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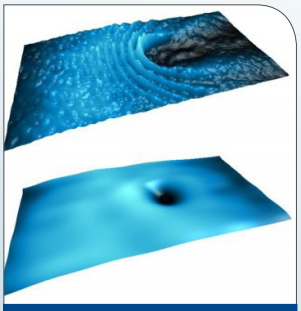
S&T NEWS BULLETIN

THE LATEST IN SCIENCE AND TECHNOLOGY RESEARCH NEWS

FEATURE ARTICLES

A stream of superfluid light

Science Daily, 05JUN2017



The flow of polaritons encounters an obstacle in the supersonic (top) and superfluid (bottom) regime. Credit: Polytechnique Montreal

To achieve superfluidity at room temperature, an international team of researchers (Italy, Canada, Finland, UK) sandwiched an ultrathin film of organic molecules between two highly reflective mirrors. Light interacts very strongly with the molecules as it bounces back and forth between the mirrors and forms the hybrid light-matter fluid. The discovery leads to the study of fundamental phenomena related to Bose-Einstein condensates with table-top experiments, and conceiving and designing future photonic superfluid-based devices where losses are completely suppressed and new unexpected phenomena can be exploited. TECHNICAL ARTICLE

Tags: Photonics, Featured Article

Ultra-stable perovskite solar cell remains stable for more than a year

Science Daily, 01JUN2017

An international team of researchers (Switzerland, Italy) engineered what is known as 2D/3D hybrid perovskite solar cell, combining the enhanced stability of 2D perovskites with 3D forms, which efficiently absorbs light across the entire visible spectrum and transports electrical charges. In tests, the solar cells have delivered a constant 11.2% efficiency for more than 10,000 hours, while showing zero loss in performance as measured under standard conditions. The breakthrough resolves the problem of perovskite solar-cell stability, and viably moves the technology into the commercial sphere. OPEN ACCESS TECHNICAL ARTICLE

Tags: Advanced materials, Solar energy, Featured Article

S&T NEWS ARTICLES

ADVANCED MANUFACTURING

Design and fabrication of 3D-printed stretchable tactile sensors

Nanowerk, 05JUN2017

Researchers at the University of Minnesota have developed a multimaterial, multiscale and multifunctional 3D printing approach to fabricate 3D tactile sensors under ambient conditions conformally onto freeform surfaces. The sensor has the capability to detect and differentiate human movements, including pulse monitoring and finger motions. The researchers expect their methodologies will open new routes for fabricating various sensors with the potential for advancing prosthetic skins, bionic organs, and human–machine interfaces. TECHNICAL ARTICLE

Tags: Advanced manufacturing, Flexible electronics

ADVANCED MATERIALS

Solid becomes liquid-like when irradiated

Physics World, 29JUN2017

The disordered atomic network resulting from irradiation resembles the disordered non-crystalline state of glassy materials. After running simulations of both irradiation damage and heating on quartz, researchers at UCLA found that irradiated quartz exhibited more disorder than glassy silica, both in the short- and the medium-range environment of the atoms. The structure and thermodynamic properties of irradiated quartz were equivalent to those of a silica-liquid melt. Their findings suggest that the structure and properties of irradiated materials can be predicted from those of their corresponding liquid and this understanding could help to identify novel radiation-resistant materials. TECHNICAL ARTICLE

Tags: Advanced materials

Strong hydrogels that respond to force, heat and light

Nanowerk, 03JUN2017

Spiropyran (SP) is a multi-stimuli-responsive mechanophore, which can change its color and fluorescence in

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response to force, heat, and light. To improve its solubility and toughening mechanisms in the hydrogels, an international team of researchers (USA - The University of Akron, China) has developed a new micellar-copolymerization method resulting in SP-crosslinked poly hydrogels that exhibit SP-induced multimechano-responsive/recovery and mechanically strong properties. The new technique is transformative to the development of other mechanophore-based hydrogels for sensing, imaging, and display applications. TECHNICAL ARTICLE

Tags: Advanced materials, Materials science

New ceramic nanofiber 'sponges' could be used for flexible insulation, water purification

Physorg.com, 02JUN2017

An international team of researchers (China, USA - Brown University) has developed a process for manufacturing lightweight, high-temperature resilient, three-dimensional sponges based on a variety of oxide ceramic nanofibers through an efficient solution blow-spinning process. The ceramic sponges consist of numerous tangled ceramic nanofibers with varying densities. They exhibit high energy absorption and recover rapidly after compression at both room temperature and 400°C. The sponge has applications in elasticity-dependent electrical resistance, photocatalytic activity, thermal insulation, water purification devices and flexible insulation. OPEN ACCESS TECHNICAL ARTICLE

Tags: Advanced materials, Materials science

Changing the nature of optics in one step

Nanowerk, 30MAY2017

A team of researchers in the US (Texas A&M University, UT Austin, Sandia National Laboratories, Los Alamos National Laboratory) fabricated nanocomposite films with vertically aligned gold nanopillars embedded in various oxide matrices with high epitaxial quality. They demonstrated anisotropic optical properties by tuning their densities on selected substrates. Their model predicts exotic properties, such as zero permitivity responses and topological transitions. The research opens possibilities for developing light-interactive photonic devices for cloaking and super-resolution imaging. TECHNICAL ARTICLE

Tags: Advanced materials, Materials science

A new spin on electronics: Study discovers a 'miracle material' for field of spintronics

Physorg.com, 29MAY2017

A team of researchers in the US (University of Utah, Washington State University) has demonstrated the optical orientation of excitons and optical detection of spin-polarized exciton quantum beating in hybrid perovskite methyl-ammonium lead iodine ($CH_3NH_3PbI_3$). They found that the perovskite has a long spin lifetime—up to nanosecond, the spin flips many times during one nanosecond, which means a lot information can be easily stored and manipulated during that time. The findings have applications in spintronics. TECHNICAL ARTICLE

Tags: Advanced materials, Microelectronics

AUTONOMOUS SYSTEMS & ROBOTICS

Teaching Robots "Manners": Digitally Capturing and Conveying Human Norms

DARPA News, 31MAY2017

For "smart" machines to be considered safe and trustworthy collaborators with human partners, robots must be able to quickly assess a given situation and apply human social norms. Working on a project funded by DARPA, a team of researchers in the US (Brown University, Tufts University) has provided a theoretical and formal framework for what norms and normative networks are and examine how norms can be learned and might emerge from novel interactive algorithms. They created a cognitive-computational model of human norms in a representation that can be coded into machines, and developed a machine-learning algorithm that allows machines to learn norms in unfamiliar situations drawing on human data.

Tags: Autonomous systems & robotics, Artificial intelligence

BIG DATA

Scientists slash computations for deep learning

Science Daily, 01JUN2017

Researchers at Rice University have developed an algorithm that combines recent ideas from adaptive dropouts and randomized hashing for maximum inner product search to select the nodes with the highest activation efficiently. They exploited the inherent sparsity in big data to increase computation and energy savings. They have shown a 95 percent savings with 1,000 neurons, the mathematics suggests that savings can be more than 99 percent with a billion neurons. OPEN ACCESS TECHNICAL ARTICLE

Tags: Big data

BIOTECHNOLOGY

DARPA Awards 'Safe Genes' Contract to Mass Gen

Global Biodefense, 06JUN2017

Under DARPA's Safe Genes program, Massachusetts General Hospital aims to deliver novel biological capabilities to facilitate the safe and expedient pursuit of advanced genome editing applications and provide the tools and methodologies to mitigate the risk of unintentional consequences or intentional misuse of these technologies. The three primary technical focus areas are: 1.) to bridge the gap between the current technological landscape and the future transformative applications of genome editing tools and engineered organisms, 2.)develop small molecules and/or molecular strategies to provide prophylactic and treatment solutions that prevent or limit genome editing activity and protect

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"If you are out to describe the truth, leave elegance to the tailor."

ALBERT EINSTEIN

the genome integrity of organisms and populations, and 3.) develop "genetic remediation" strategies that eliminate unwanted engineered genes from a broad range of complex population and environmental contexts to restore systems to functional and genetic baseline states.

Tags: Biotechnology, S&T Policy, Synthetic biology

COMMUNICATIONS TECHNOLOGY

General-Purpose Brain-Computer Interface Brings Thought Control to Any PC

MIT Technology Review, 30MAY2017

Researchers in Israel have developed a system that enables the use of regular computers using an off-the-shelf EEG/EMG headset. The system provides a pointing device and virtual keyboard that can be used to operate any Windows based system and minimizes the user effort required for interacting with a personal computer. Effectiveness of the proposed system is evaluated by a usability study, indicating decreasing learning curve for completing various tasks. Open Access TECHNICAL ARTICLE

Tags: Communications technology, Biotechnology

COUNTER WMD

Novel influenza A viruses and pandemic threats

Lancet, 03JUN2017

A surge in human infections caused by avian influenza A H7N9 virus in China has prompted pandemic concerns and has focused attention on novel influenza A viruses. Since 2013, more than 1400 human beings infected with avian influenza A H7N9 virus, resulting from poultry exposures, have been reported during winter–spring epidemics in China. Avian influenza A H7N9 virus infection of human beings can cause severe illness, with high mortality (about 40%) in hospital inpatients.

Tags: Counter WMD

The Mobile Laboratory: How a Scientist Tests for Infectious Diseases out of a Suitcase

Select Science, 01JUN2017

This is an interview with a researcher from Germany who created a mobile laboratory to keep his research going even in corners of the world with poor infrastructure. He devised protocols using a new DNA amplification technology called Recombinase Polymerase Amplification (RPA) to test for diseases such as Ebola. All RPA reagents are stable at 40°C for up to three months and it is very fast. The mobile suitcase laboratory could be used at borders crossings, ports of entry and low-resource settings to identify epidemic outbreaks as early as possible.

Tags: Counter WMD, S&T Germany

Disease experts reveal their biggest worries about the next pandemic

Business Insider, 25MAY2017

According to experts, there is a reasonable probability the world will experience a pandemic outbreak in the next 10-15 years. Epidemiologists say a fast-moving airborne pathogen could kill more than 30 million people in less than a year. Among their concerns are lack of trust in scientists and experts, not learning lessons from the past, antibiotic resistance, destruction of species and environments that might hold the keys to future medical breakthroughs and lack of funding for public health workers.

Tags: Counter WMD, Bioweapons

CYBER SECURITY

First Quantum-Secured Blockchain Technology Tested in Moscow

MIT Technology Review, 06JUN2017

Blockchain is a distributed database which is cryptographically protected against malicious modifications. They rely on digital signatures which are vulnerable to attacks by means of quantum computers. An international team of researchers (Russia, Canada, France) proposes a possible solution to the quantum-era blockchain challenge and report an experimental realization of a quantum-safe blockchain platform that utilizes quantum key distribution across an urban fiber network for information-theoretically secure authentication. These results address important questions about realizability and scalability of quantum-safe blockchains for commercial and governmental applications. Open Access TECHNICAL ARTICLE

Tags: Cyber security, Quantum science

ENERGY

The first low-cost system for splitting carbon dioxide

Nanowerk, 05JUN2017

An international team of researchers (Switzerland, Spain) has developed a catalyst by depositing atomic layers of tin oxide on copper oxide nanowires. Tin oxide suppresses the generation of side-products leading to the production of CO in the electroreduction of CO_2. The catalyst was integrated into a CO_2 electrolysis system which uses the same catalyst as both the cathode that reduces CO_2 to CO and the anode that oxidizes water to oxygen. The system was able to selectively convert CO_2 to CO with an efficiency of 13.4% using solar energy. The research is expected to help worldwide efforts to synthetically produce carbon-based

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fuels from CO_2 and water. TECHNICAL ARTICLE
Tags: Energy, Advanced materials, Solar energy

Printed, flexible and rechargeable battery can power wearable sensors

Science Daily, 24MAY2017

Researchers at UC San Diego printed a highly stretchable, zinc-silver oxide battery by incorporating polystyrene-block-polyisoprene-block-polystyrene (SIS) as a hyper-elastic binder for custom-made printable inks. They added bismuth oxide to the batteries to make them rechargeable. The prototype battery has about 1/5 the capacity of a rechargeable hearing aid battery, 1/10 as thick, cheaper and uses commercially available materials. The researchers are working to improve the battery's performance. Next steps include expanding the use of the technology to different applications, such as solar and fuel cells; and using the battery to power different kinds of electronic devices. TECHNICAL ARTICLE
Tags: Energy, Battery

IMAGING TECHNOLOGY

Seeing the invisible with a graphene-CMOS integrated device

Science Daily, 05JUN2017

Researchers in Spain working under the EU Graphene Flagship combined a graphene-CMOS integrated circuit with quantum dots to create an array of photodetectors, producing a high-resolution image sensor. When used as a digital camera the device was able to sense UV, visible and infrared light at the same time. Graphene–CMOS integration is pivotal for incorporating 2D materials into the next-generation microelectronics, sensor arrays, low-power integrated photonics and CMOS imaging systems covering visible, infrared and terahertz frequencies. TECHNICAL ARTICLE
Tags: Imaging technology, S&T EU

INFORMATION TECHNOLOGY

Magnetoelectric memory cell increases energy efficiency for data storage

Nanowerk, 30MAY2017

To increase power efficiency, and thereby decrease heat waste, by orders of magnitude, for read operations at room temperature, an international team of researchers (Russia, France) has developed a magnetoelectric random access memory (MELRAM) cell. It is based on mechanically combining the properties of two magnetic alloys -- one based on terbium-cobalt and the other iron and cobalt stacked on top of one another. The nanocomposite multilayer provides strong magnetoelectric interaction at room temperature which is the origin of its extra-low power consumption. The research could aid production of devices such as instant-on laptops, close-to-zero-consumption flash drives, and data storage centers that require much less air conditioning.
OPEN ACCESS TECHNICAL ARTICLE
Tags: Information technology

MATERIALS SCIENCE

Novel method to study quantum fluctuations in exotic phases of matter

Science Daily, 29JUN2017

To understand the link between quantum fluctuations and the effective charge of current-carrying particles, an international team of researchers (Japan, France) used a magnetic field to tune the Kondo state (rise in resistance at extremely low temperature) in a carbon nanotube, ensuring that the quantum fluctuations were the only variable in the system. By directly monitoring the conductance and shot noise of the carbon nanotube, they demonstrated a continuous crossover between Kondo states with different symmetries. The findings have applications in areas such as superconductivity, Mott insulators, and the fractional quantum Hall effect.
TECHNICAL ARTICLE
Tags: Materials science

Nanoparticle shape controls properties

Nanotechweb, 05JUN2017

Researchers at UT San Antonio have shown that for silicon–germanium the magnitude of the size effect is determined by the nanoparticle shape, with highly faceted particles experiencing exaggerated changes to their thermal stability and optical properties. In contrast, neither size nor shape was found to have a significant effect on the temperature range over which Si and Ge are immersible. The research facilitates experimental efforts to create nanoparticles with properties tuned for applications in computing and thermoelectric engineering. TECHNICAL ARTICLE
Tags: Materials science

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Scientists see electron bottleneck in simulated battery

Nanowerk, 30MAY2017

An international team of researchers (USA - Texas A&M University, Lawrence Berkeley National Laboratory, NIST, Binghamton University, Canada) has demonstrated that in individual nanowires of layered V2O5, lithiation gradients observed on Li-ion intercalation arise from localized electrons coupled to local structural distortions. These give rise to small polarons that serve as a bottleneck for further Li-ion insertion. The findings shed light on the slowdown of the performance of electrodes made with vanadium pentoxide. Open Access TECHNICAL ARTICLE

Tags: Materials science, Battery

MICROELECTRONICS

Device designed to exploit scattering of light by mechanical vibrations

Physorg.com, 07JUN2017

Researchers in Brazil have engineered coupled optical microcavities to enable low threshold excitation of mechanical travelling-wave modes through backward stimulated Brillouin scattering. Exploring the backward scattering, they propose silicon microcavity designs based on laterally coupled single and double-layer cavities. They propose a device that could exploit a mechanism for the scattering of light by mechanical vibrations that could be transposed to photonic microchips. Open Access TECHNICAL ARTICLE

Tags: Microelectronics

Engineer unveils new spin on future of transistors with novel design

Nanowerk, 05JUN2017

A team of researchers in the US (Northwestern University, UT Dallas, University of Illinois at Urbana-Champaign, University of Central Florida) proposes a spintronic circuit in which electrons moving through carbon nanotubes create a magnetic field that affects the flow of current in a nearby graphene nanoribbon, providing cascaded logic gates that are not physically connected. Because the communication between each of the graphene nanoribbons takes place via an electromagnetic wave, they expect communication will be much faster, with the potential for terahertz clock speeds. The carbon materials can be made smaller than silicon-based transistors. They are working to build a prototype. TECHNICAL ARTICLE

Tags: Microelectronics

Neuromorphic Chips Are Destined for Deep Learning—or Obscurity

IEEE Spectrum, 29MAY2017

At the Neuro Inspired Computational Elements Workshop held in March, leading researchers spoke frankly about their challenges. Neuromorphic systems have small user bases, in universities or industrial research groups, and require specialized knowledge. Currently there is no compelling demonstration of a high-volume application where neuromorphics outperform the alternative. The meta-issue hovering over the neuromorphic community is that the researchers don't know whether the spiking behavior they are mimicking in the brain is central to the way the mind works, or merely one of its many accidental by-products.

Tags: Microelectronics

QUANTUM SCIENCE

New method improves stability of perovskite quantum dots

Science Daily, 29JUN2017

Perovskite quantum dots have issues with stability against air, heat, light, and water. Researchers in Switzerland used atomic layer deposition (ALD) to encapsulate the perovskite quantum dots with an amorphous alumina matrix. They demonstrated that the nanocomposites show an exceptional stability against exposure to air (for at least 45 days), irradiation under simulated solar spectrum (for at least 8h) to thermal treatment (at least up to 200ºC in air), and finally against immersion in water. Their work is expected to greatly impact the field by enabling fundamental optoelectronic studies. TECHNICAL ARTICLE

Tags: Quantum science, Advanced materials, S&T Switzerland

Entangle, swap, purify, repeat: Enhancing connections between distant nodes

Science Daily, 01JUN2017

An international team of researchers (the Netherlands, UK) has developed an entanglement distillation protocol that could be used to enhance the purity and robustness of entanglement between quantum nodes of a quantum network. They employed two diamond chips, each featuring two types of spin—a nitrogen-vacancy electron spin, which was used as a "communication" qubit, and a nearby carbon-13 nuclear spin, which was used as a "memory" qubit. The memory qubit is vulnerable to losing the state given by the communication qubit, and so the researchers developed a way to monitor the memory particle in real time. The team was able to account and adjust for any errors between the communicating qubits, thus enhancing the entanglement on each iteration. TECHNICAL ARTICLE

Tags: Quantum science, Communications technology

The synchronized dance of skyrmion spins

Nanowerk, 30MAY2017

Researchers in Singapore used computer simulations to understand the internal behavior of the three fundamental modes of skyrmions. They found that in one of the modes, called the breathing mode, the pattern of spins

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alternately expands and contracts. In the two other modes, the circular arrangement of spins rotates in clockwise and counterclockwise directions, respectively. Because the mode frequencies of skyrmions are in the microwave range, the quasi-particles could be used for new microwave nano-oscillators, which are important building blocks for microwave integrated circuits. Research could also lead to skyrmion-based devices such as microwave nano-oscillators, used in a range of applications including wireless communication, imaging systems, radar and GPS. Open Access TECHNICAL ARTICLE

Tags: Quantum science

S&T POLICY

China claims to have developed hypersonic anti-missile with 8000+mph speed

Next Big Future, 03JUN2017

China has made a new-generation aerospace defense missile that incorporates top space technologies capable of bringing down targets tens of kilometers above the ground that fly 10 times faster than a bullet. The descriptions "tens of kilometers" and "10 times faster than a bullet" indicate its range should be from 10 km to 100 km and its minimum velocity around 12,000 km/h—a typical bullet used by a handgun, the slowest of all bullets, normally travels about 1,200 km/h.

Tags: S&T policy, Military technology, S&T China

SENSORS

Researchers develop extremely sensitive hydrogen sensor

Physorg.com, 06JUN2017

An international team of researchers (the Netherlands, Belgium, UK) reports that palladium-capped hafnium thin films show a highly reproducible change in optical transmission in response to hydrogen exposure ranging over six orders of magnitude in pressure. The optical signal is hysteresis-free within this range, which includes a transition between two structural phases. A temperature change results in a uniform shift of the optical signal. The optical behaviour as a function of its hydrogen content makes hafnium well-suited for use as a hydrogen detection material. Open Access TECHNICAL ARTICLE

Tags: Sensors

Sensing the nanoscale with visible light, and the fundamentals of disordered waves

Science Daily, 01JUN2017

An international team of researchers (Israel, USA - City University of New York) illuminated a stack of nanometrically thin dielectric layers with varying thickness. They found that even 2nm variation in thickness somewhere in the stack can be sensed if light illuminates the structure at a very specific angle of incidence. This work demonstrates that light can be trapped in structures much thinner than the wavelength of light and that minute changes in this structure are observable. These findings may allow the use of optical methods to make high-speed measurements of nanometric defects in computer chips and photonic devices. TECHNICAL ARTICLE

Tags: Sensors, Materials science, Photonics ■

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