Innovations Report

Mar 2006 Part I

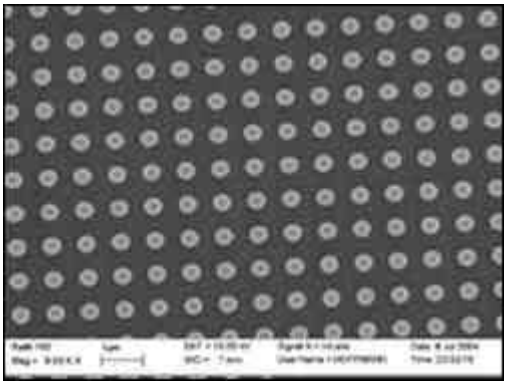
- ICT
- Microelectr. & Nanotech
- Life Sciences

Table of Contents

ICT

A new magnetic phenomenon may improve RAM memories and the storage capacity of hard drives

The application of 'displaced vortex states' - small magnetic circular movements of just a few thousandths of a millimetre - may accelerate the arrival of a new type of magnetic memory (MRAM) that does not disappear when a computer is switched off



A team of scientists from the Universitat Autònoma de Barcelona, in collaboration with colleagues from the Argonne National Laboratory (USA) and the Spintec laboratory (Grenoble, France), has for the first time produced microscopic magnetic states, known as "displaced vortex states", that will allow an increase in the size of MRAMs (which are not deleted when the computer is switched off). The research has been published in Physical Review Letters and Applied Physics Letters.

In the near future we will turn our computers on and they will be ready to work almost instantaneously; no longer will we have to wait a while for the operating system and certain programs to load into the RAM. At the moment, SRAM and DRAM do not allow this, as they are quick, but they are deleted when the computer is switched off (that is, they are "volatile"); Flash memories, which we use for digital cameras, are not deleted, but they are slow; MRAM, which is still being developed, is fast and non-volatile, but has a relatively low storage capacity. A team of scientists from the UAB Department of Physics, in collaboration with colleagues from the Argonne National Laboratory (USA) and the Spintec laboratory (Grenoble, France), have discovered a magnetic phenomenon that could be useful in the quest for the ideal type of memory: an MRAM with large storage capacity.

The "displaced vortex states", first observed by UAB researchers, are small circular movements of just a few thousandths of a millimetre that form in the tiny zones where the data is stored. The information on hard drives has normally been saved by orientating these zones in specific directions. The zones pointing upwards, for example, codify a 1, and those pointing downwards a 0. The smaller and more compact these zones are, the greater the capacity of the hard drive. But if they are too close together, the magnetic field created by one can affect the neighbouring zone and wipe the data. However, if the field is saved in a whirlpool form, in "vortex state", it does not leave the tiny zone to which it is confined and does not affect the neighbouring data, thus making it possible for a much larger hard drive capacity.

The scientists have achieved these "vortex states" on small, circular structures that are smaller than a micrometre (a thousandth of a millimetre) and combine layers of material with opposing magnetic properties: a layer of ferromagnetic material and a layer of antiferromagnetic material. What makes the configuration of the magnets observed by the UAB scientists new is that the vortex states are "displaced", that is, once the magnetic field is no longer applied, the eye of the whirpool moves off-centre with regard to the circular structure on which it formed. This seemingly insignificant detail is the key to applying the technique to increasing the capacity not only of hard drives but also Magnetic Random Access Memories (MRAMs) that are fast, non-volatile, but until now with small storage capacity.

"The phenomenon observed could also be applied to other fields, such as improving the read heads of hard drives", according to Jordi Sort, a UAB-ICREA physicist and the coordinator of the research. "But the reason that motivated us is even more fundamental: this is a very peculiar physical state that can be observed only in extremely small magnetic structures."

Nature 440

Electrical solitons come of age

Individual packets of light energy, known as optical solitons, have long been the darlings of communications engineers. Finally, their electrical siblings are getting a look in — and could become the new favourites.

Digital communication systems seem so robust that many of us take their reliability as an axiom of modern life. That reassuring façade, however, belies a surprising fragility: in practical communication systems, impairments of a distinctly analogue nature can affect the propagation of digital pulses. Nonlinear effects, for instance, amplify the low- and high-amplitude portions of a signal differently, and so distort the signal's shape. And even without amplitude nonlinearity, the signal shape can still be distorted if the elements of different frequency of a signal wave — its so-called Fourier components — propagate at different velocities (as they do in most practical media). This kind of dispersion limits signalling to rates at which the smeared-out trailing edge of one pulse only negligibly perturbs the leading edge of the next.

The quest to mitigate effects that distort the shape of digital signals has been an obsession for communications engineers. Their efforts have paid off handsomely: modern communication channels using optical fibres can sustain data rates greater than 50 gigabits a second over a distance exceeding that between Earth's poles. That's fast enough to transmit the entire print collection of the US
Such achievements are possible when the shape distortion produced by nonlinearity cancels that produced by dispersion. The result is a single pulse of stable shape, dubbed a soliton. Writing in IEEE Transactions on Microwave Theory and Techniques, Ricketts, Li and Ham show that this fortuitous cancellation does more than simply allow the faithful propagation of digital pulses: in fact, it can be used as part of an electrical oscillator to generate pulses in the first place. And in a paper in Physical Review Letters, Wu, Kalinikos and Patton describe a related system that deliberately provokes inherently nonlinear dynamics to produce chaotic soliton oscillations. Both of these systems are purely electronic; their relative ease of manufacture gives them many advantages over the 'photonic' devices, involving light waves, that currently dominate soliton research.

These modern developments ultimately trace their origins to an observation made in the early nineteenth century, when, the Scottish naval engineer John Scott Russell noticed that the wave produced by a prow's rapid drop onto the water's surface propagated quickly down the canal with negligible change in shape over a distance of several kilometers. Scott Russell was certain that the abnormally low attenuation and dispersion of this 'wave of translation' revealed principles of fundamental importance, unfortunately the lack of any practical significance of such 'solitary waves' — solitons — meant that the subject would remain largely ignored for more than a century. Not until the 1960s did theoretical studies resume in earnest and reveal the conditions under which amplitude nonlinearity counteracts dispersion to permit the creation and propagation of solitons. These studies coincided with the development of lasers, whose high power density provides a practical means of teasing nonlinear behaviour out of optical fibres. It is these photonic descendants of Scott Russell's fluid solitons that have revolutionized long-distance digital communications in the past decades.

Optical soliton systems exploit the nonlinearity of an optical fibre's refractive index, under high electric fields. In contrast, electronic soliton systems use a transmission line in which the amplitude of the response to an applied pulse is itself nonlinear. Purely electronic soliton systems offer the same theoretical advantages enjoyed by their optical cousins, but have the added appeal that they are simpler to produce, as they can be manufactured using standard integrated-circuit technology.

Ricketts and colleagues for example, use the voltage-dependent capacitance of conventional semiconductor junction diodes to create a discrete nonlinear transmission line. They connect this transmission line around an amplifier to make a closed feedback loop that produces an oscillating electrical signal. Ensuring the stability of an oscillating circuit requires careful control of some

appropriate system parameter. In this case, the authors adjust the amplifier's gain dynamically both to guarantee that oscillations start and to avoid the onset of chaos. The result is a stable, periodic train of self-generated solitons. The short-duration, periodic soliton train produced by the oscillator could be widely deployed in communication and instrumentation technologies.

Wu and colleagues use a topologically similar arrangement, but bring about nonlinear feedback using a ferromagnetic film made of yttrium–iron–garnet. The complex properties of this material allow a rich variety of nonlinear behaviour, ranging from stable-amplitude oscillations to chaos. Rather than ensuring stable oscillations, Wu and colleagues operate their oscillator in a chaotic regime. The chaotic nature of the signal readily scrambles a message over a large bandwidth, and so reduces the probability that it can be detected or interfered with. Meanwhile, synchronizing a chaotic transmitter with its intended receiver permits unambiguous decoding of the original message. Much effort is currently going into such chaotic, covert communication schemes. The convenience of having such systems in a flexible electronic form using electrical solitons will do much to accelerate their development.

Software to bring order to information chaos

A new software system that enables faster and more comprehensive analysis of vast quantities of information is so effective that it not only creates order out of chaos and allows computers to perform tasks that before only people could perform, it is also creating new information from old data.

"Our greatest contribution was to create a framework for integrating structured and unstructured information," says Dr Babis Theodoulidis, Senior Lecturer at the University of Manchester's Institute of Science and Technology and coordinator of the IST-funded PARMENIDES project behind these tools.

Currently, the vast majority of information is unstructured text, like reports, newspaper articles, letters, memos, essentially any information that is not part of a database.

"Analysing text requires human intervention and, when you are trying to analyse perhaps thousands of documents in many different languages, really large scale text analyses becomes very expensive, or even impossible," says Theodoulidis.

Structured information is found only in databases, like customer management software, personnel files, library catalogues, and any information that is organised by specific fields of data, such as name, address and so on.

"Analysing structured data is not new. Analysing unstructured information using computers is only a recent development, but integrating and analysing the combined data has never been done before. Our framework makes that possible," says Theodoulidis.

Practical applications

It means that, once the appropriate priming and tuning is completed, a computer can analyse a given text and put it into context. "For example, a company might get a letter of complaint and then an employee needs to read and forward it to the right person," says Theodoulidis. "But in our system the letter is 'read' by a computer, which then links the letter to the company's personnel database and forwards the letter to the right person."

The Greek Ministry of Defence (MoD) used the PARMENIDES system to analyse large quantities of unstructured data, like newspaper reports about terrorist attacks, and then combine that with military intelligence. This type of analysis could reveal that one group is changing its methods from car bombs to suicide bombs or chemical attacks. Or that one group is beginning to work with another.

"We got our greatest result with the MoD. Before PARMENIDES, they analysed all their unstructured data manually, essentially people reading articles. Now that's almost entirely automatic," says Theodoulidis.

But PARMENIDES' framework does not just provide a snapshot analysis, it can analyse data over time, too, enabling the system to spot new trends or developments that would remain hidden otherwise. Healthcare consultant BioVista, for example, combined recruitment and business information to track the shifting research priorities in biotech companies over time.

Furthermore, its method of analysis creates new, hidden information from old data. The work was so successful that BioVista hired two software developers and created its own IT department to develop the technology. "Before that they simply outsourced their IT, but they see a value in this type of system and want to pursue it," says Dr Theodoulidis.

'Mental typewriter' controlled by thought alone

A computer controlled by the power of thought alone has been demonstrated at a major trade fair in Germany.

The device could provide a way for paralysed patients to operate computers, or for amputees to operate electronically controlled artificial limbs. But it also has non-medical applications, such as in the computer games and entertainment industries.

The Berlin Brain-Computer Interface (BBCI) – dubbed the "mental typewriter" – was created by researchers from the Fraunhofer Institute in Berlin and Charité, the medical school of Berlin Humboldt University in Germany. It was shown off at the CeBit electronics fair in Hanover, Germany.

The machine makes it possible to type messages onto a computer screen by mentally controlling the movement of a cursor. A user must wear a cap containing electrodes that measure electrical activity inside the brain, known as an electroencephalogram (EEG) signal, and imagine moving their left or right arm in order to manoeuvre the cursor around.

"It's a very strange sensation," says Gabriel Curio at Charité. "And you can understand from the crowds watching that the potential is huge."

Learning algorithms

Curio says users can operate the device just 20 minutes after going through 150 cursor moves in their minds. This is because the device rapidly learns to recognise activity in the area of a person's motor cortex, the area of the brain associated with movement. "The trick is the machine-learning algorithms developed at the Fraunhofer Institute," Curio says.

John Chapin, an expert in using implanted electrodes to control computers, agrees EEG sensing technology is advancing rapidly. "There's been a lot of progress on the non-invasive side in recent years,"

The German researchers hope to develop a commercial version of the device as an aid for paralysed patients and amputees.

Chapin adds that brain-computer interfaces could have a range of uses beyond the medical. "Signals from the brain give you a fraction of a second advantage," he says. The device could make a novel game controller and be used in other ways. The researchers have even begun testing the machine as a driving aid, as it can sense a sudden reaction and control a vehicle's brakes before even the driver can.

Can Computers Be Aware Of Their Surroundings?

Electronics and computing engineers from the University of Ulster have teamed up with neuroscientists, physicists and biologists from across Europe to investigate the incorporation of the senses we humans take for granted into intelligent computer systems of the future.
The multi-disciplinary team concentrated on attempting to replicate in silicon the biological brain's ability to capture data from the senses of touch and sight. In biological life forms, the brain can combine information from different senses to create a comprehensive representation of its surroundings.
Professor Martin McGinnity, Professor of Intelligent Systems Engineering and Director of the Intelligent Systems Engineering Laboratory (ISEL), is the coordinator of the EU's Future and Emerging Technologies-funded SENSEMAKER project with partner instutions: Trinity College, Dublin, two CNRS laboratories in France and the University of Heidelberg in Germany.
He said: "The objective was to study sensory fusion in biological systems and then translate that knowledge into the creation of intelligent computational machines. The ultimate aim is to create machines which can capture information through sensory perception, process it in a way similar to the brain and then act intelligently on that information. The research will have practical application in a wide range of areas including robotics and industrial automation.

"The results of the research project are very promising : we were able to create a theoretical model on how aspects of the process work and also to produce a demonstration system in hardware and software that merged vision and touch – albeit at a very basic level compared to that of living forms. We would hope that in the future we could create models that are more faithful to biology. Once we can get the models right we may be able to implement better, more realistic systems."
He said intelligent systems need to adapt and react autonomously to their environment without reprogramming; they need to be able to react to changing circumstances in a manner that humans would describe as intelligent; for that they need a perception system that enables them to be aware of their surroundings.

But a greater understanding of biological sensory fusion, and how to implement it in artificial systems, could do potentially much more. "This type of research teaches us a lot about how we can translate the principles of living biological systems into artificial computer systems; while the primary focus is to create intelligent computational systems, this field of research may also lead to new ways of treating people with sensory-related disabilities with more advanced prosthetics"

Two other projects will carry aspects of the scientists' work further. The FACETS project, also funded by the EU thorough its Future Emerging Technologies programme, will continue to explore machine perception, focusing on vision. Meanwhile ISEL is actively engaged in a major proposal to create a Centre of Excellence in Intelligent Systems. The Centre will progress a range of research problems related to the creation of intelligent systems, including sensory fusion, learning, adaptation, self-organisation, the implementation of large-scale biological neural sub-systems in hardware and distributed computational intelligence.

Microelectronics & Nanotech

Researcher Works On Molecular Diode

Researchers from the University of South Florida, the University of Chicago and the Russian Academy of Sciences (Moscow) have recently developed the principles of operation and completed an experimental testing of a single molecule for use as a diode. A paper explaining their research has just been accepted for publication in Physical Review Letters by the American Physical Society.

“Single molecule diodes are the fundamental building blocks of an emerging technology called ‘nanoelectronics,’ a field that holds promise for application in all kinds of electronic devices, from cell phones to sensors,” said Ivan Oleynik of USF.
Computer industry execs might start breathing easier because their biggest fear - that smaller and faster devices will eventually come to an end because silicon microchips will get so small that eventually they will contain too few silicon atoms to work - might be lessened as advancements in molecular electronics come to the rescue.“Molecular electronics is enabling an area of nanoscience and technology that holds promise for the next generation of electronic devices, said Oleynik. “Single molecular electronic devices rely on organic molecules with electronic responses tailored through synthetic organic chemistry.”

Functioning at under several nanometers (a nanometer is a billionth of a meter), the molecular diode studied by the team of researchers acted as a rectifier (diode) because of the chemical asymmetry in different parts of an organic molecule comprised of both thiophene and thiazole. As a major component of electric circuitry, a diode is responsible for conducting electrical current by working something like a light switch, but allows current to flow only forward. The first diodes were large vacuum tubes, and most modern diodes are based on solid-state semiconductors.

The team’s most recent finding and the basis for their publication was an explanation of how the intrinsic chemical asymmetry of “designer” molecules results in rectification of electrical current. The left and right parts of the organic molecule interact differently with electrons that “tunnel” through the molecule. Importantly, the electronic interactions with the left and right parts of the molecule respond differently to the change of the polarity of applied voltage.

The potentially bright future of molecular electronic technology is calculated on an ability to control molecular structure. Much of the work is yet empirical and involves “chemical intuition” as a driving force in molecular design as well as the applications of molecular devices.
“The next step is in developing the virtual integrated prototyping of molecular devices and optimizing their electronic functionalities by choosing the most appropriate chemical composition that has desirable electronic properties,” explained Oleynik. “This will require the development of a scientific understanding of electron transport through molecules as well as the introduction of new concepts and new language to explain such transport.”

Success in pioneering the field of molecular electronics would mean new life could be breathed into Moore’s Law, the prediction made by Intel’s Gordon Moore in 1965 that the density of transistors on a chip would double very 18-24 months. While Moore’s observation has been true, everyone in the industry knows that there has always been a limit to the number of atoms that would render a device smaller, cheaper, faster but still operable. New technology that would expand the limits of microelectronics has been a continuing quest.
“Molecular electronics is a viable alternative that may reach the ultimate limit of miniaturization – one molecule per transistor, diode or switch,” concluded Oleynik

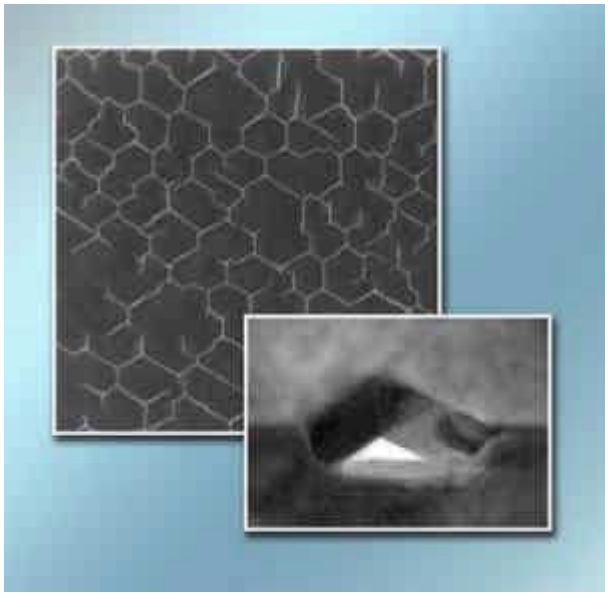
Nanoscale Tubing Assembles Itself Instantly

Making tubes useful often means joining them to other tubes and linking them together in networks. Easy enough to do with standard water pipes — but on the nanoscale, joining nanotubes is hard to do.

Efforts to link nanotubes have usually begun with the most familiar kind, cylinders whose structure is equivalent to one or more rolled-up sheets of a layered crystal like graphite. Now researchers at Lawrence Berkeley National Laboratory's National Center for Electron Microscopy (NCEM) and the Christian Albrechts University of Kiel, Germany, have found a completely new way to form complex networks of nanotubes. The researchers describe their results in the March 3, 2006 issue of Physical Review Letters, now available online.

The new method causes extensive hexagonal networks of tubes, intricately branched and connected, to form in less than a second on the surface of a layered crystal. The tubes themselves are prismatic folds, having the cross section of a pitched roof.

Erdmann Spiecker of Berkeley Lab's Materials Sciences Division, on leave from the University of Kiel, led the team that analyzed the nanofold network phenomenon. Spiecker is a member of the group headed by Wolfgang Jäger in Kiel, where colleagues from another group first observed the mysterious networks when they deposited metal atoms on the surfaces of layered crystals of titanium telluride and vanadium selenide (materials known as transition metal dichalcogenides).



A multilayered crystal of vanadium selenide after enough copper atoms penetrate the uppermost layers of the crystal, a hexagonal network of nanofold tubes appears spontaneously, each tube 30 nanometers across and enclosing an empty space 4 nanometers high. (Image courtesy of DOE/Lawrence Berkeley National Laboratory)

’Nano skins’ show promise as flexible electronic devices

A team of researchers has developed a new process to make flexible, conducting ’nano skins’ for a variety of applications, from electronic paper to sensors for detecting chemical and biological agents. The materials, which are described in the March issue of the journal Nano Letters, combine the strength and conductivity of carbon nanotubes with the flexibility of traditional polymers.

A flexible, conducting "nano skin" with organized arrays of nanotubes embedded throughout. Credit: Rensselaer/Yung Joon Jung

"Researchers have long been interested in making composites of nanotubes and polymers, but it can be difficult to engineer the interfaces between the two materials," says Pulickel Ajayan, the Henry Burlage Professor of Materials Science and Engineering at Rensselaer Polytechnic Institute. "We have found a way to get arrays of nanotubes into a soft polymer matrix without disturbing the shape, size, or alignment of the nanotubes."

Nanotube arrays typically don’t maintain their shape when transferred because they are held together by weak forces. But the team has developed a new procedure that allows them to grow an array of nanotubes on a separate platform and then fill the array with a soft polymer. When the polymer hardens, it is essentially peeled back from the platform, leaving a flexible skin with organized arrays of nanotubes embedded throughout.

The skins can be bent, flexed, and rolled up like a scroll, all while maintaining their ability to conduct electricity, which makes them ideal materials for electronic paper and other flexible electronics, according to Ajayan.

"The general concept (growing nanotubes on a stiff platform in various organizations, and then transferring them to a flexible platform without losing this organization) could have many other applications, all the way from adhesive structures and Velcro-like materials to nanotube interconnects for electronics,"

Life Sciences

Common properties in the genes implicated in the development of cancer

Two researchers from the University of Navarra, Javier Novo and José Luis Vizmanos, have performed a bioinformatic study on the genes which have been implicated in the development of cancer. The research project has been described in an article which will be published shortly in Trends in Genetics, one of the five best journals in the area of "Genetics and Inheritance".

This bioinformatic study has permitted the researchers to identify certain common properties in those genes which are involved in the development of cancer. Dr. Novo explained that "the objective consisted in discovering whether those genes which suffer translocations (breakages) in this disease have any structural or functional characteristics in common".

Concretely, the research project performed by the two scientists of the Department of Genetics at the University of Navarra has provided, for the first time, clear data which support the hypothesis that the most important mechanisms in the development of tumors are those which generate random breakage.

"When a normal cell becomes tumorous, one of the most important changes that it experiences is that its genome becomes unstable, and breaks in various places," explained Dr. Novo. Until now, there have been many examples of this kind of breakage published, "but it was not well known what caused them nor how they were produced; for example, if they were produced at random, or if there was something in the sequence which aided in their appearance in concrete locations."

Database with Genome Regions

The authors of the article published in Trends in Genetics have constructed a data base with all the regions of the genome which break in the various types of tumors. "Over the course of several months, with the help of students from the School of Sciences, we collected from the scientific literature all the breakages which have been described in relation to cancer, we located them in the sequence of the human genome and we studied the characteristics of the regions in which they appear."

Characterizing the processes which provoke breakage is one of the issues which arouses greatest interest among the scientific community. In addition, according to this researcher, "understanding the mechanisms by which cancer develops could mean a great advance in the struggle against this disease".

At Berkeley: Intelligently Designed Molecular Evolution

Evolutionary paths to new therapeutic drugs, as well as a wide assortment of other enzyme products, have been created through, of all things, intelligent design. A team of researchers with the Lawrence Berkeley National Laboratory (Berkeley Lab) and the University of California at Berkeley have developed a technique in which the evolution of an important class of proteins is steered towards a desired outcome.

“We’ve taken enzymes that are promiscuous, meaning they have the capacity to evolve along many different functional lines, and trained them to become specialists,” said Jay Keasling, who led this study. “This technology could be used by pharmaceutical manufacturers in the future to create specific enzyme products.”

According to the theory of divergent molecular evolution, primordial enzymes and other proteins started out as “promiscuous” so that primitive organisms would be better able to adapt to their environment. Driven by selective pressures, these promiscuous enzymes and other proteins evolved along divergent lines to acquire the specialized functions needed by a host organism to survive.

“This process is highly dependent on the fact that the functions of promiscuous proteins can be altered with just a small number of amino acid substitutions, a property known as plasticity,” In nature, the divergent evolution of promiscuous enzymes is achieved through trial and error, similar to the way in which the human immune system works. Multiple combinations of many different amino acid substitutions are tested in promiscuous enzymes until an evolutionary path that achieves a desired result is found. The amino acid substitutions that significantly drive molecular evolution are called “plasticity residues.”

To test this idea, Keasling worked with a type of naturally occurring enzyme a sesquiterpene synthase produced by the Grand fir tree, which has the capacity to develop into any of 52 different sesquiterpenes from a sole substrate. “We were able to take it and construct seven specific and active enzymes synthases. These seven enzymes use different reaction pathways to produce specific products that are as diverse as they can be from one another and we were able to rapidly and efficiently evolve it down a pathway of our choice,” Keasling said. “We are recapitulating evolution into intelligent design. In the case of this particular Grand fir enzyme synthase, it naturally makes a soup of small amounts of 52 different products. We were able to focus it instead on making large amounts of one of seven of those products.”

While the researchers have not yet reached the point where they can design a promiscuous enzyme to make any kind of product they want, even one that does not occur in nature, this demonstration represents a significant step in that direction. The idea would be to one day be able to design an enzyme synthase that would evolve along a specific functional pathway to yield a desired molecular product, then introduce it into microbes for mass production. In addition to synthesizing therapeutic drugs, other possible applications would include flavors, fragrances and nutraceuticals.

Since plasticity residues also play other important biological roles, in addition to the evolution of promiscuous proteins, Keasling and Yoshikuni said their technology, with some modifications, could prove useful for designing novel functions into other types of enzymes and proteins, as well as protein ligands and receptors, transcription factors and antibodies.

Researchers Identify First Compound To Block Progression Of Alzheimer's Disease

Researchers at UC Irvine have found that a new compound not only relieves the cognitive symptoms of Alzheimer's disease, but also reduces the two types of brain lesions that are hallmarks of this devastating disease, thereby blocking its progression.
In a study with genetically modified mice, a team of UCI researchers led by Frank LaFerla, found that a compound known as AF267B, developed by Abraham Fisher of the Israel Institute for Biological Research, reduced both plaque lesions and tangles in brain regions associated with learning and memory. Although drugs exist on the market today to treat the symptoms of Alzheimer's, AF267B represents the first disease-modifying compound, meaning it appears to affect the underlying cause and reduces the two signature lesions, plaques and tangles.

The researchers report their findings in the March 2 issue of Neuron.

"AF267B could be a tremendous step forward in the treatment of Alzheimer's disease," said LaFerla, who serves as co-director of the UCI Institute for Brain Aging and Dementia. "Not only does it appear to work on the pathology of Alzheimer's and ease its symptoms, it crosses the blood-brain barrier, which means it does not have to be directly administered to the brain, a significant advantage for a pharmaceutical product. Although we cannot determine what the effects of AF267B will be in humans until clinical trials are complete, we are very excited by the results our study has yielded." According to LaFerla, AF267B works by mimicking the effects of the neurotransmitter acetylcholine, a chemical in the brain essential for learning and memory. Neurotransmitters act as carriers for messages between brain cells and bind to receptors on the cells' surfaces. Acetylcholine generally binds to specific receptors in the brain, including the M1 receptor, a potentially novel therapeutic target for Alzheimer's disease.

Scientists have known for years that there is a major loss of the neurons that produce acetylcholine in the brains of Alzheimer's patients. Compounds classified as M1 agonists -- meaning that they mimic the effects of acetylcholine and bind to M1 receptors -- are regarded as one hope for counteracting or compensating for the loss of acetylcholine. Unfortunately, previous M1 agonists had been tested but failed in clinical trials.AF267B, however, appears to have overcome the problems seen with earlier generations of M1 agonists.

"These findings are highly important because they offer a new understanding of the importance of cholinergic activation of cells in the hippocampus and cerebral cortex that are essential for creating and preserving memories," said James L. McGaugh, research professor of neurobiology and behavior and a member of the National Academy of Sciences who pioneered the study of drug and stress-hormone influences on memory. "The evidence suggests the exciting prospect of possibly preventing the development of this devastating disease."

’Shuttling’ protein possibly key to resilience of cancer cells

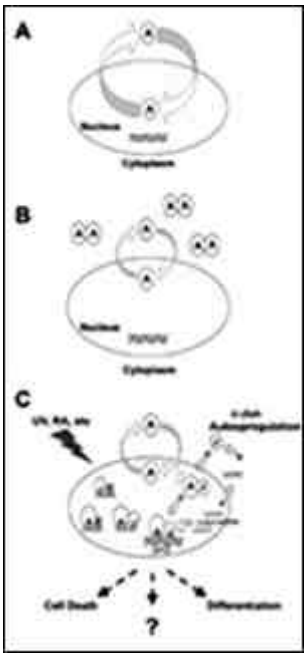
Researchers at Purdue University have discovered a molecular mechanism that may play a crucial role in cancer’s ability to resist chemotherapy and radiation treatment and that also may be involved in Alzheimer’s and heart disease.

The scientists, using an innovative imaging technique invented at Purdue, have learned that a protein previously believed to be confined to the nucleus of healthy cells actually shuttles between the nucleus and cytoplasm, the region of the cell surrounding the nucleus. Moreover, the protein’s shuttling is controlled by the presence of another protein in the nucleus and its attachment to that second protein.

"Our findings may provide a new avenue for the development of innovative treatments for certain cancers and other conditions," said Chang-Deng Hu, an assistant professor in Purdue’s Department of Medicinal Chemistry and Molecular Pharmacology and an investigator at the Walther Cancer Institute in Indianapolis.

The experiments were done using a line of "teratocarcinoma" malignant tumor cells from mice called F9, which, when subjected to the right biochemical signals, have the ability to alter their properties and are considered to be "cancer stem cells." The hypothetical cancer-resistance role of cancer stem cells could explain why tumors return after treatment. If stem cells prove to be critical to cancer’s resistance to treatment, new medications might be developed to target cancer stem cells while chemotherapy or radiation is administered, Hu said.

Research findings are detailed in a paper appearing this month in the EMBO Journal, published by the European Molecular Biology Organization. The paper was written by postdoctoral research associate Han Liu, laboratory technician Xuehong Deng and graduate student Y. John Shyu, all in the Department of Medicinal Chemistry and Molecular Pharmacology; Jian Jian Li, an associate professor in the Department of Health Sciences; Elizabeth J. Taparowsky, a professor in the Department of Biological Sciences; and Hu.



This diagram depicts how a protein called ATF2 constantly shuttles from the nucleus to the cytoplasm in cells, a mechanism that may play a crucial role in cancer’s ability to resist chemotherapy and radiation treatment and that also may be involved in Alzheimer’s and heart disease. ATF2 was previously believed to be confined to the nucleus of healthy cells, but researchers at Purdue University discovered that it actually shuttles between the nucleus and cytoplasm. The researchers used a novel imaging technique invented at Purdue to track the protein, learning that its shuttling is controlled by the presence of another protein in the nucleus and its attachment to that second protein. The findings could provide a new avenue for the development of innovative treatments for certain cancers and other conditions. (Purdue Department of Medicinal Chemistry and Molecular Pharmacology)