OFFICE OF STRATEGIC INTELLIGENCE & ANALYSIS (OSI&A)
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S&T Global Highlights

FEATURED ARTICLES

[Unmatched data capacity and security with revolutionary vortex beams](#) (Pg. 2)
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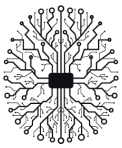

[Velcro DNA helps build nanorobotic Meccano](#) (Pg. 2)
Researchers in Australia have created custom-designed and programmable nanostructures using DNA origami. This technology has the potential to support tasks ranging from drug delivery to processing optical signals.

[Researchers discover new third class of magnetism that could transform digital devices](#) (Pg. 3)
Scientists in the United Kingdom have discovered a new class of magnetism called altermagnetism which has been imaged for the first time in a new study. The findings could lead to the development of new magnetic memory devices with the potential to increase operation speeds of up to a thousand times.

ABOUT

S&T Global Highlights

This newsletter features recent publications in science and technology research directly relevant to the DoD's Critical Technology Areas or adjacent to those fields and potentially of interest to the broader OUSD(R&E) Enterprise. S&T Global Highlights is intended to provide insights into global research efforts, and intentionally limits the inclusion of U.S.-based research and excludes DoD research efforts.

Inclusion of a research article or summary is in no way an endorsement by the DoD or OUSD(R&E), and does not constitute validation of the research findings. Articles may have been abbreviated, synopsized, or excerpted.

Questions, feedback, or suggestions?

Please contact OSI&A's Global Research Watch Team.

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FEATURED ARTICLES

Unmatched data capacity and security with revolutionary vortex beams

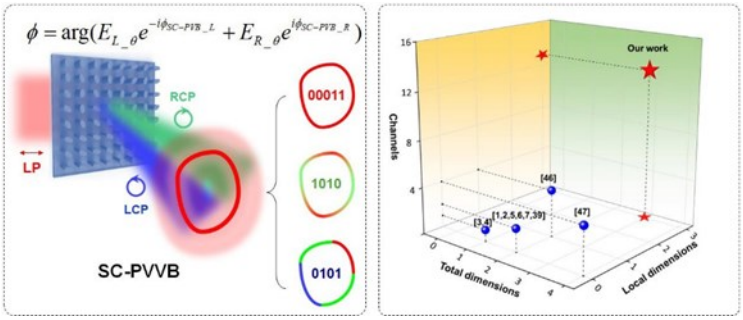
From: Changchun Institute of Optics (China)
2 December 2024 | Press Release | DOI

Researchers have developed an innovative optical technology capable of enhancing data transmission by utilizing spatial-frequency patching metasurfaces. This approach allows light beams to carry significantly more data across multiple independent channels, overcoming traditional optical beam limitations. Its applications extend to secure communication, encryption, and advanced optical systems.

Revolutionary Optical Technology for Data Transmission

Scientists have unveiled an advanced optical technology that significantly boosts the capacity and security of data transmission. This breakthrough involves a novel spatial-frequency patching metasurface capable of manipulating light beams in unprecedented ways. The result is the creation of super-capacity perfect vector vortex beams (SC-PVVBs), which feature intricate spatial and polarization characteristics. These beams can carry vast amounts of information, making them perfect for high-density data communication systems.

Traditional optical beams face capacity limits due to reliance on global phase modulation. SC-PVVB technology bypasses these constraints by locally adjusting the spatial frequency. This innovation enables creation of multiple independent data channels, each capable of storing and transmitting information separately, unlocking new possibilities for efficient and secure data transmission.



A single geometric metasurface is used to form SC-PVVB with multidimensional modulation ability for optical encryption, enabling precise control over the beam's morphology, polarization azimuth and ellipticity angles (left panel). A comparison between the PVVBs of existing works and our method in terms of local and total dimensions, and channels, demonstrating at least 13 distinct data channels with our approach (right panel). Credit: Changchun Institute of Optics

Unlocking Multi-Dimensional Data Channels

This approach enables precise control over the beam's structure and polarization, allowing for at least 13 distinct data channels. This could lead to ultra-secure and high-capacity optical communication systems. One of the key innovations is the ability to control the spatial intensity and polarization of these beams on a local scale, allowing information to be embedded across three dimensions of the light beam. Researchers used a specially designed Dammann grating to generate arrays of SC-PVVBs, maximizing their data-carrying potential.

Expanding Applications and Future Impacts

The potential applications of this technology go beyond data transmission, with implications for optical encryption, secure communications, and even particle manipulation. With a capacity to handle large data volumes while ensuring robust security, SC-PVVBs represent a significant advancement in optical information technology, paving the way for future innovations in communication and encryption systems.

Velcro DNA helps build nanorobotic Meccano: Innovative nanostructures pave the way for advanced robotics – and mini dinosaurs

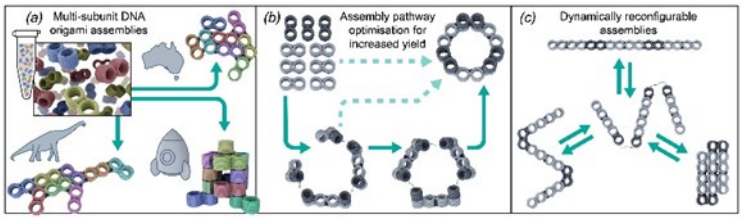
From: University of Sydney (Australia)
27 November 2024 | Press Release | DOI

Researchers at the University of Sydney Nano Institute have made a significant advance in the field of molecular robotics by developing custom-designed and programmable nanostructures using DNA origami.

This innovative approach has potential across a range of applications, from targeted drug delivery systems to responsive materials and energy-efficient optical signal processing. The method uses "DNA origami", so-called as it uses the natural folding power of DNA, the building blocks of human life, to create new and useful biological structures.

As a proof-of-concept, the researchers made more than 50 nanoscale objects, including a "nano-dinosaur," a dancing robot and a mini-Australia that is 150 nanometers wide, a thousand times narrower than a human hair.

The research, led by first author Dr. Minh Tri Luu and research team leader Dr. Shelley Wickham, focuses on the creation of modular DNA origami "voxels" that can be assembled into complex three-dimensional structures. (Where a pixel is two-dimensional, a voxel is realized in 3D.)



DNA origami subunits. Credit: University of Sydney

These programmable nanostructures can be tailored for specific functions, allowing for rapid prototyping of diverse configurations. This flexibility is crucial for developing nanoscale robotic systems that can perform tasks in synthetic biology, nanomedicine and materials science.

Dr. Wickham, who holds a joint position with the Schools of Chemistry and Physics in the Faculty of Science, said: "The results are a bit like using Meccano, the children's engineering toy, or building a chain-like cat's cradle. But instead of macroscale metal or string, we use nanoscale biology to build robots with huge potential."

Dr. Luu said: “We've created a new class of nanomaterials with adjustable properties, enabling diverse applications – from adaptive materials that change optical properties in response to the environment to autonomous nanorobots designed to seek out and destroy cancer cells.”

Velcro DNA

To assemble the voxels, the team incorporate additional DNA strands on to the exterior of the nanostructures, with the new strands acting as programmable binding sites.

Dr. Luu. said: “These sites act like Velcro with different colors – designed so that only strands with matching ‘colors’ (in fact, complementary DNA sequences) can connect.”

He said this innovative approach allows precise control over how voxels bind to each other, enabling the creation of customizable, highly specific architectures.

One of the most exciting applications of this technology is its potential to create nanoscale robotic boxes capable of delivering drugs directly to targeted areas within the body. By using DNA origami, researchers can design these nanobots to respond to specific biological signals, ensuring medications are released only when and where they are needed. This targeted approach could enhance the effectiveness of cancer treatments while minimizing side effects.

In addition to drug delivery, the researchers are exploring the development of new materials that can change properties in response to environmental stimuli. For instance, these materials could be engineered to be responsive to higher loads or alter their structural characteristics based on changes in temperature or acidic (pH) levels. Such responsive materials have the potential to transform medical, computing and electronics industries.

Dr Wickham said: “This work enables us to imagine a world where nanobots can get to work on a huge range of tasks, from treating the human body to building futuristic electronic devices.”

The research team is also investigating energy-efficient methods for processing optical signals, which could lead to improved image verification technologies. By harnessing the unique properties of DNA origami, these systems could improve the speed and accuracy of optical signal processing, paving the way for enhanced techniques in medical diagnostics or security.

Dr. Luu, a postdoctoral researcher in the School of Chemistry, said: “Our work demonstrates the incredible potential of DNA origami to create versatile and programmable nanostructures. The ability to design and assemble these components opens new avenues for innovation in nanotechnology.”

Dr. Wickham said: "This research not only highlights the capabilities of DNA nanostructures but also emphasizes the importance of interdisciplinary collaboration in advancing science. We are excited to see how our findings can be applied to real-world challenges in health, materials science , and energy.”

As researchers continue to refine these technologies, the potential for creating adaptive nanomachines that can operate in complex environments, such as within the human body, is becoming increasingly feasible.

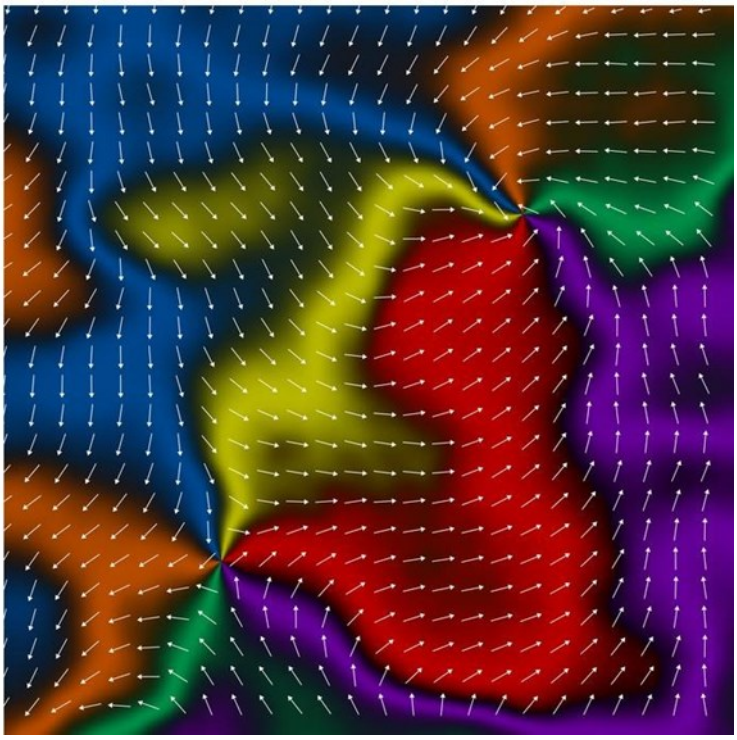
Researchers discover new third class of magnetism that could transform digital devices

From: University of Nottingham (United Kingdom), MAX IV Laboratory (Sweden)
11 December 2024 | Press Release | DOI

A new class of magnetism called altermagnetism has been imaged for the first time in a new study. The findings could lead to the development of new magnetic memory devices with the potential to increase operation speeds of up to a thousand times.

Altermagnetism is a distinct form of magnetic order where the tiny constituent magnetic building blocks align antiparallel to their neighbors but the structure hosting each one is rotated compared to its neighbors.

Scientists from the University of Nottingham’s School of Physics and Astronomy have shown that this new third class of magnetism exists and can be controlled in microscopic devices.



Mapping an altermagnetic vortex pair in manganese telluride (MnTe). The six colors, with arrows overlayed, show the direction of the altermagnetic ordering within the material. The size of the region shown is one square micrometer ($1\mu m^2$). Credit: University of Nottingham

Professor Peter Wadley, who led the research, explains: “Altermagnets consist of magnetic moments that point antiparallel to their neighbors. However, each part of the crystal hosting these tiny moments is rotated with respect to its neighbors. This is like antiferromagnetism with a twist! But this subtle difference has huge ramifications.”

Magnetic materials are used in the majority of long term computer memory and the latest generation of microelectronic devices. This is not only a massive and vital industry but also a significant source of global carbon emissions. Replacing the key components with altermagnetic materials would lead to huge

increases in speed and efficiency while having the potential to massively reduce our dependency on rare and toxic heavy elements needed for conventional ferromagnetic technology.

Altermagnets combine the favorable properties of ferromagnets and antiferromagnets into a single material. They have the potential to lead to a thousand fold increase in speed of microelectronic components and digital memory while being more robust and m energy efficient.

Senior Research Fellow, Oliver Amin led the experiment and is co-author on the study, he said: “Our experimental work has provided a bridge between theoretical concepts and real-life realization, which hopefully illuminates a path to developing altermagnetic materials for practical applications.”

The new experimental study was carried out at the MAX IV international facility in Sweden. The facility, which looks like a giant metal doughnut, is an electron accelerator, called a synchrotron, which produces x-rays.

X-rays are shone onto the magnetic material and the electrons given off from the surface are detected using a special microscope. This allows an image to be produced of the magnetism in the material with resolution of small features down to the nanoscale.

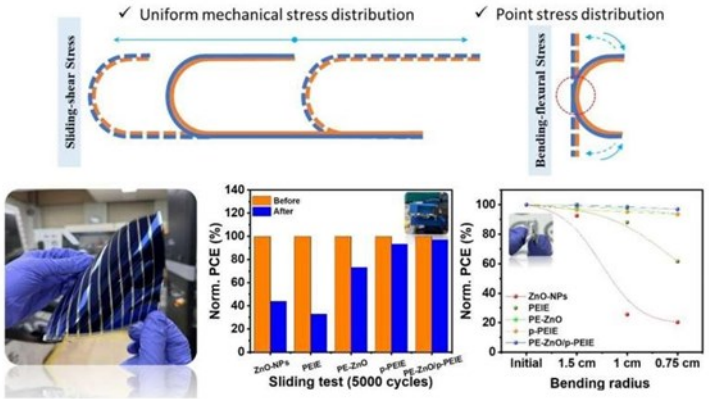
PhD student, Alfred Dal Din, has been exploring altermagnets for the last two years. This is yet another breakthrough that he has seen during his project. He comments: “To be amongst the first to see the effect and properties of this promising new class of magnetic materials during my PhD has been an immensely rewarding and challenging privilege.'“

ARTICLE SUMMARIES

Thin-film innovation promises tougher electronic devices

From: National Research Council of Science and Technology (South Korea)
15 December 2024 | Press Release | DOI

A National Research Council of Science and Technology research team has developed a dual-layer thin-film material technology that improves the durability of energy and electronic devices by combining organic and inorganic materials. The key achievement of this research is the significant enhancement of mechanical durability by minimizing physical stress during rolling or unrolling processes. The team addressed the challenges of delamination in thin-film materials with layered heterogeneous materials by developing an innovative interfacial thin-film material. This material consists of mechanically flexible organic materials and mechanically robust inorganic materials, allowing flexible devices to withstand various physical and chemical stresses. When used as an interfacial layer between transparent electrodes and active layers in applications like solar cells and displays, the material improves bonding properties and enhances both mechanical and chemical durability. The breakthrough has broad industrial applications, including roll-to-roll manufacturing processes, energy, displays, and robotics.

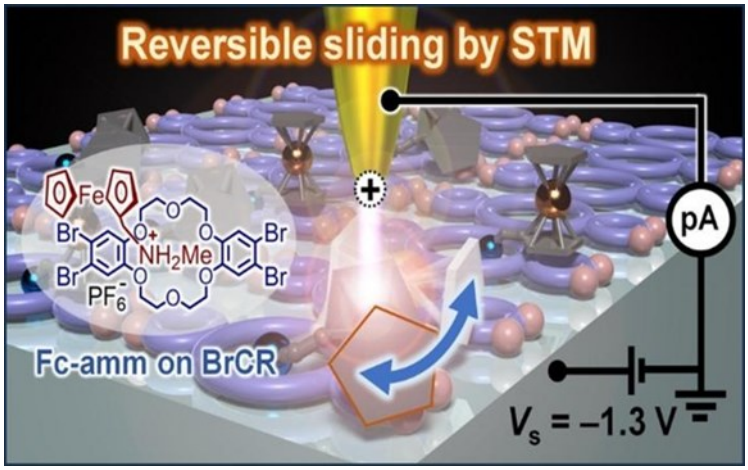


The film-based rollable solar cell/optical sensor device developed by the research team maintained high efficiency even after undergoing 5,000 cycles of repetitive stress testing. Credit: National Research Council of Science and Technology

World’s smallest molecular machine: reversible sliding motion in ammonium-linked ferrocenes

From: Chiba University (Japan)
30 November 2024 | Press Release | DOI

A research team from Chiba University has successfully stabilized and adsorbed ferrocene molecules onto a noble metal surface by pre-coating the surface. This approach overcame a major hurdle in the practical application of these molecules. By pre-coating the surface with a two-dimensional crown ether molecular film, the team was able to anchor the ferrocene molecules and prevent their decomposition. The researchers created the world's smallest electrically controlled molecular machine by applying an electrical voltage to the molecules, causing them to undergo lateral sliding motion and rotation of the carbon rings. The motion was reversible and could be precisely controlled using electrical signals. This breakthrough opens up possibilities for the development of ferrocene-based molecular machinery with applications in catalysts, molecular electronics, medicines, and quantum materials. The ability of these molecular machines to perform specialized tasks at the atomic level has the potential to revolutionize fields such as precision medicine, smart materials, and advanced manufacturing.

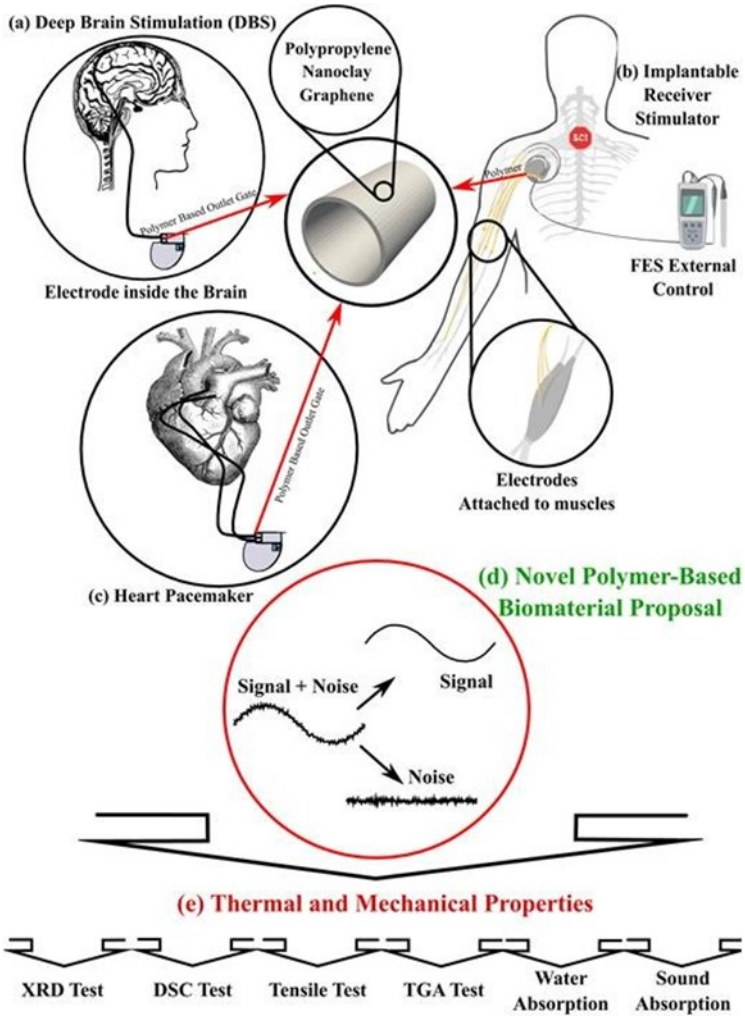


The complex of ammonium-linked ferrocene (Fc-amm) and crown ether is assembled on a Cu(111) surface, and its sliding motion is activated by hole injection into the ferrocene group using scanning tunneling microscopy. Credit: Chiba University

Rethinking the brain pacemaker: How better nanocomposites can improve signals

From: University of Tabriz (Iran)
10 December 2024 | Press Release | DOI

Researchers at the University of Tabriz have developed organic materials for brain and heart pacemakers to address the issue of external noise interference by using nanocomposites. The team created these nanocomposites using a plastic base called polypropylene, a clay called Montmorillonite, and graphene. They developed five different materials and conducted performance tests to measure noise absorption and signal transmission. The researchers used scanning electron microscopy to analyze the structure of the composite materials, focusing on characteristics such as density, distribution of clay and graphene, and pore sizes. They measured the signal-to-noise ratio and tested the impact of material thickness on performance. The goal of the ongoing research is not only to identify biocompatible materials for pacemakers but also to improve the connection between the signal source and the electrodes. The team also aims to develop biomaterials for other medical applications, such as enhancing the performance of hearing aids.

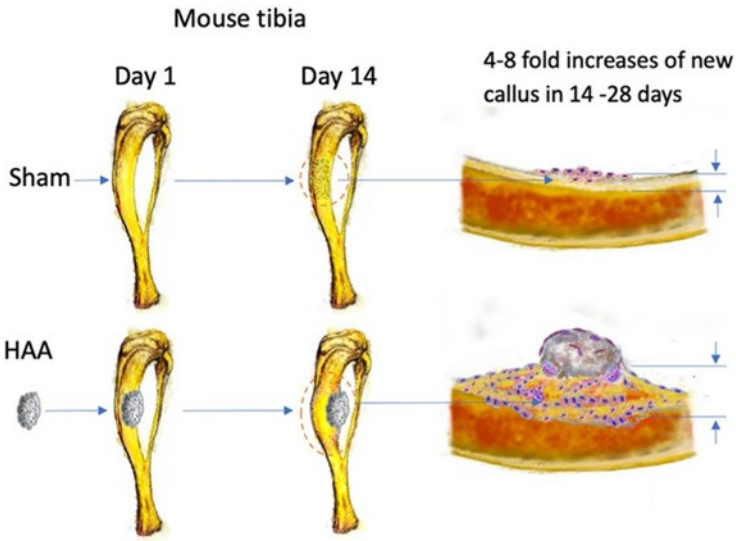


Study overview: (a) utilization of nanocomposites in DBS, (b) FES controller, and (c) heart pacemaker. (d) Signal suppression within the specified applications using the proposed nanocomposite and (e) thermomechanical analysis. Credit: University of Tabriz

Scientists develop coral-inspired material to revolutionize bone repair

From: Swansea University (United Kingdom)
26 November 2024 | Press Release | DOI

Researchers at Swansea University have developed a revolutionary bone graft substitute, inspired by coral, by using biomimetic material. This approach promotes faster healing and naturally dissolves in the body after repair. Bone defects from fractures, tumors, and non-healing injuries are major causes of disability. Traditional methods using autografts or allografts face challenges like limited supply, infection risk, and ethical concerns. The new biomimetic material, developed using advanced 3D-printing technology, mimics coral's porous structure and chemical composition, blending seamlessly with human bone. Preclinical in vivo studies showed the material fully repaired bone defects within 3-6 months and triggered the formation of new, strong cortical bone in 4 weeks. This new material overcomes the limitations of current synthetic bone grafts, which often fail to integrate well or cause side effects. Researchers highlighted that this invention bridges the gap between synthetic substitutes and donor bone, offering a safe, effective, and scalable solution. The team seeks partnerships to bring this technology to patients globally, promising improved patient quality of life and reduced healthcare costs.



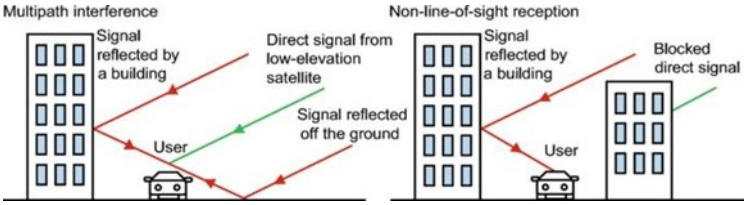
A murine animal model for rapid assessment of osteogenesis. Hydroxyapatite/ aragonite (HAA) is implanted into the mice juxtaskeletally.
Credit: Swansea University

Deciphering city skies: AI unveils Global Navigation Satellite System (GNSS) error identification

From: Chinese Academy of Sciences (China)
22 November 2024 | Press Release | DOI

Researchers have developed an innovative AI-powered solution to address Non-Line-of-Sight (NLOS) errors in urban Global Navigation Satellite System (GNSS) navigation by using the Light Gradient Boosting Machine (LightGBM). This method analyzes multiple GNSS signal features to accurately identify and

differentiate NLOS errors, significantly improving the precision and reliability of GNSS-based positioning systems. This study introduces a machine learning approach using LightGBM to tackle NLOS errors. The model's performance was validated through dynamic experiments in Wuhan, China, proving its effectiveness in urban environments. The method involves using a fisheye camera to label GNSS signals as Line-of-Sight (LOS) or NLOS based on satellite visibility. The LightGBM model analyzes signal features such as signal-to-noise ratio, elevation angle, pseudorange consistency, and phase consistency, achieving 92% accuracy in distinguishing LOS from NLOS signals. This approach outperforms traditional methods like XGBoost in both accuracy and computational efficiency. This advancement is crucial for urban navigation, where accuracy is essential. In urban environments, GNSS signals are often obstructed by tall buildings, vehicles, and other structures, leading to NLOS errors and positioning inaccuracies. These errors are particularly problematic for autonomous vehicles and intelligent transportation systems. This advancement holds significant implications for industries relying on GNSS technology, including autonomous vehicles, drones, and urban planning, making navigation safer and more efficient in densely populated cities.



Schematic of multipath interference and NLOS reception.
Credit: Chinese Academy of Sciences

Empowering neuroscience: Wireless power enables insights into neural behaviors in freely moving animals

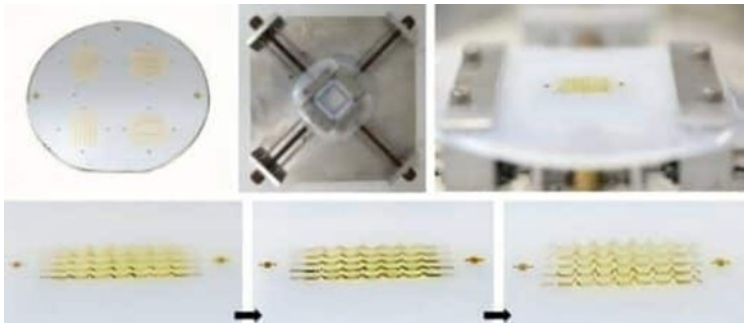
From: Laval University (Canada), University of Bordeaux (France)
20 November 2024 | Press Release | DOI

Researchers from Laval University and the University of Bordeaux have developed a system for electro-physiological recording of freely moving laboratory mice by using a lightweight and compact receiver coil. The system utilizes this small coil to minimize interference with the animals' natural behavior. The design effectively balances power transfer efficiency and operational practicality, allowing for real-time neuronal activity monitoring in mice. A wireless power transfer system is embedded within the homecage and powers small bio-instruments, such as an electrophysiology recording headstage, attached to the head of the mouse. The system operates through inductive wireless power transfer, eliminating the need for wires or tethered power sources. The lightweight and compact design enables the mice to move freely during experiments. The system achieves high efficiency without bulky equipment and operates at a frequency that meets safety standards to prevent overheating or tissue damage. The wireless system allows for continuous monitoring of brain activity in real time, providing opportunities for more extensive and long-term neuroscience studies. This advancement has the potential to contribute to the development of new treatments for brain disorders and innovations in brain-machine interfaces and neural technologies.

Wearable energy harvester achieves 280 times efficiency boost

From: Daegu Gyeongbuk Institute of Science and Technology (South Korea)
5 December 2024 | Press Release | DOI

A team from the Daegu Gyeongbuk Institute of Science and Technology has developed a three-dimensional stretchable piezoelectric energy harvester that can generate electrical energy from body movements. The device, designed to be wearable, can be attached to the skin or clothes. Unlike previous piezoelectric energy harvesters that used organic or composite-based materials with low energy efficiency, the team used lead zirconate titanate (PZT), which has high piezoelectric efficiency. They designed PZT into a three-dimensional structure that is both stretchable and insensitive to deformation, ensuring high energy efficiency. Additionally, they introduced a curvature-specific coupling electrode design to prevent the cancellation of electrical energy, resulting in an energy efficiency 280 times higher than conventional stretching piezoelectric energy harvesters. The team expects this technology to be commercially viable and lead to practical applications of wearable energy harvesters.



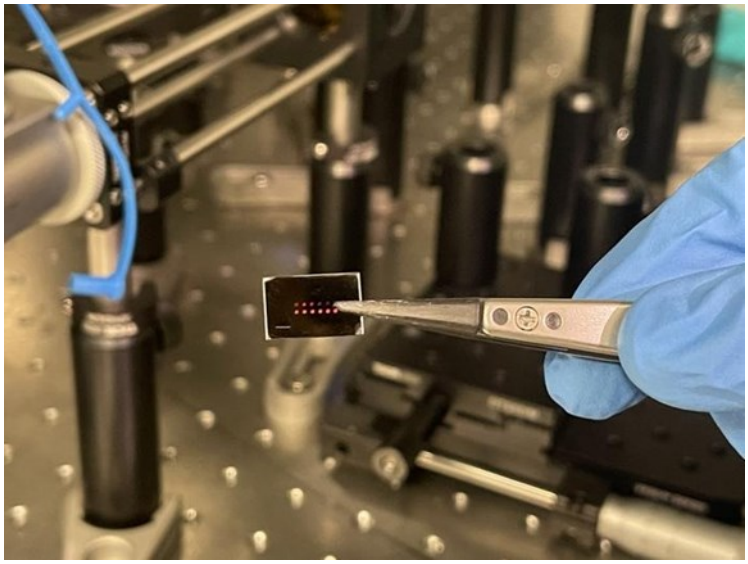
Optical images of the compressive buckling process.
Credit: Daegu Gyeongbuk Institute of Science and Technology

Scientists develop cost-effective lasers for extended short-wave infrared (SWIR) applications

From: Institute of Photonic Sciences (Spain)
6 December 2024 | Press Release | DOI

Researchers from the Institute of Photonic Sciences have developed a novel approach to laser technology by using colloidal quantum dots made of lead sulfide (PbS). The team successfully emitted coherent light in the extended short-wave infrared (SWIR) range, making it the first semiconductor lasing material to cover such a broad wavelength range. The researchers achieved this without altering the chemical composition of the quantum dots. They also demonstrated lasing with nanosecond excitation, eliminating the need for bulky and expensive femtosecond laser amplifiers. By employing larger quantum dots, the team increased

the absorption cross-section of the dots, resulting in a significant reduction in the optical gain threshold. This breakthrough has the potential to address critical challenges in various industries, including hazardous gas detection, eye-safe light detection and ranging (Lidar) systems, photonic integrated circuits, and imaging within the SWIR biological window. The technology is compatible with silicon CMOS (complementary metal–oxide–semiconductor) platforms, allowing for on-chip integration and greater miniaturization.

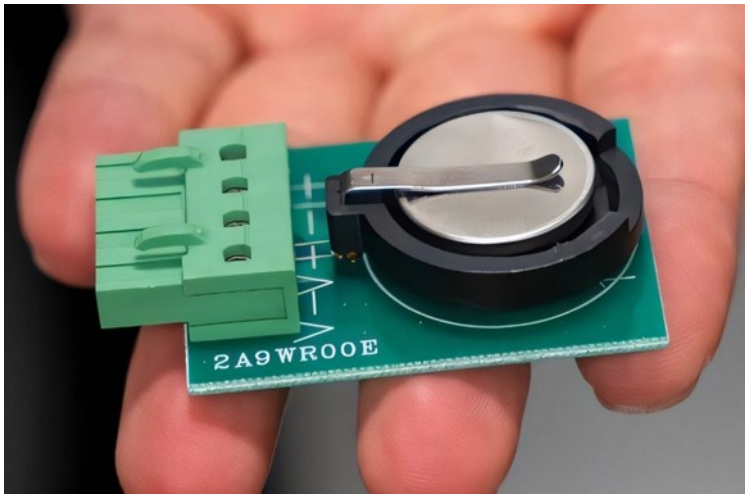


Lasers of PbS colloidal quantum dots. Credit: Institute of Photonic Sciences

Magnesium electrolyte sparks next generation battery design

From: University of Waterloo (Canada)
6 December 2024 | Press Release | DOI

Researchers at the University of Waterloo have made significant progress in developing next-generation batteries by using magnesium instead of lithium. Magnesium is more abundant and less costly than lithium, offering a more sustainable and cost-effective alternative for energy storage. However, initial magnesium battery designs, introduced in 2000, did not provide sufficient voltage to compete with lithium-ion batteries. The researchers have designed an electrolyte that enables a highly efficient magnesium anode. The new electrolyte allows magnesium batteries to operate at up to three volts, a significant improvement over the initial one-volt output. The electrolyte developed is inexpensive, non-corrosive, and non-flammable, addressing previous issues with magnesium battery electrolytes. This breakthrough brings magnesium batteries closer to commercialization, as the new design can be scaled up quickly for the market.

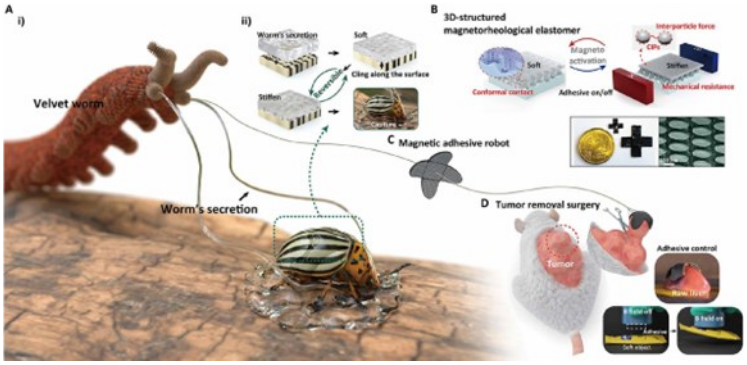


An example of a coin cell, which includes a magnesium-ion full battery with an organic cathode, magnesium metal anode, and the Waterloo-designed electrolyte. Credit: University of Waterloo

X-shaped, tiny, soft robot can manipulate and move objects ranging from tofu to nuts and bolts

From: Max Planck Institute for Intelligent Systems (Germany), Korea University (South Korea)
20 November 2024 | Press Release | DOI

A team from the Max Planck Institute and Korea University, has developed a tiny soft robot capable of manipulating various hard and soft objects by using suction grippers and magnetic particles. The multi-use robot is designed to operate in extreme conditions, including jellied or mucus-type environments, using magnetic control. The robot, resembling two overlapping Band-Aids forming an X, features a central manipulator and legs for locomotion. It is constructed from a composite polymer base, created by mixing a polydimethylsiloxane matrix with neodymium iron boron particle fillers, and shaped using a cast and 3D printer. The legs are equipped with octopus-type suction grippers and magnetic particles, allowing the robot to adhere to targets. Inspired by the velvet worm, which uses tiny appendages to manipulate or stick to objects, the robot can adhere to and manipulate a wide range of targets, whether wet, oily, gooey, or dry. It can handle various objects, including tissue, metal, tofu, fish flesh, fish eggs, and fish organs. The robot demonstrated its versatility by screwing and unscrewing a nut and assisting in the removal of a cancerous tumor from a live mouse. This innovation showcases the robot's potential for diverse applications in challenging environments.



Bioinspired adhesion-controlled soft millirobot with its adhesion mechanism and applications. Credit: Max Planck Institute

LAST BUT NOT LEAST
More S&T news in every issue

The Global Research Watch team reviews hundreds of articles each month for S&T Global Highlights, however space limits publication to only a small fraction of those stories. This section captures the 'best of the rest' from the previous month's research in fast fact form, allowing the Global Research Watch team to cover more critical technology breakthroughs from a greater diversity of sources.

Soft e-skin utilizes magnetic fields to independently sense three-axis forces

From: University of Montpellier (France)
19 November 2024 | Press Release | DOI

Scientists have developed a new soft e-skin that detects forces on three axes by using a sensor consisting of three layers: a flexible magnetic film on top, an elastomer sheet in the middle, and a printed circuit board at the bottom. This breakthrough will enable advanced robotics, haptic interfaces, and prosthetics.

New route to "quantum spin liquid" materials discovered for first time

From: University of Birmingham (United Kingdom)
15 November 2024 | Press Release | DOI

Scientists have created a new material with complex, disordered magnetic properties at the quantum level, based on a ruthenium framework. This breakthrough opens new pathways for exploring quantum states of matter, engineering new materials to explore quantum states, and developing new magnetic properties for quantum applications.

Max Planck Institute scientists find a new way of entangling light and sound

From: Max Planck Institute for the Science of Light (Germany)
13 November 2024 | Press Release | DOI

Researchers have demonstrated an efficient method to entangle photons with acoustic phonons by using an optoacoustic scheme based on Brillouin scattering. This proposed entangling scheme can operate at temperatures in the tens of Kelvin making it robust and suitable for integration into quantum signal processing, even at higher environmental temperatures.

A nervous system-inspired framework to deploy self-organizing robot swarms

From: Free University of Brussels (Belgium)
13 November 2024 | Press Release | DOI

Scientists have developed a new swarm architecture inspired by the human nervous system by using a self-organizing nervous system architecture acting as middleware. This breakthrough allows robots to self-organize into sub-swarms, improving coordination in sensing, movement, and mission planning.

Neat, precise and brighter than ever: New technologies improve temporal coherence of X-ray free electron (XFEL) pulses

From: Paul Scherrer Institute (Switzerland)
12 November 2024 | Press Release | DOI

Researchers developed a method to make XFEL light more orderly by inserting magnetic chicanes to control the timing of the electron beam between undulator modules. These advancements will enable new scientific opportunities with XFELs, providing precise spectral control for studying ultrafast chemical reactions and biological processes.

Designing a spiral ladder-inspired tool that allows precision control of light direction and polarization

From: Singapore University of Technology and Design (Singapore)
12 November 2024 | Press Release | DOI

Scientists have developed a tool to control light direction and polarization for sensing, communications, and quantum computing by using twisted bilayer metasurfaces, inspired by spiral ladders and double-headed drums. The bilayer metasurfaces advance theoretical understanding and practical applications, enabling efficient emitters and routers for circularly polarized waves.

Primary investigation on ram-rotor detonation engine

From: Tsinghua University (China)
6 November 2024 | Press Release | DOI

Researchers have proposed a new concept for detonative propulsion, called the Ram-Rotor Detonation Engine (RRDE), which is expected to break through the limitations of detonation engines by using principles from the ram-rotor compressor. The RRDE offers advantages such as a simple, compact structure, high efficiency, and adaptability to a wide range of flight Mach numbers.

Seatbelt-integrated biosensor could reliably track the alertness and stress of pilots and drivers

From: National University of Singapore (Singapore)
17 October 2024 | Press Release | DOI

Scientists have developed a seatbelt-integrated biosensor by using metamaterials. The sensors can be integrated into seatbelts in cars, airplanes, and other transport means to monitor drivers' physiological signals, potentially preventing accidents.