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S&T NEWS BULLETIN

THE LATEST IN SCIENCE AND TECHNOLOGY RESEARCH NEWS

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FEATURE ARTICLES

The Future of Computing Depends on Making It Reversible

IEEE Spectrum, 25AUG2017

Experts in industry, academia, and government laboratories anticipate that semiconductor miniaturization won't continue much longer-maybe 5 or 10 years. Unconventional semiconductor technology, such as carbon-nanotube transistors, tunneling transistors, or spintronic devices face the same fundamental physical barriers as CMOS technology. Today's computers rely on erasing information all the time by overwriting, wasting the associated energy. In principle, it is possible to carry out any desired computation without losing information in such a way that the computation could always be reversed to recover its earlier state. This idea of reversible computing goes to the very heart of thermodynamics and information theory, and indeed it is the only possible way within the laws of physics that we might be able to keep improving the cost and energy efficiency of general-purpose computing far into the future. TECHNICAL ARTICLE

Tags: Information technology, Featured Article

Custom robots in a matter of minutes

MIT News, 23AUG2017

Interactive Robogami enables the fabrication of a wide range of robot designs. Photo: MIT CSAIL

A team of researchers in the US (MIT, Columbia University) has developed Interactive Robogami, a tool to design ground robots that can be fabricated as flat sheets and then folded into 3D structures. Using Interactive Robogami, designers can compose new robot designs from a database of print-and-fold parts. The designs are tested for the users' functional specifications via simulation and fabricated. They have demonstrated that the tool is intuitive for novice designers and expressive enough to create a wide variety of ground robot designs. In tests, it took 10 to 15 minutes to design, three to seven hours to print and 30 to 90 minutes to assemble. The team found that their 3-D print-and-fold method reduced printing time by 73 percent and the amount of material used by 70 percent. TECHNICAL ARTICLE

Tags: Autonomous systems & robotics, Featured Article

S&T NEWS ARTICLES

ADVANCED MANUFACTURING

Team develops novel 3-D printed high-performance polymer that could be used in space

Science Daily, 24AUG2017

Kapton, an aromatic polymer, is used in the multi-layer insulation that forms the outer wrapping of spacecraft, satellites, and planetary rovers to protect them from extreme heat and cold. It is difficult to produce it in any format other than thin sheets because of its molecular structure. Researchers at Virginia Tech have developed a way to 3D print Kapton which could be used in any shape, size, or structure. The new polymer maintains its properties above 680 degrees Fahrenheit and is equivalent in strength to the conventionally processed thin-film Kapton material. Besides the aerospace industry, the polymer is used in electronic devices. TECHNICAL ARTICLE

Tags: Advanced manufacturing, Advanced materials

ADVANCED MATERIALS

Carbon nanotubes worth their salt

Science Daily, 24AUG2017

A team of researchers in the US (Lawrence Livermore National Laboratory, Northeastern University, UC Merced) focused on water and ion transport through relatively short fragments of CNTs embedded in lipid bilayer membranes. Strong confinement generated highly accelerated water flow compared with that observed in

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biological water transporters. A key factor in the transport rate was the tunable rearrangement of intermolecular hydrogen bonding. By changing the charges at the mouth of the nanotube, the authors were able to alter the ion selectivity. The research has implications for the next generation of water purification technologies and development of the next generation of high-flux membranes. TECHNICAL ARTICLE

Tags: Advanced materials

Research team uses computation and experiment to understand how novel material properties form

Physorg.com, 22AUG2017

An international team of researchers (Germany, USA - University of Alabama, Iowa State University) details the 3D simulations of an aluminum-silver-copper (Al-Ag-Cu) alloy as it solidifies and compares the microstructure characteristics with experimental photographs. The method sets the stage for larger simulations of more complex materials. They created a multiphysics software package, Pace3D, for incorporating a wide variety of material models and implemented a highly optimized version that breaks down massive 3D simulations into roughly 10,000 computerized cubes. It solves a variety of physics equations within each cell. The team's accurate simulation results represent a proof of concept. Their goal is to design microstructures for multi-component alloys based on applications. TECHNICAL ARTICLE

Tags: Advanced materials, Materials science

AUTONOMOUS SYSTEMS & ROBOTICS

Origami-inspired robot

Science Daily, 24AUG2017

Researchers at the University of Illinois Urbana-Champaign constructed a robot using origami building blocks to mimic the gait and metameric properties of earthworms. They used the Kresling crease pattern of origami, which is a chiral tower with a polygonal base. The tower couples its expansion and contraction to longitudinal and rotational motion, similar to a screw. They used buckling instabilities to accomplish a large-stroke snapping motion from small inputs. Beyond locomotion, the design could find applications in manipulators, booms and active structures. TECHNICAL ARTICLE

Tags: Autonomous systems & robotics, Biomimetics

COUNTER WMD

DNA detectives crack the case on biothreat look-alikes

Science Daily, 24AUG2017

A team of researchers in the US (Los Alamos National Laboratory, FDA) is improving the identification of the bacterium that causes tularemia which is considered a 'Category A' bioterrorism agent by the Centers for Disease Control and Prevention. They showed that of the more than 120 Francisella genomes that have been sequenced, only a few contain plasmids that differentiate pathogenic strains that are not biothreat agents. This becomes a useful signpost for researchers, adding genomic features that can prevent misidentification of bacterial relatives that happen to share an otherwise similar genetic profile. OPEN ACCESS TECHNICAL ARTICLE

Tags: Counter WMD, Bioweapons

ENERGY

No batteries required: Energy-harvesting yarns generate electricity

Science Daily, 25AUG2017

An international team of researchers (South Korea, USA - UT Dallas, industry partner, Virginia Polytechnic Institute and State University, Wright-Patterson Air Force Base, China) spun nanotubes into high-strength, lightweight yarns and twisted them to make it elastic. Fundamentally, these yarns are supercapacitors. When the carbon nanotube yarn is inserted into an electrolyte bath to generate electricity, the yarns are charged by the electrolyte itself. No external battery or voltage, is needed. Possible applications are harvesting energy from the motion of ocean waves or from temperature fluctuations or sewn into a shirt to serve as a self-powered breathing monitor. TECHNICAL ARTICLE

Tags: Energy, Flexible electronics

Researchers develop highly flexible, wearable display

Physorg.com, 25AUG2017

Surface roughness and flexibility are the technical limitations that have prevented commercialization of clothing-integrated wearable electronics. Researchers in South Korea used two different approaches, fabric type and fiber type, to realize clothing-integrated wearable displays. Based on their previous work, they introduced OLEDs into fabrics to develop the most highly flexible and reliable technology for wearable displays. According to the researchers, their wearable device facilitates the operation of OLEDs even at a bending radius of 2mm. OPEN ACCESS TECHNICAL ARTICLE

Tags: Energy, Flexible electronics, Microelectronics

Breakthrough in magnesium batteries

Science Daily, 24AUG2017

Magnesium batteries are safe but their ability to store energy has been limited. A team of researchers in the US (University of Houston, Vanderbilt University, Oak Ridge National Laboratory, Texas A&M, Lawrence Berkeley National Laboratory, Argonne National Laboratory) has developed a new battery by inserting magnesium monochloride into a host, such as titanium disulfide, demonstrating much faster diffusion than traditional magnesium versions. It has a storage capacity of 400

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"I can no longer laugh at ignorance or stupidity. Those are our chief enemies, and it is dangerous to make fun of them." CHARLES RICHTER

mAh/g, compared with 100 mAh/g for earlier magnesium batteries. However, the voltage remains low at about one volt. The general strategy of inserting various polyatomic ions in higher voltage hosts may lead to higher-energy batteries. Open Access TECHNICAL ARTICLE

Tags: Energy, Battery

More solar power thanks to titanium

Physorg.com, 24AUG2017

Hematite is a convenient and cheap catalyst candidate for artificial photosynthesis, however, the electrons set free by the chemical reaction tend to be trapped again and get lost. Researchers in China introduced a nanometer-thin passivation layer of titania. Not only does this prevent charge recombination between the hematite electrode structure and the substrate, but it also provides the iron oxide with a considerable doping source to increase its charge-carrier density. Passivation and doping produced more than four times higher photocurrent under standardized conditions. The addition of an iron hydroxide co-catalyst pushed the photocurrent density to more than five times above that of the undoped system. TECHNICAL ARTICLE

Tags: Energy, S&T China, Solar energy

FORECASTING

Technology networks: the autocatalytic origins of innovation

ArXiv, 11AUG2017

An international team of researchers (UK, USA - industry, Italy) shows how the technological landscape of the patents database evolves as a self-organising autocatalytic structure that grows in size, and arrives to cover most of the technology network. Technology classes in the core of the autocatalytic structure perform better in terms of their innovativeness, as measured by the rate of growth of the number of patents. Open Access TECHNICAL ARTICLE

Tags: Forecasting

INFORMATION TECHNOLOGY

Monitoring network traffic more efficiently

MIT News, 24AUG2017

A team of researchers in the US (MIT, industry) has come up with a new approach to network monitoring that provides great flexibility in data collection while keeping both the circuit complexity of the router and the number of external analytic servers low. The system called Marple, consists of a programming language that enables network operators to specify a wide range of network-monitoring tasks and a small set of simple circuit elements that can execute any task specified in the language. Simulations using actual data center traffic statistics suggest that, in the data center setting, Marple should require only one traffic analysis server for every 40 or 50 application servers. Their paper will be presented at an upcoming ACM annual conference SIG meeting. Open Access TECHNICAL ARTICLE

Tags: Information technology, Communications technology

Researchers create magnetic RAM

Physorg.com, 23AUG2017

Magnetoelectric random access memory (MELRAM), developed by an international team of researchers (Russia, France), consists of a piezoelectric material and a layered structure characterized by high magneto elasticity. As the structure is anisotropic it can be magnetized along two directions that correspond to the logical zero and one in binary code. In contrast to dynamic RAM, magnetoelectric memory cells are capable of maintaining their state. The magneto-electric interaction itself contains the potentiality of the readout of the information encoded in the magnetic subsystem. A transition to magnetoelectric memory could enable substantial energy savings, as well as the instantaneous startup of devices. TECHNICAL ARTICLE

Tags: Information technology

MATERIALS SCIENCE

2D semiconductors could make negative conductance devices

Nanotechweb, 25AUG2017

Previous negative nonconductance (NTC) devices are largely attributed to two working mechanisms: quantum mechanical tunneling and mobility degradation at high electrical field. An international team of researchers (US - UCLA, industry partner, Saudi Arabia) studied the charge transport in multilayer two-dimensional semiconductors and showed that by varying the measurement temperature, bias voltage, and body thickness, the NTC behavior can be attributed to a vertical potential barrier in the multilayer 2DSCs and the competing mechanisms between intralayer lateral transport and interlayer vertical transport. This NTC behavior can be exploited for creating frequency doublers and phase shift keying circuits with only one transistor, greatly simplifying the circuit design compared to conventional technology. TECHNICAL ARTICLE

Tags: Materials science, Microelectronics

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How to store data on magnets the size of a single atom

Nanowerk, 25AUG2017

New means of data storage is required for data held worldwide which is expected to rise from 4.4 trillion gigabytes in 2013 to 44 trillion gigabytes by 2020. Researchers in the UK have achieved magnetic hysteresis in a single molecule magnet (SSM) at –213 °C using a new molecule based on the rare earth element dysprosocenium. There are other challenges, however. To store individual bits of data, molecules must be fixed to surfaces. This has been demonstrated with SMMs in the past but not for this latest generation of high-temperature SMMs. The synthetic chemistry techniques developed by the researchers facilitate designing molecules with customised magnetic properties, which will have applications in quantum computing and even magnetic resonance imaging. TECHNICAL ARTICLE

Tags: Materials science, Information technology, S&T UK

Featured Resource

Directory of Open Access Journals (DOAJ)

DOAJ is a community-curated online directory that indexes and provides access to high quality, open access, peer-reviewed journals.

Nanobubbles seen to propel nanoparticles

Nanotechweb, 25AUG2017

Researchers at Caltech have made ultrafast measurements of the motion of spherical gold nanoparticles in water using liquid-cell 4D electron microscopy (4D-EM). When excited with femtosecond laser pulses, the particles (which are sensitive to light) appear to be driven by a strong random driving force coming from photo induced steam nanobubbles near the particles' surface. The result could help in the development of light-activated artificial micro- and nanomotors that work in liquid environments. TECHNICAL ARTICLE

Tags: Materials science

New way to make steel that is both stronger and more ductile

Physorg.com, 25AUG2017

An international team of researchers (China, Taiwan) has developed a new technique they call deformed and partitioned (D&P) that involves cold rolling, followed by tempering in a low temperature environment. Metastable austenite grains are embedded somewhere in the process which helps retain ductility while allowing for controlled defects that give the metal its strength. According to the researchers, the resulting product is a steel with a yield strength of 2.2 GPa and 16 percent uniform elongation. They suggest the desired properties are due to the type of matrix formed during the rolling and tempering process. Open Access TECHNICAL ARTICLE

Tags: Materials science

Experiments confirm theory of 'superballistic' electron flow

Nanowerk, 24AUG2017

The theory of superballistic flow predicts that electrons can pass more easily through constrictions by interacting with one another. An international team of researchers (UK, Italy, the Netherlands, USA - MIT, Israel, Russia, Japan) has confirmed the theory and demonstrated it in an experiment employing devices built from an atomically thin layer of graphene. When the electrons travel in dense groups, they are much more likely to bounce off each other than the walls. Such lossless collisions conserve the total energy and the net momentum. The work points toward the possibility of using interactions among electrons to design low-power electronics and opens up new territory in our understanding of charge flow in which electrons behave in a collective manner. TECHNICAL ARTICLE

Tags: Materials science, Microelectronics

Strange state of matter in superconducting crystal

Science Daily, 24AUG2017

Electrons in most metals act individually, free to move through a metal to conduct electric currents and heat. An international team of researchers (USA - Los Alamos National Laboratory, Florida State University, Cornell University, Germany) found that in layered cerium, rhodium and indium (CeRhIn5), the electrons unite to flow in the same direction when in high magnetic fields of 30 tesla and the direction of flow can be controlled by tilting the magnetic field. This rare state of matter between liquid and crystal is called "electronic nematic". Researchers believe that the electronic nematicity state may be closely related to superconductivity. The findings lay the groundwork for answering one of the most compelling questions in physics. TECHNICAL ARTICLE

Tags: Materials science

MICROELECTRONICS

DARPA's Drive to Keep the Microelectronics Revolution at Full Speed Builds Its Own Momentum

DARPA News, 25AUG2017

Recently about 100 innovators throughout the broader technology ecosystem, including participants from the military, commercial, and academic sectors, gathered at DARPA headquarters at the kickoff meeting for the Agency's new CHIPS program (Common Heterogeneous Integration,

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and Intellectual Property (IP) Reuse Strategies program). Central to the design and intention of the program is the creation of a new community of researchers and technologists that mix-and-match mindsets, skillsets, technological strengths, and business interests. Among the specific technologies that could emerge are compact replacements for entire circuit boards, ultrawideband radio frequency (RF) systems and fast-learning systems.

Tags: Microelectronics, DARPA, S&T Policy

High-frequency chip brings researchers closer to next generation technology

Physorg.com, 24AUG2017

Using a phased array antenna system, researchers at UC Davis have designed a high-frequency electronic chip, potentially capable of transmitting tens of gigabits of data per second—a rate that is orders of magnitude above the fastest internet speeds available today. It successfully operates at 370 GHz with 52 GHz of bandwidth. The research shows that it is possible to harness the large available bandwidth at millimeter-wave and terahertz bands on a single, compact chip. It is a step toward the development of scalable systems that can be used to sharpen technologies like spectroscopy, sensing, radar, medical imaging and high-speed communication. TECHNICAL ARTICLE

Tags: Microelectronics, Communications technology

NEUROSCIENCE

Insight into brain's complexity revealed thanks to new applications of mathematics

Medical Express, 25AUG2017

Researchers working on the EU sponsored Blue Brain project have developed a new approach to neuroscience based on mathematics that helps reveal a universe of multi-dimensional geometrical structures and spaces within the networks of the brain. Their work reveals structures in the brain with up to eleven dimensions, exploring the brain's deepest architectural secrets. The high number and variety of high-dimensional directed cliques and cavities they found had not been seen before in neural networks, either biological or artificial. More information

Tags: Neuroscience, S&T EU

PHOTONICS

Light forces electrons to follow the curve in 2D materials

Nanowerk, 25AUG2017

Based on valleys in gapped Dirac materials, an international team of researchers (Singapore, University of Wisconsin-Madison) has theoretically predicted that an unusual Hall-type motion can be harnessed at room temperature and without a magnetic field in gapped Dirac materials. Graphene–boron-nitride heterostructures, with smaller electronic bandgap, are more effective than those with a larger bandgap including molybdenum disulfide. This phenomenon could be useful for the development of novel far infrared and terahertz optoelectronics. A new type of photodetector concept could potentially possess zero net dark current even with a large bias voltage. TECHNICAL ARTICLE

Tags: Photonics, Materials science

QUANTUM SCIENCE

Qubits can swim through seawater

Physics World, 25AUG2017

Researchers in China used photons with wavelengths of 405 nm, which falls within the "blue-green" window in which light absorption in water is relatively low, to show that quantum information encoded in single 405 nm photons can be transmitted 3m with a fidelity of greater than 98%. They also worked out that encoding quantum information in the polarization states of a photon gives the qubit its best chance of surviving its watery journey. This is because seawater is isotropic and therefore there should be no strong de-polarization effects. The results confirm the feasibility of a seawater quantum channel, representing the first step towards underwater quantum communication. OPEN ACCESS TECHNICAL ARTICLE

Tags: Quantum science, Foreign S&T, S&T China

High-dimensional quantum encryption performed in real-world city conditions for first time

Science Daily, 24AUG2017

An international team of researchers (Canada, Germany, USA - University of Rochester, Iran) has sent a quantum-secured message containing more than one bit of information per photon through the air above the city of Ottawa, taking advantage of both the spin and orbital angular momentum photonic degrees of freedom. The combination of optical angular momenta allows creation of a 4-dimensional quantum state. High-dimensional quantum encryption can send more information per photon and tolerate more signal-obscuring noise before the transmission becomes unsecure. In future work, they are planning to implement their scheme in a network that includes three links that are about 5.6 km apart and that uses adaptive optics to compensate for turbulence. OPEN ACCESS TECHNICAL ARTICLE

Tags: Quantum science, Communications technology

Unconventional quantum systems may lead to novel optical devices

Physorg.com, 22AUG2017

An international team of researchers (China, Japan, Canada) presents an experimental work tying together three concepts—non-unitary quantum walks at a

single-photon level, PT symmetry, and topological edge states originating from Floquet topological phases. They observed that Floquet topological edge states arise between regions with different bulk topological properties. As the Floquet topological properties are characterized by a pair of topological numbers, controlling these properties may lead to the development of new quantum optical devices. Their findings provide a new platform where the interplay of PT-symmetric quantum dynamics and topological properties not only offer a quantum mechanical version of PT-symmetric systems, but may also lead to potential applications in quantum information, quantum computation, and quantum sensing. TECHNICAL ARTICLE

Tags: Quantum science, Sensors

S&T POLICY

New NSF awards will bring together cross-disciplinary science communities to develop foundations of data science

NSF News, 24AUG2017

The National Science Foundation announced $17.7 million in funding for 12 Transdisciplinary Research in Principles of Data Science (TRIPODS) projects, which will bring together the statistics, mathematics and theoretical computer science communities to build the theoretical foundations of data science that will enable continued data-driven discovery and breakthroughs across all fields of science and engineering. Conducted at 14 institutions in 11 states, these projects will promote long-term research and training activities in data science that transcend disciplinary boundaries.

Tags: S&T policy

SCIENCE WITHOUT BORDERS

Germany seeks 'big flip' in publishing model

Science magazine, 25AUG2017

More than 150 German libraries, universities, and research institutes have formed a united front to force academic publishers into a new way of doing business. Instead of buying subscriptions to specific journals, consortium members want to pay publishers an annual lump sum that covers publication costs of all papers whose first authors are at German institutions. Those papers would be freely available around the world; meanwhile, German institutions would receive access to all of the publishers' online content. A successful outcome could help trigger what some call a "big flip," a global transition toward open access. Libraries and universities in other countries pushing for similar agreements had limited success.

Tags: Science without borders, Bibliometrics

SENSORS

Drones relay RFID signals for inventory control

MIT News, 25AUG2017

The scale of modern retail operations makes even RFID scanning inefficient. Researchers at MIT have developed a system called RFly that enables small, safe, aerial drones to read RFID tags from tens of meters away while identifying the tags' locations with an average error of about 19 centimeters. The current drones safe enough to fly within close range of humans are small, lightweight drones with plastic rotors, and are too small to carry RFID readers with a range of more than a few centimeters. The researchers overcame this by using the drones to relay signals emitted by a standard RFID reader. This not only solves the safety problem but also means that drones could be deployed in conjunction with existing RFID inventory systems, without the need for new tags, readers, or reader software. According to the researchers, by enabling drones to find and localize items and equipment, the research will provide a fundamental technological advancement for accurate inventory and tracking saving billions of dollars.

Tags: Sensors

China's quantum submarine detector could seal South China Sea

New Scientist, 22AUG2017

The new magnetometer, built by researchers in China, uses not one SQUID but an array of them. The idea is that by comparing their readings, researchers can cancel out some of the extra artifacts generated by motion. This would be relevant to an anti-submarine warfare device, according to experts. Researchers estimate that a SQUID magnetometer of this type could detect a sub from 6 kilometres away and with better noise suppression the range could be much greater. Not everyone is convinced the Chinese magnetometer is ready for deployment. Although the announcement concerning Chinese work has been removed, several of the previous papers culminating in this breakthrough are still available. TECHNICAL ARTICLE 1, TECHNICAL ARTICLE 2, OPEN ACCESS TECHNICAL ARTICLE 3

Tags: Sensors, Military technology, S&T China

Getting hold of quantum dot biosensors

Science Daily, 22AUG2017

An international team of researchers (Australia, China) used electron beam lithography and reactive ion etching to develop an all-silicon nanoantenna which consists of a silicon ring surrounding a pair of silicon cylinders. The structure concentrates the infrared light used to trap the quantum dots into the small 50 nanometer gap between the cylinders. Using the nanoantenna, they trapped a

quantum dot suspended in a microfluidic chamber and videotaped the trapping. With the power of the optical force, a potential use for the nanoantennas would be to increase the flux of molecules on nanosensors.
TECHNICAL ARTICLE

Tags: Sensors, Quantum dots, Quantum science ■

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