles randomly throughout nickel. The resulting composite produced enhanced voltage output due to the spin Seebeck effect. This means that for a given amount of heat, the composite material generated more electrical power than either material could on its own. They amplified the voltage output 10 times or more. According to the researchers their idea can be applied to a variety of material combinations, enabling entirely new approaches that don't require expensive metals like platinum or delicate processing procedures like thin-film growth. [OPEN ACCESS TECHNICAL ARTICLE, TECHNICAL ARTICLE 2](#)

*Tags: Energy, Materials science*

## FEATURED RESOURCE

### MDPI

Multidisciplinary Digital Publishing Institute, an academic open-access publisher, publishes 160 diverse peer-reviewed, scientific, open access, electronic journals. Headquartered in Switzerland, it is supported by more than 12,800 active scientists and academic editors on journals' international editorial boards.

### Artificial leaf as mini-factory for drugs

[PhysOrg.com, 21DEC2016](#)

Researchers in the Netherlands used luminescent solar concentrators (LSC's) which have special light-sensitive molecules, similar to the antenna molecules in leaves, that capture a large amount of incoming light. By incorporating very thin channels in a silicon rubber LSC through which a liquid can be pumped, they were able to bring the incoming sunlight into contact with the molecules in the liquid with high enough intensity to generate chemical reactions. They demonstrated that even on a cloudy day the chemical production was 40 percent higher than in a similar experiment without LSC material. The discovery has applications in sunlight-based production of valuable chemical products like drugs or crop protection agents. [TECHNICAL ARTICLE](#)

*Tags: Energy, Biotechnology, Solar energy*

### Scientists build bacteria-powered battery on single sheet of paper

[Science Daily, 21DEC2016](#)

Researchers at Binghamton University placed a ribbon of silver nitrate underneath a thin layer of wax to create a cathode. They made a reservoir out of a conductive polymer on the other half of the paper, which acted as the anode. Once properly folded and a few drops of bacteria-filled liquid are added, the microbes' cellular respiration powers the battery. Different folding and stacking methods can significantly improve power and current outputs. They were able to generate 31.51 microwatts at 125.53 microamps with six batteries in three parallel series and 44.85 microwatts at 105.89 microamps in a 6x6 configuration. The batteries have application in point-of-care devices. [TECHNICAL ARTICLE](#)

*Tags: Energy, Battery, Biotechnology*

## ENVIRONMENTAL SCIENCE

### Scientists identify a new approach to recycle greenhouse gas

[Science Daily, 22DEC2016](#)

Researchers at UC Irvine found that the intracellular environment of the bacterium *Azotobacter vinelandii* could be used to convert CO<sub>2</sub> to CO. The observation opens up new avenues for biotechnological adaptation of this reaction into a process that effectively recycles the greenhouse gas into the starting material for biofuel synthesis that will help us simultaneously combat global warming and energy shortages. [TECHNICAL ARTICLE](#)

*Tags: Environmental science*

## FORECASTING

### Control algorithms could keep sensor-laden balloons afloat in hurricanes for a week

[Science Daily, 22DEC2016](#)

Researchers at UC San Diego have developed practical strategies for building and coordinating scores of sensor-laden balloons within hurricanes. Using onboard GPS and cellphone-grade sensors, each drifting balloon becomes part of a 'swarm' of robotic vehicles, which can periodically report, via satellite uplink, their position, the local temperature, pressure, humidity and wind velocity. This provides in situ sampling of environmental conditions for a longer range of time and from many vantage points within developing hurricanes. It has the potential to greatly improve efforts to estimate and forecast the intensity and track of future hurricanes in real time.

*Tags: Forecasting, Climatology*

## IMAGING TECHNOLOGY

**System of flat optical lenses that can be easily mass-produced and integrated with image sensors**[PhysOrg.com](#), 23DEC2016

An international team of researchers (USA - Caltech, South Korea) has developed a system of flat optical lenses stacking two metasurfaces dotted with tens of millions of silicon cylinders smaller than a micron across that alter the way light passes through them. Controlling the width of the nanoposts allows adjusting the path of light passing through the metasurface to create flat lenses. By coupling two metasurfaces together, each nanopost-side-out, they created a lens system that can capture and focus light from a 70-degree angular range. The cameras have applications in medical devices and consumer electronics. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Imaging technology*

## INFORMATION TECHNOLOGY

**Tool to understand spread of fake news launched**[Science Daily](#), 21DEC2016

An international team of researchers (China, USA - Indiana University) has built a tool, called Hoaxy that visualizes how claims in the news—and fact checks of those claims—spread online through social networks. Hoaxy's visualizations illustrate both temporal trends and diffusion networks as they relate to online claims and fact-checks. Temporal trends plot the cumulative number of Twitter shares over time. Diffusion networks show how claims spread from person to person. Not all claims you can visualize on Hoaxy are false, or that the fact-checkers are 100 percent correct all of the time. It's up to users to evaluate the evidence about a claim and its rebuttal. [TECHNICAL ARTICLE](#)

*Tags: Information technology*

## MATERIALS SCIENCE

**Tortoise electrons trying to catch up with hare photons give graphene its conductivity**[EurekAlert](#), 16DEC2016

How electrons interact with other electrons at quantum scale in graphene affects how quickly they travel in the material, leading to its high conductivity. An international team of researchers (the Netherlands, Brazil) used pseudo-quantum electrodynamics, a theory that describes the interaction between electrons mediated by photons existing in different space-time dimensions. They found that electrons have a tendency to increase their velocity towards that of the photons, which travel at the speed of light. The weak magnetic field does not change this trend.

Therefore, the electrons' collective behaviour, which is linked to conductivity, remains the same as in the absence of a weak field. [OPEN ACCESS TECHNICAL ARTICLE](#)  
*Tags: Materials science, Advanced materials*

## MICROELECTRONICS

**Nano system operates with interacting electrons, but no electric current**[PhysOrg.com](#), 22DEC2016

An international team of researchers (Sweden, Ukraine) has developed a nanoelectromechanical system consisting of a carbon nanotube suspended between two electrode leads acting as an electron reservoir. A tip electrode above the nanotube acts as a second reservoir, containing electrons with opposite spin as the electrons in the first reservoir. Electrons can tunnel freely from their reservoirs to the nanotube and back but they cannot travel to the opposite reservoir, and so there is no charge transfer. When the electron reservoirs have different temperatures, hot and cold electrons tunnel to the nanotube and heat is transferred. As they travel back, they produce a feedback mechanism causing the nanotube to vibrate. By adjusting the temperatures of the reservoirs, the direction and strength of the feedback mechanism can be controlled, and the vibrations can be either pumped or damped. Since the system uses heat flow to generate mechanical motion, it effectively acts as a nanoscale heat engine. [TECHNICAL ARTICLE](#)

*Tags: Microelectronics***Spin filtering at room temperature with graphene**[Nanowerk](#), 22DEC2016

To study conductivity between stacked graphene sheets and how they interact with other materials, researchers at the Naval Research Laboratory developed a recipe to grow large multi-layer graphene films directly on a smooth, crystalline nickel alloy film while retaining that film's magnetic properties, then patterned the film into arrays of cross-bar junctions. When the nickel and graphene structures align, only electrons with one spin can pass easily from one material to the other, an effect termed spin filtering, that results in spin polarization of an electric current. The result is relevant to next-generation MRAM. [TECHNICAL ARTICLE](#)

*Tags: Microelectronics, Government S&T*

## QUANTUM SCIENCE

**Electron-photon small-talk could have big impact on quantum computing**[Science Daily](#), 22DEC2016

A team of researchers in the US (Princeton University, UC Santa Barbara, industry partner) fabricated a device to trap

both an electron and a photon, then adjusted the energy of the electron in such a way that quantum information could transfer to the photon. This coupling enables the photon to carry the information from one qubit to another located up to a centimeter away. The circuit design reduces interference from electromagnetic radiation and filters reduce noise. Eventually they plan to extend the device to work with spin. [TECHNICAL ARTICLE](#)

*Tags: Quantum science*

### [Engineered quantum dots convert low-intensity IR light into visible light](#)

[Nanotechweb](#), 22DEC2016

Researchers at Los Alamos National Laboratory have demonstrated Auger up-conversion in thick-shell lead selenide/cadmium selenide semiconducting quantum dots in which two low-energy, core-based excitons are converted into a single, higher-energy shell-based exciton. Devices made from such nanostructures could efficiently up-convert light at infrared wavelengths that has an intensity as low as a few watts per square centimetre.

[TECHNICAL ARTICLE](#)

*Tags: Quantum science, Government S&T*

## S&T POLICY

### [Hotter Days Will Drive Global Inequality](#)

[MIT Technology Review](#), 20DEC2016

A team of researchers in the US (Stanford University, UC Berkeley) used advanced statistical techniques to isolate temperature effects from other variables, such as changes in policies and financial cycles. They predict the average global income to be 23 percent less by the end of the century than it would be without climate change. But the effects of a hotter world will be shared very unevenly, with a number of northern countries, including Russia and much of Europe, benefiting from the rising temperatures. The uneven impact of the warming could mean a massive restructuring of the global economy.

*Tags: S&T policy, Climatology*

## SCIENCE WITHOUT BORDERS

### [Improvements to a decision-making algorithm](#)

[PhysOrg.com](#), 27DEC2016

Highly specialised computer algorithms can help find the best possible solutions to multi-objective complex problems. Researchers in Japan have made improvements to the MOEA/D algorithm which searches for an optimal

set of solutions. It does not automatically delete a solution if another neighbouring solution is deemed better but rather allows the user to specify target areas of the Pareto frontier (set of possible solutions) that need to be met. Initial trials using the updated MOEA/D with 2–8 objectives showed improvements in its searching ability by enhancing solution diversity. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Science without borders, Mathematics*

### [The Biggest Technology Failures of 2016](#)

[MIT Technology Review](#), 27DEC2016

From algorithms that spread fake news to glowing plants that don't glow, here are MIT Technology Review's picks for the worst technologies of the year.

*Tags: Science without borders*

### [Majorana fermions predicted in a superconducting material](#)

[MIT News](#), 21DEC2016

In a theoretical analysis, researchers at MIT have shown that a low-temperature material made from the elements praseodymium, osmium, and antimony and similar materials made of heavy metals should be able to host Majorana fermions. According to the researchers, [one recent experiment](#) confirms that time-reversal symmetry is broken in the superconducting state of this material. This reinforces their conclusion that it is indeed a very promising candidate to apply their theory. [OPEN ACCESS TECHNICAL ARTICLE](#)

*Tags: Science without borders, Particle physics*

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