

FUTURE ENERGY

Annual

2012

featuring

Best of
Future Energy eNews 2012

&

IRI Annual Report for 2012

Thomas Valone, Editor



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PRESIDENT'S LETTER

Some of you may recognize the “Hubble 3D” IMAX movie which we are promoting on the cover of this Annual. Most cities across the country are featuring the movie which I highly recommend if you can find a theater that is showing it. The one hour experience ends with a simulated trip through the stars, using Hubble images. Also on the cover is our “**Breakthrough Developments in Energy and Propulsion**” DVD which is so well done that we are going to post it on the IRI site under “Watch the Videos”. Also, an interviewee, Dr. Max F-Z will show a fusion demo at COFE6.

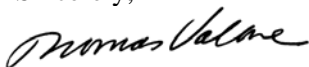
This year for the first time, our *Future Energy Annual 2012* also includes the current 2012 IRI Financial Report and a summary of the 2012 Future Energy eNews, in keeping with most nonprofit organizations. Of course, our accounting had to be done a little sooner but we like being as current as possible, which I am sure you appreciate.

In 2012, http://www.rmi.org/Amory_Lovins_presentation_Reinventing_Fire_Launch was a memorable experience, which I recommend to our members (only 26 minutes). In many ways IRI can pattern itself after Amory's Rocky Mountain Institute but mostly we are more progressive and forward-thinking. Furthermore, IRI is poised for the future where mankind will need the most help. A good example is the “**Climate Change 15-minute Briefing with Dr. Tom Valone**” video we posted on YouTube and also on the IRI website under “Watch the Videos”. Thanks to Dr. Jim Hansen (NASA), who I thanked personally, the “CO2 and Climate Beast” graph published in *Technology Review* in 2006 (<http://www.integrityresearchinstitute.org/climatechart.pdf>) has demonstrated the most reliable predictive picture of our coming century based on the past 400,000 years.

As we continue to seek out new energy technologies and new ways of coping with the dangers of climate change, our **Future Energy Program** is attracting more attention from mainstream organizations and benefactors. We have begun negotiations with a few philanthropic representatives who are the most promising that IRI has ever reached. More news will be forthcoming in 2013 as a result of our unique niche of new energy service, unequalled by any other group, and proving to be more valuable as time goes on. A good example is the **Conference on Future Energy** (COFE) series, which featured two true breakthroughs in 2012. As reported to our IRI Members, FE eNews and also summarized in this FE Annual, we have another technology that IRI advocated starting about 20 years ago which now Boeing has proven really works: “**Inertial Propulsion**”. Order some of our reports on this amazing “propellantless” subject as more information will certainly surface, thanks to engineer Mike Gamble. The other is the proof of energy extraction from zero point energy, thanks to Professor Garret Modell. Lastly, we call your attention to the “**LEDs Exceed 100% Efficiency**” article which suggests a quantum vacuum connection.

Your support and encouragement for this important work is much appreciated.

Sincerely,



Thomas Valone, PhD, PE
President

INTEGRITY RESEARCH INSTITUTE HIGHLIGHTS 2012

Conferences & Presentations: Our Institute had a busy year in 2012. Chief among many conferences was 1). *“The Fourth “SPESIF” Space and Propulsion Energy Technologies Applications Forum/COFE5 February 29-March 2, 2012.* This year IRI again hosted the event at the University of Maryland, Samuel Riggs Center which included our yearly Conference on Future Energy. There were over 40 presentations with speakers from Academia as well as Government and Corporate Facilities that deal with energy innovation in Space, Domestic technologies and Health areas. New this year, was the live streaming of all presentations via Adobe Connect, which was invaluable as it also recorded all the talks and made it available to many in their homes. Proceedings of this conference is



Dave Goodwin from DOE receiving Integrity in Research Award from Dr Valone.

available online free at the Elsevier Science Physics Procedia. This year, the IRI “Integrity In Research Award was given to David Goodwin of the US Department of Energy. We benefited attendance of 100+ and proceedings are available online all over the world benefiting thousands. 2) **Interviews in May 4th** for an Energy Video, by DelSol Films from Canada. Over 3 hours taping discussing emerging energy technologies and events. 3) **Interview tapping for the new video “Sirius”** (see trailer image – right) **by the Disclosure Project on September 6th.** Over 5 hours of discussion, testimonials and emerging energy technologies. The video is in the final stages of production and will be available soon to the public. 4) **Breakthrough Energy (BEM) Conference in Holland, November 8-10.** A taped presentation was sent since due to Hurricane Sandy, Dr. Valone was unable to attend at the last minute. Over 200 in attendances benefited from presentation which is now online. A short introductory video on BEM is also online at <http://player.vimeo.com/video/59314655> .



Future Energy News Program:

FUTURE ENERGY eNEWS



Research of new emerging technologies; public appearances, free newsletters, brochures, and reports that include the latest news on energy developments, discoveries and research given to the public. *“Future Energy eNews”* is sent via email, monthly, to over 8000 recipients worldwide, free of charge through Constant Contact email service. Also we

published the Quarterly “*Future Energy Quarterly Magazine*, and mailed it to all members for free. This magazine contains all the latest papers and articles relating to emerging energy technologies. Also we continue to upgrade our IRI website including more information on emerging energy technologies, climate change, video uploads and press releases.

The Single Electron Spin in a Magnetic Field Experiment Program. This is an exciting new atomic energy program that we are doing together with Veden Academy, a Non Profit in Germany. The experiment aims to study single quantum events with a single electron spin under different influences. The experiment is suitable to discover new interactions with energy fields. In order to make experiments with a single electron spin, a Magnesium-Ion will be stored in a linear Paul Trap. The experiment will be built up in cooperation with Veden Akademie e.V. (a charitable research trust) in Kränzlin, Germany, who has a donation for the labour cost for the scientist, adequate laboratory space, vacuum equipment and voltage sources. The Ion-Trap will be machined and set up in Kolberg, Germany. An ultra-high vacuum chamber will be set up to accommodate the trap. Around the vacuum chamber two Helmholtz-coils will provide the necessary magnetic field to orientate the spin. A 280 nm Laser with a line with of 1-3 MHz will used to study the energy state of the electron spin via fluorescence. A UV-camera will take pictures of the stored ions in the energetic higher spin state. When external influences changes the spin state of the electron the ion will disappear on the picture and will be seen again when the state is flipped back to the higher state.

Electrogravitics Program. This year we made serious progress on this program. For years IRI has educated the public regarding Electrogravitics mainly through our two books: *Electrogravitics Systems* and *Electrogravitics II* and through presentations at conferences and workshops. After 20 years of gathering research, especially in 2010 from a retired *Black Project consultant*, we now feel that we have enough corroboration to move forward into a test mode. In November of 2012, we met with Dr. Paul LaViolette (left) and world renowned journalist Linda Moulton Howe (above), to discuss research on a solid state Electrogravitic Propulsion Device as per Dr. LaViolette’s book *Secrets of Antigravity Propulsion* (p. 275) and Ms. Moulton-Howe’s documentation compiled for years. We are seeking funding for this most important development and plan to start in late 2013.



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Zero Point Energy Program. The research continues on the possibility of tapping zero point energy through zero biased diodes. In our lab, we are currently researching this ability and many journal papers are being prepared for submission to several physics journals including one for the Institute of Physics Journal which will propose the use of *zero biased diode arrays* as thermal electric noise

DEAC Power Cell with THz Limit

Assume a 10 cm² (10 cc) box for convenience and 1 pW/diode

Nano-sized diodes = 10¹¹ per cm²
 assuming 2 nm per layer with 1 nm substrate, yields 5000 diode layers =
 500 trillion diodes × 1 pW = 500 W

This conservative estimate, assuming only a 1% efficiency for total energy conversion, still reaches the kW/m² range of production, 24/7 from ambient thermal and non-thermal energy combined. This calculation also ignores the 1/f and the fringe of noise that exceeds 10 nV and 10 fA per 1000 hertz.

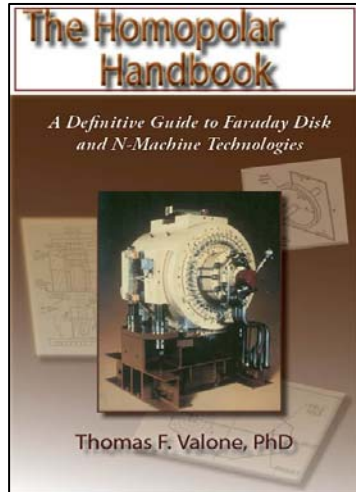
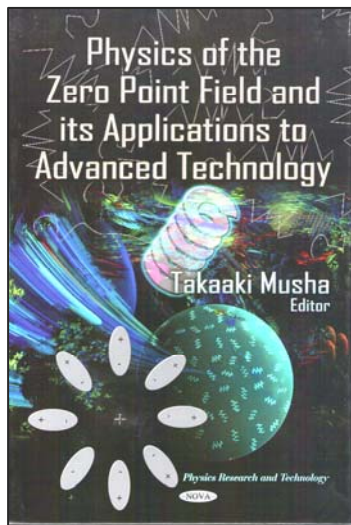
rectifiers and non-thermal energy harvesters. We are currently seeking more funding for this program through investors. Much research is still being done for this paper and completion is slated for 2015.

Bioenergetics Program. We are truly committed to this program that includes research on equipment, therapy machines and providers of electrotherapy. We are currently researching and documenting the effects of the EM-PULSE device of Dr. Glen Gordon and will continue to do so until 2014. The preserving of the invaluable, Puharich Laboratory Notebooks by Dr. Andrija Puharich will continue through 2014. This year we had the most generous volunteer services of Mr. Storm Williams who scanned a huge number of laboratory notes using his own equipment and donating his services and time to IRI (one of the Puharich notebooks can be seen to the left of Storm). Thanks Storm! Our line of **PREMIER** electrotherapy devices continue to be improved and are still our bestseller. The Microcurrent Electrotherapy clothes project is moving forward awaiting examination of our non-provisional application received in June 2011 from the US Patent and Trademark Office. We also are working and researching with Tesla Researcher Mark Voltage System. We have



Bean his Carcinotron High designed and produced several tesla coils, Lakovsky antennas to research the effects this this HV device has on the body and are documenting their effects.

IRI Publications: 1) “The new and revised edition of *The Homopolar Handbook* was made available in the summer of 2012 after painstakingly being scanned from old camera ready copy to an electronic form. Also updated material was added since the book has now been in print since 1994. Still a favorite that sells all over the world! 2) Also we edited and published all the papers from *SPESIF 2012* through *Elsevier Science, Physics Procedia*. The cost for making these proceedings available free to the public was paid by IRI through the generous donations of 3 sponsors. 3) “*Future Energy Annual 2011*” was also published and mailed free to our membership. Includes our latest papers on Energy, including Zero Point Energy, Electrogravitics, Energy generation, Bioelectromagnetics, as well as the IRI Annual Report for 2010 and financials 4) We are also happy to report that we now hold the copyright of the 200-page book “*Understanding Tesla Coils and Beyond*” authored by Mark Bean, who generously donated the unpublished manuscript to



IRI. We are in the process of editing the book and publication has been slated for 2013. 5) Dr. Valone also contributed two chapters to the new book *“Physics of the Zero Point Field and its Application to Advanced Technologies”* printed by Nova Publishers and in cooperation with Dr. Takaaki Musha (cover seen on previous page). Dr. Valone’s chapters are entitled: “Historical Background of the ZPF” and the final chapter entitled: “Future Prospects of Advanced ZPF Technologies”.

Buildings & Clothes Could Melt to Save Energy



New Scientist, 05 January 2012 by [Phil McKenna](#)

<http://www.newscientist.com/article/mg21328466.100-buildings-and-clothes-could-melt-to-save-energy.html>

Phase-change materials that freeze at around room temperature could revolutionize energy storage, cooling things that are too hot and warming them later on.

THE sun has risen, and a brand new building on the University of Washington's campus in Seattle is about to melt.

It is no design flaw: encapsulated within the walls and ceiling panels is a gel that solidifies at night and melts with the warmth of the day. Known as a phase change material (PCM), the gel will help reduce the amount of energy needed to cool office space in the building - scheduled to house the molecular engineering department when completed this month - by a whopping 98 per cent.

PCMs don't have to be as high-tech as this, of course. We have been using ice, a phase change material that melts at 0 °C, to keep things cool for thousands of years. But advances in materials science and rising energy costs are now driving the development of PCMs that work at different temperatures to help people and goods stay cool or warm, or to store energy.

PCMs are attractive energy-savers because of their ability to absorb or release massive amounts of energy while maintaining a near-constant temperature. "To melt ice takes the same amount of energy as would be required to warm an equal volume of water by 82 °C," says Jan Kosny of the Fraunhofer Center for Sustainable Energy Systems in Cambridge, Massachusetts, who began to explore the potential of PCMs three decades ago by looking at beeswax as a way to store heat from the sun. The reason PCMs are so useful is because energy is needed to break the molecular bonds between atoms when a substance melts, and is released when bonds are formed as it solidifies.

The "bioPCM" gel in [the university building](#), derived from vegetable oils, will be "charged" each night when windows automatically open to flush the building with cold outdoor air. The solid gel then absorbs heat as it melts the next day. The idea is the same as using thick concrete or adobe walls, which reduce indoor temperature fluctuations, but only a fraction of the material is required. "**Our bioPCM is 1.25 centimetres thick yet it acts like the thermal mass of 25 centimetres of concrete,**" says Peter Horwath, founder of [Phase Change Energy Solutions](#), based in Asheboro, North Carolina.

Phasing in

©NewScientist

A new breed of phase change materials (PCMs) melts and freezes at different temperatures to store energy for a range of applications

MATERIAL	USES/PROS & CONS	TEMPERATURE
Energain (DuPont)	<ul style="list-style-type: none"> + In buildings, high surface area allows for large energy storage - Paraffin-based; flammable 	20°C
Micronal (BASF)	<ul style="list-style-type: none"> + Wax capsules in building material; no leaks if damaged - Flammable 	21-26°C*
HeatSource (One Earth Designs)	<ul style="list-style-type: none"> + Herders' clothing; made from yak butter and Chinese plant oils - Heavy 	~37°C
BioPCM (Phase Change Energy Solutions)	<ul style="list-style-type: none"> + Soy-based gel in wall cavities + Low flammability - Can leak if punctured 	23-29°C*

*multiple compounds have different melting temperatures

A recent report by technology research firm [Lux Research](#) predicts the use of phase change materials in buildings will grow from near zero today to \$130 million in annual sales by 2020.

Meanwhile, a number of other applications are emerging. UK-based Star Refrigeration is using carbon dioxide, which changes phase from liquid to gas at a very low temperature, to keep data centres cool. Heat emitted by today's high-performance server farms can overwhelm even the most advanced water cooling systems. By piping CO₂ through heat exchangers, the company recently demonstrated an ability to pull nearly twice as much heat from the computers as the systems used at present.

In western China, PCMs derived from yak butter and local plant oils are helping yak herders keep warm. The material is encased in plastic and then woven into traditional clothing. It melts as herders work up a sweat walking to mountain pastures then, when they stop moving, the pent-up heat is slowly released, keeping them warm as they watch their herds. More than 100 families are now using the materials as part of an ongoing pilot project that also includes bed rolls warmed by cooking stoves in the day to keep people warm at night. "Families that use them are starting to see a significant difference in the amount of fuel they need," says Scot Frank of One Earth Designs, also based in Cambridge, which developed the compounds.

Another promising application for PCMs is vaccine delivery in developing countries. Vaccines need to be kept cold during transport, which is a challenge in countries with limited refrigeration. They are typically packaged in ice, but their effectiveness can be severely compromised if they freeze. Using materials that change phase between 4 and 8 °C, US packaging manufacturer Sonoco says it has developed a solution that can keep vaccines cool for up to six days. Sonoco is now testing the Greenbox with a non-profit biotechnology developer called PATH, to meet World Health Organization standards.

Harnessing PCMs for energy storage could also give solar power a boost. Today systems that concentrate solar thermal energy rely on liquid salts to store heat. This allows power plants to produce energy when the sun is not shining, but requires massive amounts of liquid and large, well-insulated storage facilities. By using chemicals that change phase instead, German manufacturer SGL Carbon says it can reduce the volume of storage material required by roughly two-thirds. The company is currently testing a prototype.

For Kosny, all of the recent interest in PCMs is something of a vindication. "Ten years ago, when I argued for the development of phase-change materials, no one was interested," he says. "Now we can't seem to develop these materials fast enough."

FIRST QUANTUM JIGGLES DETECTED IN SOLID OBJECT

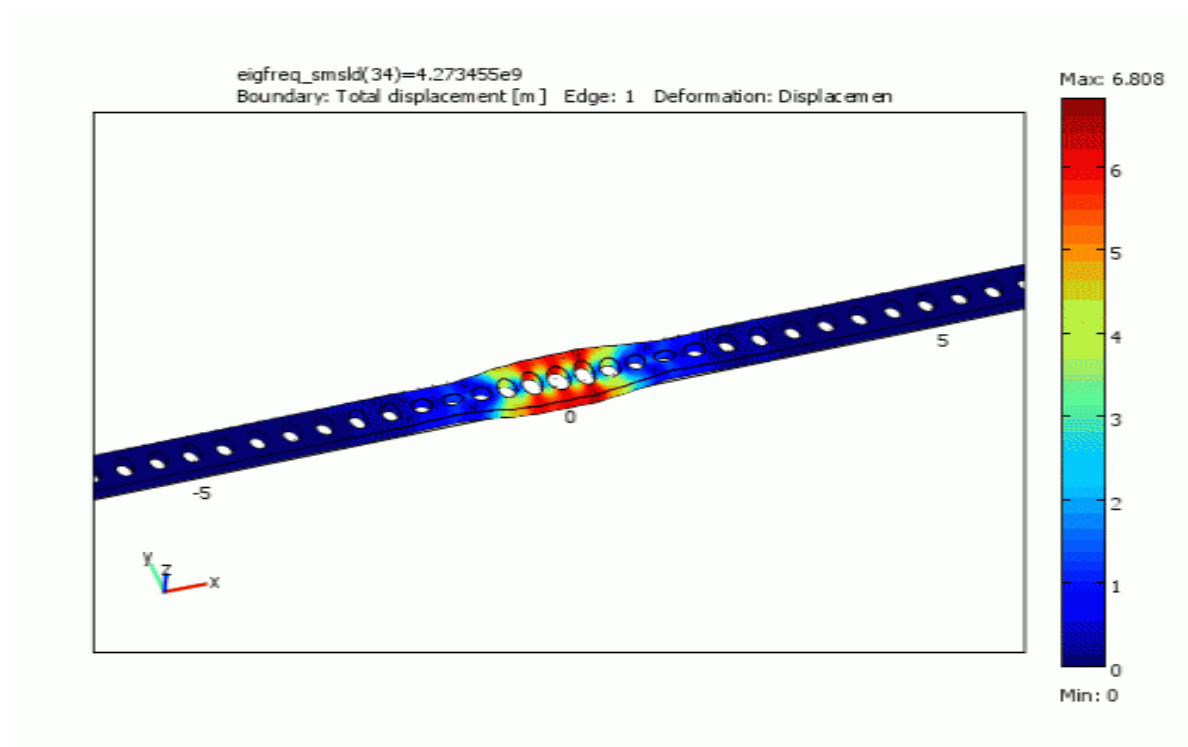
New Scientist, January 28, 2012,

<http://www.newscientist.com/article/mg21328495.200-first-quantum-jiggles-detected-in-solid-object.html>

NOTHING sits still. Even at absolute zero, when the thermal jiggling of matter is frozen, all things must still buzz to the tune of quantum mechanics. Now this subtle jittering has been detected in a small silicon bar, the first solid object ever to reveal its quantum vibrations. This phenomenon, called **zero-point fluctuation**, is a consequence of Heisenberg's uncertainty principle, which says that we can never pin down the precise position and motion of any object. So far zero-point energy has only been seen directly in single atoms or small collections of particles. The new experiment uses a silicon bar about 12 micrometres long and less than a micrometre across. [Oskar Painter](#) at the California Institute of Technology in Pasadena and colleagues cooled the bar to within half a degree of absolute zero and then used a laser to detect [its motion](#).

Some photons from this laser got a shift in energy when they hit the vibrating bar. Ordinary thermal vibrations can either boost or reduce photon energy, but the **zero-point quantum vibration** is different. Because it is the lowest energy state possible, it can only absorb energy. Painter's group detected this bias towards lower-energy scattered light, a clear signature of a quantum twang ([Physical Review Letters, DOI: 10.1103/physrevlett.108.033602](#)). "Seeing these effects in large objects can provide us with a way to probe the foundations of quantum mechanics," says Caltech team member Amir Safavi-Naeini.

Ref: "Observation of Quantum Motion of a Nanomechanical Resonator", Oskar Painter et al., Phys. Rev. Ltrs., PRL 108, 033602 (2012) Jan. 20, 2012

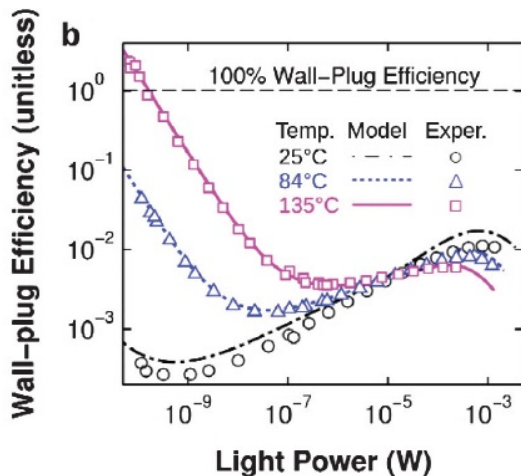


Zero-point vibration color-coded displacement: up to 5 um at center – FE eNews – Feb. 2012

LED's Exceed 100% Efficiency

March 5, 2012 by Lisa Zyga, PhysOrg.com <http://www.physorg.com/news/2012-03-efficiency.html>

An LED's power conversion (wall-plug) efficiency varies inversely with its optical output power. Wall-plug efficiency can exceed 100%, the unity efficiency, at low applied voltages and high temperatures. Image credit: Santhanam, et al. ©2012 American Physical Society.



(PhysOrg.com) -- For the first time, researchers have demonstrated that an LED can emit more optical power than the electrical power it consumes. Although scientifically intriguing, the results won't immediately result in ultra-efficient commercial LEDs since the demonstration works only for LEDs with very low input power that produce very small amounts of light. The efficiency is around 230% according to calculations - Ed. Note

Researchers, Parthiban Santhanam and coauthors from MIT, have published their study in *Physical Review Letters*.

As the researchers explain in their study, the key to achieving a [power conversion efficiency](#) above 100%, i.e., "unity efficiency," is to greatly decrease the applied voltage. According to their calculations,

as the voltage is halved, the input power is decreased by a factor of 4, while the emitted light power scales linearly with voltage so that it's also only halved. In other words, an LED's efficiency increases as its output power decreases. (The inverse of this relationship - that LED efficiency decreases as its output power increases - is one of the biggest hurdles in designing bright, efficient LED lights.)

In their experiments, the researchers reduced the LED's input power to just 30 picowatts and measured an output of 69 picowatts of light - **an efficiency of 230%**. The physical mechanisms worked the same as with any LED: when excited by the applied voltage, electrons and holes have a certain probability of generating photons. The researchers didn't try to increase this probability, as some previous research has focused on, but instead took advantage of small amounts of excess heat to emit more power than consumed. This heat arises from vibrations in the device's atomic lattice, which occur due to entropy.

This light-emitting process cools the [LED](#) slightly, making it operate similar to a thermoelectric cooler. Although the cooling is insufficient to provide practical cooling at room temperature, it could potentially be used for designing lights that don't generate heat. When used as a heat pump, the device might be useful for solid-state cooling applications or even power generation.

Theoretically, this low-voltage strategy allows for an arbitrarily efficient generation of photons at low voltages. For this reason, the researchers hope that the technique could offer a new way to test the limits of energy-efficiency electromagnetic communication.

More information: Parthiban Santhanam, et al. "Thermoelectrically Pumped Light-Emitting Diodes Operating above Unity Efficiency." *Phys. Rev. Lett.* 108, 09740 (2012). DOI: [10.1103/PhysRevLett.108.097403](https://doi.org/10.1103/PhysRevLett.108.097403)
<http://inhabitat.com/mit-researchers-create-led-light-that-exceeds-100-percent-efficiency>
<http://gizmodo.com/5890719/scientists-create-230-percent-efficient-led-bulbs>
<http://prl.aps.org/abstract/PRL/v108/i9/e097403>

Solar Cell Thinner Than Spider Silk Could Power Internet of Things

Christopher Mims 04/04/2012 Technology Review

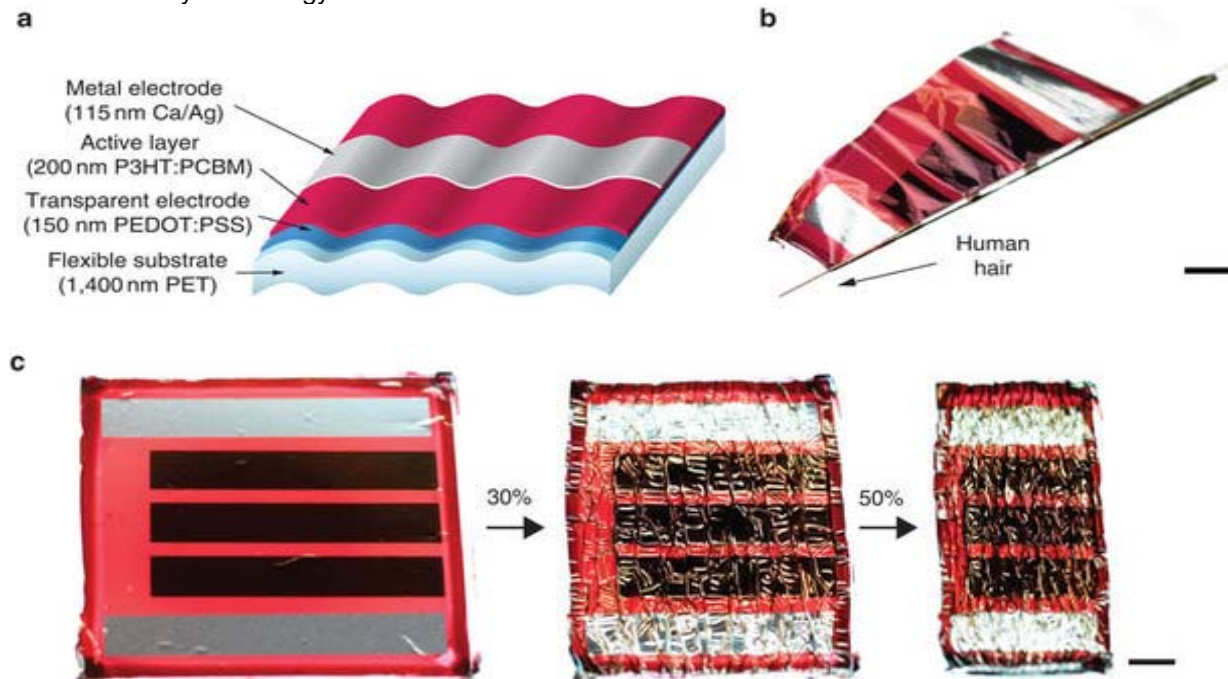
<http://www.technologyreview.com/blog/mimssbits/27700/?nlid=nleng&nid=2012-04-09>

Will ephemeral plastic solar cells make ubiquitous sensor networks a reality?

When you think about how to power a distributed network of environmental sensors--the kind we'll want to have in order to [connect the entirety of our physical world to the Internet of Things](#)--the answer is obvious: solar power. Most of these sensors are by nature too tiny to have access to much of a temperature gradient, and a steady supply of vibrations isn't always available. Batteries have limited lifespans and add bulk and expense. That's one of the reasons that organic and polymer-based solar cells are so interesting, particularly the latest development: A polymer-based (i.e. plastic) solar cell thinner than spider silk that can be bent and crumpled and still produces power

From the [abstract of the paper](#) announcing their development:

These ultrathin organic solar cells are over ten times thinner, lighter and more flexible than any other solar cell of any technology to date.



This solar plastic only [converts 4.2 percent of the sun's energy into electricity](#), which is awful by the standards of conventional polycrystalline solar cells, but absolutely miraculous when you consider how thin and versatile this material could be. For example, Tsuyoshi Sekitani from the University of Tokyo, one of the researchers on this project, [told the AFP](#) that this material could be worn on clothing like a badge, to power a personal health monitor. So why not a thin film under a protective shield, on the back of gadgets, so that prolonging their battery life is as simple as leaving them in a sunny spot?

When it comes to the Internet of Things, [tiny sensors require tiny amounts of energy](#), and that's exactly what organic solar cells can provide. Price and size are the factors that will determine whether or not they become ubiquitous, and this announcement suggests that it's only a matter of time before both requirements are met by organic solar cells.

Antimatter Propulsion Engine Redesigned Using CERN's Particle Physics Simulation Toolkit

<http://www.technologyreview.com/blog/arxiv/27847/?nld=nldly&nld=2012-05-16>

By KFC, Technology Review, 5-14-2012

Latest simulation shows that the magnetic nozzles required for antimatter propulsion could be vastly more efficient than previously thought--and built with today's technologies

Smash a lump of matter into antimatter and it will release a thousand times more energy than the same mass of fuel in a nuclear fission reactor and some 2 billion times more than burning the equivalent in hydrocarbons. So it's no wonder that antimatter is the dream fuel for science fiction fans. The problem, of course, is that antimatter is in rather short supply making the prospect of ever building a rocket based on this technology somewhat remote.

But from time to time physicists put aside these concerns and have a little fun working out how good antimatter rocket engines can be. Today it's the turn of Ronan Keane at Western Reserve Academy and Wei-Ming Zhang at Kent State University, both in Ohio, who take a new approach to the problem with some interesting results. First, some basic rocket science. The maximum speed of a rocket depends on its exhaust velocity, the fraction of mass devoted to fuel and the configuration of the rocket stages. "The latter two factors depend strongly on fine details of engineering and construction, and when considering space propulsion for the distant future, it seems appropriate to defer the study of such specifics," say Keane and Zhang.

So these guys focus on the exhaust velocity--the speed of the particles produced in matter-antimatter annihilations as they leave the rocket engine. The thrust from these annihilations comes largely from

using a magnetic field to deflect charged particles created in the annihilation. These guys focus on the annihilation of protons and antiprotons to produce charged pions. So an important factor is how efficiently the magnetic field can channel these particles out of the nozzle.

In the past, various physicists have calculated that the pions should travel at over 90 per cent the speed of light but that the nozzle would be only 36 per cent efficient. That translates into an average exhaust velocity of only a third of lightspeed, barely relativistic and somewhat of a disappointment for antimatter propulsion fans.

All that is set to change now, however. Keane and Zhang have come up with a different set of figures with the help of software developed by CERN that simulates the interaction between particles, matter and fields of various kinds.

CERN uses this software, called GEANT4 (short for Geometry and Tracking 4), to better understand how particles behave at the Large Hadron Collider, which itself collides beams of protons and antiprotons. So it's ideally suited to Keane and Zhang's task. The new work produces some good news and some bad news. First the bad. The new simulations indicate that pions produced in this way will be significantly slower than previously thought, travelling at only 80 per cent of light speed.

The good news is that the GEANT4 simulations indicate that a magnetic nozzle can be much more efficient than previously envisioned, reaching 85 per cent efficiency. That translates into an average exhaust velocity of about 70 per cent light speed. That's much more promising. "True relativistic speeds once more become a possibility," say Keane and Zhang. These guys have another surprise up their

sleeve. Their nozzle has a magnetic field strength of around 12 Tesla. "Such a field could be produced with today's technology, whereas prior nozzle designs anticipated and required major advances in this area," they say.

That will bring a smile to the face of many science fiction fans. There is, of course, the small problem of gathering enough antimatter for a journey of any decent length. The number of antiatoms made at CERN is small enough to be countable. By one estimate, at this rate it will take a thousand years to make a single microgram of antimatter.

Keane and Zhang point out that all earlier estimates predate the PAMELA spacecraft's discovery last year that Earth is surrounded by a ring of antiprotons and suggest that this could be mined for fuel. What they don't mention, however, is that PAMELA spotted only 28 antiprotons in two years--far less than the rate at which CERN makes them on a daily basis.

Keane and Zhang finish by noting that other fuel technologies have advanced at an exponential rate, liquid hydrogen production, for example. If antimatter manufacture turns out to follow a similar trajectory, who knows what could happen.

Interesting, entertaining and wildly ambitious--all good fun.

Ref: arxiv.org/abs/1205.2281: Beamed Core Antimatter Propulsion: Engine Design and Optimization

T. Townsend Brown Story Revealed

Starburst Foundation. Dr. Paul LaViolette

<http://starburstfound.org/electrograviticsblog/?p=49>

In 1955 and 1956 Townsend Brown made two trips to Paris where he conducted tests of his electrokinetic apparatus and electrogravitic vacuum chamber tests in collaboration with the French aeronautical company Société Nationale de Construction Aeronautiques du SudOuest (S.N.C.A.S.O.) . He was invited there by Jacques Cornillon, the company's U.S. technical representative. The project was named Project Montgolfier in honor of the two French brother inventors who performed early aircraft flights. The project continued for several years until the company changed ownership resulting in a final report which was written up in 1959.



TT Brown flying his discs at the SNCASO facility outside Paris.
Photo courtesy J Cornillon

Details of the Project Montgolfier experiments remained a closely guarded secret for many years until Jacques Cornillon courageously decided to make them public prior to his death in July 2008. Brown's proposal, the project's top secret final report, and an assortment of revealing diagrams and photos are posted on the Cornillon website at: Project Montgolfier: <http://projetmontgolfier.info/> and are available for free download. Brown's proposal is in English, whereas the secret Montgolfier Project final report is in French. An English translation of this 100 page final report is

available from the Peeteelab website for a fee of \$5.95 Canadian. (Note there is a translation error in the statement of the electrokinetic disc wire size, which is 100 times smaller than quoted. Refer to the original French document for the proper size.)

The flying disc carousel experiment that the Montgolfier Project conducted in 1955 used 2-1/2 foot diameter discs (75 cm dia.) hung from 4 meter tethers suspended from the ends of a 3 meter arm. Based on the description given, this seems to have been almost the same flying disc test that Brown gave to the Navy at Pearl Harbor a year or two earlier.

Brown had finished his collaboration with S.N.C.A.S.O. in 1956. From a letter that Mr. Cornillon later wrote to a colleague, we learn that in October 1957 Brown was in the process of test flying 10 foot diameter discs energized at a voltage of 300 kV! Here we see that Brown had followed the plan he had first set out in his 1952 Project Winterhaven proposal which was to eventually test fly a ten foot diameter disc powered by 500 kV (70% more voltage than he used in his 1957 test flight). Hence we see that by this early date Brown had progressed beyond the toy model stage to flying small



Left: TT Brown holding disc. Right: closeup showing outward-leading wire. Photo courtesy J. Cornillon

scale aircraft. To reach this stage he must have been receiving substantial funding from either the military or from a major corporation. More about Project Winterhaven and Brown's research may be found in the book [Secrets of Antigravity Propulsion](#). In addition the Project Montgolfier team constructed a very large vacuum chamber for performing vacuum tests of smaller discs at a pressure of 5×10^{-5} mm Hg; see below.

In reading the section describing the vacuum chamber results, we learn that when the discs are operated at atmospheric pressure they move in the direction of the leading edgewire regardless of outboard wire polarity. This indicates that in normal atmospheric conditions the discs are propelled forward primarily by unbalanced electrostatic forces due to the prevailing nonlinear field configuration (which causes thrust in the direction of the low field intensity ion cloud regardless of the ion polarity). On the other hand, the report says that under high vacuum conditions the discs always moved in the direction of the positive pole, regardless of the polarity on the outboard wire. This indicates that in the absence of the unbalanced forces exerted by ion clouds, the discs moved mainly on the basis of the electrogravitic field effect, always toward the positive (negative G) direction.

These vacuum chamber experiments were a decisive milestone in that they demonstrated beyond a doubt that electrogravitic propulsion was a real physical phenomenon. The report concludes saying: "It seems perfectly reasonable to conclude that a concentrated force of some kind accumulates within the presence of a strong dielectric." (i.e., presumably in the presence of a high-K dielectric.) Based on the angle of the disc suspension cable seen in the photo on the right below, one may estimate that the disc was traveling at a speed of ~8.7 meters per second, or about 20 mph. It would have completed one revolution of its 18 meter course in 2 seconds.

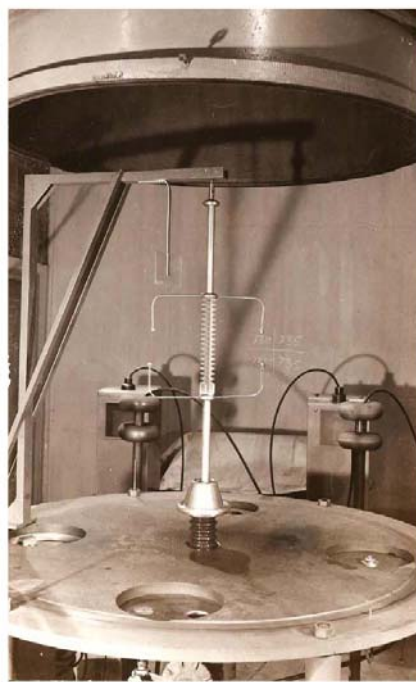


Ed. Note:

Electrogravitics Systems, and **Electrogravitics II**, both edited by Thomas Valone which tell the complete history and developments of TT Brown's amazing discovery are available in book form and eBook form.

<http://www.integrityresearchinstitute.org/electrogravitics.html>

It should also be noted that Dr. LaViolette's book, *SubQuantum Kinetics* is probably the only book in the world that explains why the positive (+) electrode is the one that indicates the direction of motion for asymmetric capacitors and symmetric discs like T.T. Brown's charged to high voltage.



Left: Vacuum vessel chamber. Right: vessel opened to show test rotor rig. Photos courtesy J Cornillon

Disc rig. Disc in flight. Photo courtesy J Cornillo

Crystal Roads Harvest Energy of Passing Cars

Innowattech Press Release <http://www.innowattech.co.il/index.aspx> *Future Energy eNews, June, 2012*

Ed. Note: Sometimes we update great future energy stories we ran years ago. The above title is from New Scientist 2008 archived on our website. Hopefully some of our subscribers will recognize the value of generating 400 kW per kilometer of roadway with harvested energy from heavy passing vehicles and offer help to facilitate licensing in this country, thus furthering energy independence.

The US needs this type of robust energy in the gigawatt range for every few kilometers of installed piezoelectric crystal converters with no pollution. No other renewable energy source seems to compare since Innowattech IPEGs are not weather-dependent and is far less costly per kW of installed power. - TV



Innowattech Energy Harvesting Systems has developed a new alternative energy system that harvests mechanical energy imparted to roadways, railways and runways from passing vehicles, trains and pedestrian traffic and converts it into green electricity. The system, based on a new breed of piezoelectric generators, harvests energy that ordinarily goes to waste and can be installed without changing the habitat. Innowattech presents a pioneering invention for Parasitic Energy harvesting. We provide genuine environmental benefits where parasitic mechanical energy on roads, highways, railways and airport runways, are harvested and transferred back, in a process by which the energy is captured, stored and reused.

Innowattech Alternative Energy Harvesting System

The Innowattech Green Energy Solution:

The piezoelectric phenomenon was first described by the Curie brothers. They observed that certain materials generate electric current when they are deformed. Today piezoelectric materials have multiple uses in industry, but most work efficiently only at high frequencies.

Innowattech has developed a new breed of piezoelectric generators with a mechanical electrical association that are ideally suited to harvest the mechanical from roadways, railways, runways and pedestrians.

In addition has developed a very efficient storage system to collect and store the electricity produced by these generators. The accumulated energy can be used for local power needs or routed into the grid.

The energy consumed by the vehicle (sourced in the fuel combustion) utilized for a variety of applications; one of them is to overcome rolling resistance. A typical asphalt road can be described as a visco-elastoplastic material, with elasticity being its dominant material characteristic.

When a vehicle passes over a road, the road deflects vertically. This deflection is released as thermal energy.

For a road with embedded piezoelectric generators, part of the energy the vehicle expands on roads deformation is transformed into electric energy (via direct piezoelectric effect) instead of being wasted as thermal energy (heat).

Innowattech's advantages:

- * Pure energy harvesting (parasitic energy only)
- * Functions in all weather conditions
- * Solution integrated with infrastructure - theft & damage proof
- * Solution does not require purchase of real estate
- * Proximity to consumer
- * Data collection, e.g. "Smart Road," etc.
- * Providing electricity for areas remote from main electricity lines

On Wednesday, December 1st 2010, Innowattech has installed a rail monitoring station with cooperation of the Israeli National Railways company. The monitoring station is located on a commercial rail near the Haifa station.

The station includes several systems that together enable Innowattech's team provide high accuracy data to the rail operators' everyday needs.

The unique full rail monitoring system was developed based on Innowattech's technology which enables the conversion of usually wasted mechanical energy into useful electrical energy.

Most of the world's tracks use plastic based pads assembled between the sleeper and the tracks. These pads are designed to reduce the impact of fluctuations during the train's travel and at the same time reduce the environmental noise.

Removing the plastic based pads:



Innowattech has developed a similar pad in geometry and size to the original pad. Innowattech's pads are embedded with PZT materials, so once the train passes; an electric pulse is created which allows creation of electrical energy. Based on Innowattech's existing knowledge it is possible to analyze and process the received signals.

Inserting Innowattec's pads:



Currently, Innowattech's system enables data on dynamic & static weight of the train and its

components (wheels, axles, locomotive and wagons), speed, count of the various railway wheels and components.

Innowattech's development team is now concentrated on expanding the information provided and is intending to present information related to measurements and components' health such as the wheel's diameter & profile, in the upcoming quarter. The processed information, displayed in tables, is transferred as a file to the relevant office in the Railway Company.

This basic information, necessary to train operators wherever they are, allows companies to reduce maintenance effectively.



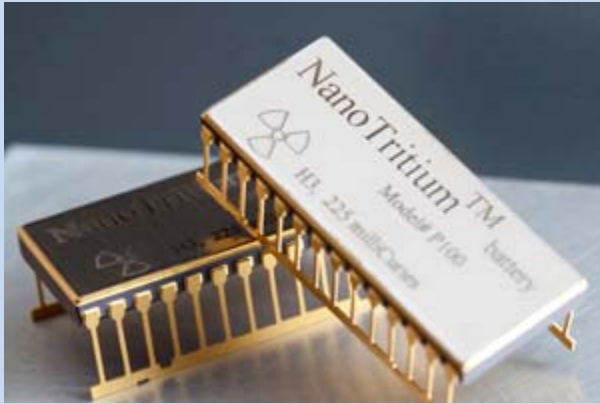
The simplicity of the monitoring station's construction and its attractive price is a breakthrough in this market and allows many railway companies to place monitoring stations along the tracks, reducing the need for transferring measuring instruments along the tracks, as is the case today in many parts of the world.

Innowattech is already in negotiations with several costumers from the railway field regarding the rail monitoring system and intends to start commercial selling very soon.

Betavoltaic Power Source Provides Source of Continuous NanoWatt Power for 20 + Years

ECN Magazine July 2012

<http://www.ecnmag.com/news/2012/06/betavoltaic-power-source-provides-source-continuous-nanowatt-power-20-years>



City Labs, Inc. has released its first commercial product, a tritium-based betavoltaic power source that enables low-power microelectronic and sensor applications where battery replacement is difficult, impossible, or life-threatening. The Model P100a betavoltaic power source provides a source of continuous nanoWatt power for 20 years or more in microelectronic platforms. Applications include environmental pressure/temperature

sensors, intelligence sensors, medical implants, trickle charging lithium batteries, semi-passive and active RFID tags, silicon clocks, SRAM memory backup, deep-sea oil well electronics, lower power processors (e.g. ASICs, FPGAs, microcontroller units, etc.). As tested and confirmed by Lockheed Martin, the City Labs NanoTritium betavoltaic is able to resist broad temperature extremes where traditional lithium batteries are subject to failure. City Labs asserts the first company in the betavoltaic battery industry to be granted a Product Regulatory General License to manufacture, sell, and distribute its NanoTritium betavoltaic power sources. These devices contain small amounts of tritium, a radioisotope commonly found in Exit signs and diver's watches. The General License provides the end-user with a safe, reliable and commercially available betavoltaic power source, and eliminates both the burden of regulatory paperwork and end-user radiological training. The General License also allows for easy purchase of the betavoltaic power source without requiring the customer to have a prior radiation license.

City Labs, Inc.

305-909-7593 305-909-7593 FREE , www.citylabs.net

RELATED ARTICLE

MIT Technology Review Features City Labs' Betavoltaic Batteries

Published In Partnership with Enterprise Florida

SPOTLIGHT ON INNOVATION: *The Technology Review Custom Team takes a look at the technologies that are changing the ways in which we do business in the clean energy, life sciences, infotech and homeland security clusters.*

BETAVOLTAIC BATTERIES

Current chemical batteries have a number of limitations, including their short lifespan and the limited range of temperatures and pressures at which they can function. **Peter Cabauy of City Labs Inc.** in Homestead, FL, discovered these limitations when he and his cofounders looked into starting a new technology company in

south Florida.

Founded in 2005 and first housed within Florida International University's technology incubator, **City Labs** originally partnered with Lockheed Martin Florida to develop betavoltaic batteries. Like photovoltaic cells, betavoltaic batteries absorb radiation, but instead of sunlight, the radiation comes from a physical source that emits electrons.

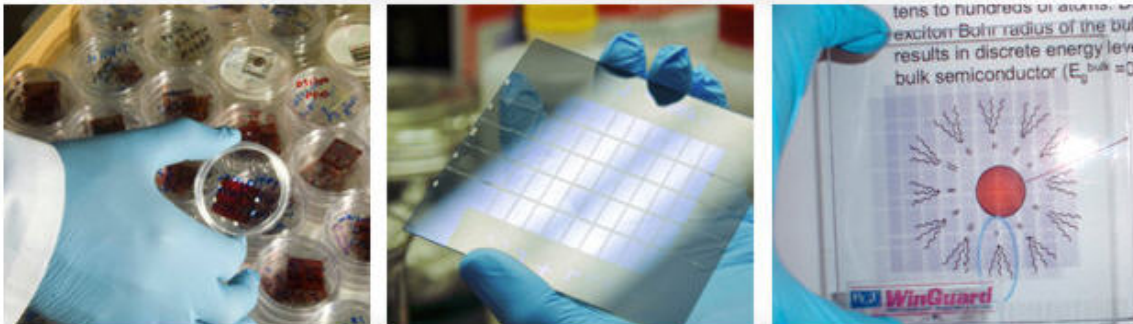
City Labs focused on tritium as a radiation source, as tritium—one of the most benign radioisotopes—is already used to power the phosphorescent glow in the watches used by divers and in exit signs (though the signs are not battery powered). In December 2010, the company was awarded a contract worth nearly \$1 million from the U.S. Air Force Research Laboratory for its tritium-based batteries.

IRI has carried for 10 years the [Nuclear Battery Report](#) by Paul Brown, (scroll down to bottom of page) who pioneered betavoltaic batteries 15 years ago.

Spray-On Photovoltaic Windows

MIT Magazine, David Zack, June 2012

<http://www.technologyreview.com/view/428366/spray-on-photovoltaic-windows/?nlid=nleng&nid=2012-07-02>



New Energy Technologies, a solar energy startup here in the US, has developed a technique to manufacture "spray-on" photovoltaic windows. The technique should ramp up production speed and bring down costs.

First of all, what's meant by a spray-on window? New Energy Technologies gives a [good run-down](#) of the product, which they call SolarWindow, on their site. The tech uses an organic solar array made up of extremely small solar cells—they measure about a quarter of the size of a grain of rice.

The Christian Science Monitor, in a [story](#) back on Earth Day, further explains that NET developed plastic polymers that, when sprayed on a window, would produce electricity. The stuff is so effective as to harvest light even from northern exposure, and indeed even from indoor fluorescent lighting. "It will generate electricity even in low light conditions," John Conklin, NET's CEO, told the Monitor. NET teamed up with the National Renewable Energy Laboratory and the University of Florida to develop the tech.

The Engineer, which [reported](#) on the manufacturing breakthrough, says that the film can be sprayed on in an ultra thin, sub-micrometer layer. The breakthrough is important for American industry, because as the Monitor pointed out in April, while American firms experimenting in spray-on solar had the technical edge, Chinese companies were so far able to produce the stuff more cheaply.

And spray-on solar is more than just an eye-catching innovation. It's potentially a revolution in solar power, a move away from the traditional rooftop solar array. "It puts energy harvesting everywhere," said Ken McCauley of Konarka, an NET competitor, to the Monitor.

Everywhere, that is, assuming the cost of production could come down. The traditional method to make spray-on solar panels was something called vacuum deposition, which was time-consuming and expensive. But NET found a way to do what the Engineer calls "high-speed roll-to-roll and sheet-to-sheet manufacturing," and it made the process possible at low temperatures and at ambient pressure.

At the end of the day, a major logjam in the ascent of solar power comes down to finance and cost-cutting. New Energy Technologies' manufacturing innovation is a step in the right direction

Bendy Batteries Lets You Wear Gadgets Power Supply

[Will Ferguson](#) 22 August 2012, New Scientist,
<http://www.newscientist.com/article/mg21528796.900-bendy-battery-lets-you-wear-gadgets-power-supply.html>

BATTERIES are going round the bend. A flexible, lithium-ion battery can fit inside the cable for your earphones so you can wear it round your neck.



I am wearing party lights, unplugged!

Developed by a team at [Pusan National University](#) in South Korea, the battery is made from electrode strands coiled into a hollow core and surrounded by an outer electrode tube. It could make future gadgets lighter because they will no longer need an integrated battery. [Flexible displays](#) or wearable electronics will be less bulky too. It might mean you can wear your power source on the wrist, round your neck or any another part of the body, its creators say.

In tests, a prototype continuously operated a red LED screen and iPod Shuffle even when

researchers tied the battery in a knot. Je Young Kim of Korean firm LG Chem and a co-creator of the device, says the battery can power a small MP3 player for up to 10 hours and provide 5 minutes of emergency calls from a cellphone ([Journal of Advanced Materials, doi.org/fz5rg5](#)).

The team's goal is to have the battery ready for mass production by 2017, for use in MP3 players or as emergency back-up power for cellphones. "This may be the first cornerstone of the [wearable energy](#) era," says Kim.

RELATED ARTICLE

Cotton transistors weave comfort into electronics

[Katherine Bourzac](#) 09 November 2011, New Scientist
<http://www.newscientist.com/article/mg21228376.100-cotton-transistors-weave-comfort-into-electronics.html>

THE next generation of wearable electronics could be a lot more comfortable, thanks to transistors made from cotton fibres. Such transistors may soon make for wearable electronics as comfy as your favourite pair of jeans or T-shirt.

Some electronic textiles, such as shirts that integrate heart-rate monitors, are already on the market. But these products incorporate wires and bulky boxes of electronics, says [Annalisa Bonfiglio](#) at the University of Cagliari, Italy, who led the new work in cotton. What's more, metal and silicon - materials typically used to build electronics - are difficult to weave into fabric, while [conductive polymer fibres](#) that can be woven do not match the comfort levels most people expect from their garments.

Cotton, by contrast, is perfect to wear but not a good conductor.

Bonfiglio and colleagues have now found a way to make cotton conductive enough to use in transistors, the devices at the heart of most electronics. They did it by giving cotton fibres a coating of gold nanoparticles combined with a conductive polymer. This material forms the gate of the transistor, which regulates the flow of current from one electrode to another.

To make a full transistor, the researchers coated the conductive cotton with a semiconducting polymer, which carries current between two electrodes - spots of conductive silver paint at either end of the cotton strand. Varying the voltage in the gate as current flows in the circuit makes the transistor switch between being very conductive and resisting current.

The transistors, which look and handle like cotton thread, can be electrically connected to one another, and to other cotton components, simply by knotting them. The team's work will be published this month in the journal [Organic Electronics](#).

Cotton transistors won't match the speed of silicon transistors in typical microprocessors any time soon, but they could perform simple computational tasks. For example, a carpet could count the number of people in a room or sense the temperature.

The new transistors also promise to make wearable biosensors better. [In separate work, Nicholas Kotov](#) at the University of Michigan in Ann Arbor has coated cotton threads in nanotubes and antibodies that change their conductivity in the presence of blood. Such sensors could warn medics if a soldier is wounded. Kotov says cotton transistors would make sensors more sensitive, because they can amplify signals.

How Power Outages Might be Avoided One Day

Kevin Bullis, Technology Review, August 2012

<http://www.technologyreview.com/news/428666/how-power-outages-in-india-may-one-day-be-avoided/?nlid=nleng&nld=2012-08-06>

Microgrids, an increasingly popular solution in the developing world, could take the pressure off India's struggling national grid.

Some 600 million people in India have been left without power after parts of the country's massive electricity grid collapsed Tuesday. While the cause isn't yet clear, the outage isn't surprising. India's grid has long been strained, with demand often exceeding supply by hundreds of megawatts, forcing regular rolling blackouts in some areas.



A big part of the solution is obvious: more power plants, more power lines, and an increased supply of coal and other fossil fuels-in India, many power plants don't operate at full capacity because they can't get enough fuel. But another part could be technology that's already starting to catch on in many parts of the developing world: microgrids.

Instead of relying only on large, centralized power plants, microgrids supply a small area with electricity from distributed sources-such as diesel generators combined with solar panels with battery storage. These localized grids can operate either attached to the national grid or apart from it, in many cases allowing businesses and hospitals and other organizations to keep going without a hiccup when the larger grid goes down.

The technology is already becoming popular in India because businesses can't simply count on the grid. "There is a tremendous amount of investment that Indian companies have to make in captive generation as a backup strategy," says Rohan Parikh, head of green initiatives at Infosys, a software company with 10 campuses across India, each with its own backup power supply. Infosys is also working on the software that helps control

microgrids.

Microgrids are an extension of on-site generators, or dedicated power supplies, sometimes called captive generation. But they have several advantages over the simple backup diesel generators that are keeping many essential services in India going right now. They use a variety of resources for power, not just diesel generators, which makes them more reliable. So they can keep running, at least in a limited way, even if supplies of diesel fuel get cut off. They can also be cleaner-if solar is used as part of the energy mix. And now that solar panel prices have fallen, distributed solar can be cheaper than running diesel generators alone for backup power. "Solar power is very attractive when compared to diesel generators in the daytime," Parikh says.

Microgrids also offer benefits for the larger grid. Utilities can call on businesses running microgrids to disconnect to ease strain during times of peak demand. That could reduce the number of power outages in a country like India.

Microgrids are no panacea. There's a limit to the amount of solar power that can be installed on a given site, for example. Parikh estimates that on-site solar will only ever account for 10 to 15 percent of the power demands of a given campus-there's just not enough roof space and open land to do much more than that. Batteries are also too expensive to store much solar power for use when the sun isn't shining. Therefore, to some extent, microgrids will need to rely on conventional fossil fuels to keep running.

Microgrids may also be important as countries such as India continue to develop, bringing power to more people even as power demand increases. One vision is that, as India develops, it could become a network of many microgrids, each connected but able to survive independently. Outages that affect entire states could become a thing of the past.

While news reports suggested that there are 600 million people who lost power with this week's outages, that's almost certainly an overestimate-if only because hundreds of millions of people in India didn't have grid power to start with. Some of these people are starting to get power for the first time, via microgrids.

Bionic Implant for Blind Woman

SINGULARITY HUB | SEPTEMBER 14, 2012

In what's being [claimed a world first](#), doctors have implanted a bionic eye into a woman, allowing her to see flashes of light. The early stage prototype performed well as a proof-of-principle, offering hope to blind people around the world that bionic implants could restore part of their vision in the coming decade.

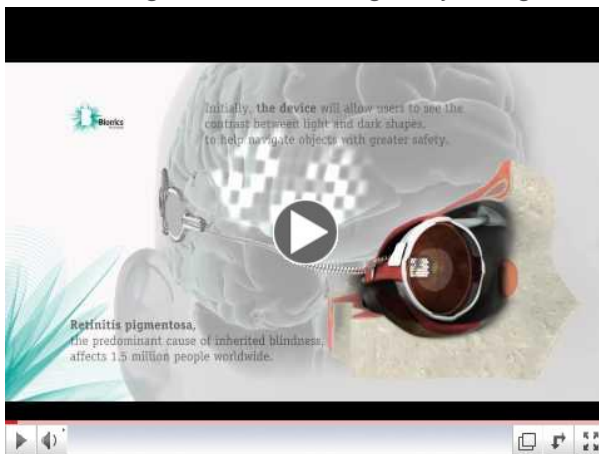


Dianne Ashworth's vision was severely impaired due to [retinitis pigmentosa](#), an inherited disease that damages the retina. A technology enthusiast herself, she eagerly volunteered to undergo the first surgery of its kind in hopes that her vision might be restored.

The rationale behind the bionic implant is to replace the damaged retinal cells with electrodes that stimulate the nerves which connect to the visual cortex. A 24-electrode array was placed at the back of

the eye just beneath the retina. From the array a wire extends back and connects to a device just behind the ear.

The following short animation gives you a good idea how the device is implanted.



Bionic Eye - Animation

Right now the bionic implant is specifically targeted toward people with retinitis pigmentosa and age-related macular degeneration. But as the research continues, the team hopes that the implant will eventually help people with other types of visual impairments as well. Clearly the technology is a long way from restoring a blind person's vision anywhere close to the visual acuity of people with normal sight. But [Bionic Vision Australia](#), the consortium of researchers that developed the implant, has a less

ambitious goal that would nevertheless make a huge difference - to increase a blind person's mobility. If they could restore sight enough to pick out edges and objects - see the steps of a [flight](#) of stairs or read large print, for instance - it would allow for much easier navigation. Just allowing them greater, vision-enabled mobility would greatly increase quality of life.

The implant surgery may sound invasive, but according to the surgeons it is a relatively simple procedure that can be taught easily to surgeons around the world - good news for blind people outside of Australia. [According to the World Health Organization](#), 39 million people worldwide are blind and another 285 million have low vision. The present device may be touted as the first bionic implant, but one notable device has been in development for several years now, and has already gotten promising results. The Argus has an external, wearable camera that transmits wirelessly to an array of more than 60 electrodes implanted in the retina. The Argus II was [approved last year](#) for sale in Europe, and it is currently [being evaluated](#) in clinical trials in the US. Just as the Australian implant aims to achieve, the Argus

has already been shown to allow the visually impaired to make out the edges and outlines of shapes.

Whether or not the bionic implant is a "world's first," as study participant Penny Allen at the Centre for Eye Research Australia **attests**, it's certainly worth getting excited about. Conveying visual input to the brain anywhere near as effectively as the retina is an incredibly difficult technological challenge. The more minds bent on overcoming that challenge, the better.

Making Fuel from Water and Sunlight

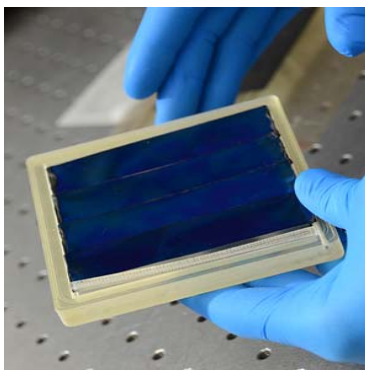
[Kevin Bullis](#)

Monday, October 22, 2012 Technology Review

http://www.technologyreview.com/news/429681/artificial-photosynthesis-effort-takes-root/?utm_campaign=newsletters&utm_source=newsletter-weekly-energy&utm_medium=email&utm_content=20121022

Artificial Photosynthesis Effort takes Root. A \$122 million innovation hub could speed the development of devices for making fuel from water and sunlight.

While a debate rages about the government's role in funding energy innovation, sparked by high-profile failures of government-backed companies such as Solyndra and A123 Systems, a less controversial federal clean-tech investment strategy has been quietly humming along, garnering bipartisan support. So-called innovation hubs, multidisciplinary research centers meant to emulate the legendary Bell Laboratories by combining scientific research with applied technology, have managed to get continued government funding even as Congress works to cut the overall federal budget.



Prototype. Joint Center for AP
different areas, including catalysis, optics, and membrane technology.

Two years after first getting funding, one of the current hubs—a Caltech-based effort focused on using sunlight to make liquid fuels—says it has made substantial progress *toward devices that convert sunlight and water into hydrogen and oxygen that could be used to power a car or generate electricity on demand. Eventually, the researchers hope to combine the hydrogen with carbon from carbon dioxide to make liquid fuels similar to gasoline or diesel.*

Researchers have been pursuing what's known as artificial photosynthesis for decades. Progress has been slow, and making the process economical on a large scale remains a seemingly distant goal. The new innovation hub, which is meant to receive \$122 million over five years, plans to hurry this research along by bringing together a large number of experts in

To speed up materials discovery, researchers at the Caltech hub, who collaborate with researchers at Lawrence Berkeley National Lab and more than 20 other research centers, have developed an ink-jet printing process that can churn out millions of slightly different variations on promising catalysts. Each sample is as small as a pixel on a screen. They're also developing equipment that can quickly test the activity of each catalyst. "It will dramatically accelerate the rate of electrocatalyst and photocatalyst discovery from a few candidates a year to a few every few milliseconds, producing thousands to millions per day," says Nate Lewis, hub director at the Joint Center for Artificial Photosynthesis.

At the same time, the hub has installed advanced 3-D printers that can make prototype devices to house the light-absorbing materials and catalysts, feed water to them, and separate and collect hydrogen and oxygen. So far, researchers have built two such prototypes that can produce fuel from sunlight-though not yet economically. The plan is to have at least four or five different versions of the devices, each with different strengths and weaknesses. The researchers want multiple versions because they can't predict where the next materials advance will be.

The idea of developing new energy technologies at innovation hubs is far different from the approach of helping companies scale up manufacturing through grants or loan guarantees, as the U.S. Department of Energy did in the case of A123 and Solyndra. It is also far different from funding research projects in the ARPA-E program, whose goal is to take a specific advance in a lab or a company, such as the discovery of a promising new material, and demonstrate its potential within three years-for example, by building a working battery using that material.

The innovation hubs pull together researchers from many different groups to focus on making breakthroughs on long-standing problems. They work on many different levels, doing everything from discovering new materials and carefully studying how they work to designing and building devices that could use those materials. While ARPA-E grants individual projects a few million dollars, each hub is meant to receive more than a hundred million dollars over five years in recognition of the larger scale of the problems they address. So far, five innovation hubs have been funded, but funding for their five-year term isn't guaranteed. The money has to be allocated every year, and the budget for next year hasn't been passed. Though the relevant House and Senate committees support continued funding for all five, Congress is facing increasing pressure to find places to cut spending.

Transforming "Noise" Into Mechanical Energy at Nanometric Level

ScienceDaily (Nov. 22, 2012)

<http://www.sciencedaily.com/releases/2012/11/121122095313.htm>

A team of researchers at the Freie Universität Berlin, co-ordinated by José Ignacio Pascual*, have developed a method that enables efficiently using the random movement of a molecule in order to make a macroscopic-scale lever oscillate.

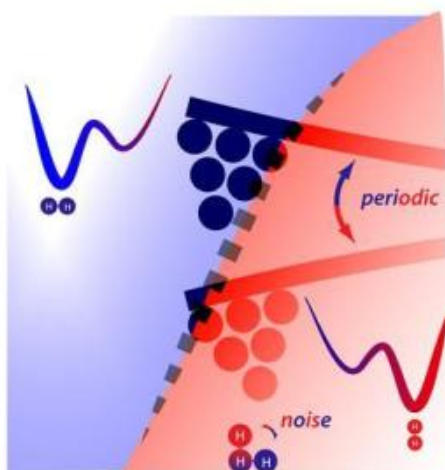


Image courtesy of Basque Research.

The research was published in *Science*. In nature, processes such as the movement of fluids, the intensity of electromagnetic signals, chemical compositions, etc., are subject to random fluctuations which normally are called 'noise'. This noise is a source of energy and its utilisation for undertaking a task is a paradigm that nature has shown to be possible in certain cases.

The research led by José Ignacio Pascual and published in *Science*, focused on a molecule of hydrogen (H₂). The researchers placed the molecule within a very small space between a flat surface and the sharp point of an ultra-sensitive atomic force microscope.

This microscope used the periodic movement

of the point located at the end of a highly sensitive mechanical oscillator in order to 'feel' the forces that exist at a nanoscale level. The molecule of hydrogen [moves](#) randomly and chaotically and, when the point of the microscope approaches it, the point hits the molecule, making the oscillator or lever move. But this lever, at the same time, modulates the movement of the molecule, resulting in an orchestrated 'dance' between the point and the 'noisy' molecule. "The result is that the smallest molecule that exists, a molecule of hydrogen, 'pushes' the lever, that has a mass 10^{19} greater; ten trillion times greater!" explained José Ignacio Pascual.

The underlying principle is a mathematical theory known as Stochastic Resonance which describes how random movements of energy are channelled into periodic movements and, thus, can be harnessed. With this research, it has been shown that this principle is fulfilled at a nanometric scale.

"In our experiment, the 'noise' of the molecule is made by injecting electric current, and not temperature, through the molecule and, thus, functions like an engine converting electric energy into mechanical," stated José Ignacio Pascual. Thus, one of the most promising aspects of this result is that it can be applied to the design of artificial molecules, which are complex molecules designed to be able to oscillate or rotate in only one direction. The authors do not discard, moreover, that this molecular fluctuation can be produced by other sources, such as light, or be carried out with a greater [number](#) of molecules, even with different chemical compositions.

*current leader of the Nanoimagen team at CIC nanoGUNE.

Therapeutic Antioxidant Electric Clothing Approved for Listing in NineSights

Valone, Thomas, Integrity Research Institute Press Release, December 22, 2012
www.bioenergydevice.org

Therapeutic Antioxidant Electric Clothing approved and posted Nov 30, 2012 at [NineSights](http://www.ninesights.com), a Nine Sigma Community <http://www.ninesights.com/docs/DOC-2621>

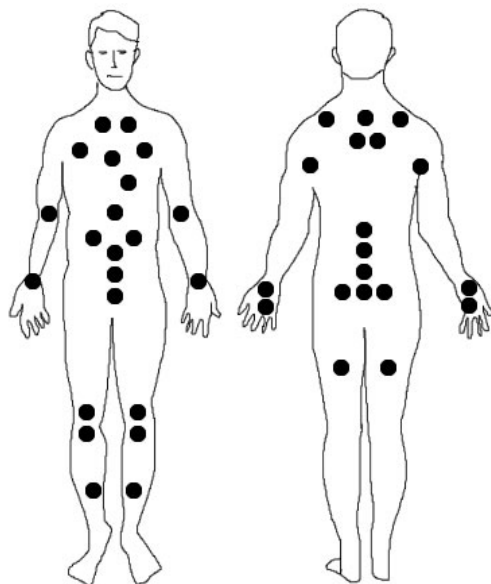


Figure from the patent application showing the major acupuncture points that are available for electric antioxidant wiring of trickle microcurrent as disclosed by Dr. Jacqueline Panting in patent application #13/135.140

All Places > Technology Offers > Documents

Therapeutic Antioxidant Electric Clothing

 Version 1

created by [Thomas Valone](#) on Nov 30, 2012 7:46 PM, last modified by [Thomas Valone](#) on Nov 30, 2012 8:04 PM

This unique invention relates to the field of electrotherapy, bioelectricity, bioelectromagnetics, sports performance enhancement, medical electricity and electromedicine. Particularly, the invention involves the novel implementation of self-powered electric therapeutic clothing with the novel addition of imbedded wiring in order to provide antioxidant microcurrent electricity delivered to the human skin at strategic acupuncture points using an integrated constant voltage, constant current, variable voltage or variable current circuit. The present invention further comprises transcutaneous and percutaneous applications for electron delivery in microdoses for health. It also is patent pending and invented by a senior staff naturopathic doctor, Jacqueline Panting, N.D., of Integrity Research Institute. Licenses are available from assignee.

 [Therapeutic antiox electric clothing nonprovisional - Panting.pdf](#)
766.9 K

More antioxidant protection
during strenuous exercise



Thorium Reactors Being Tested in Norway

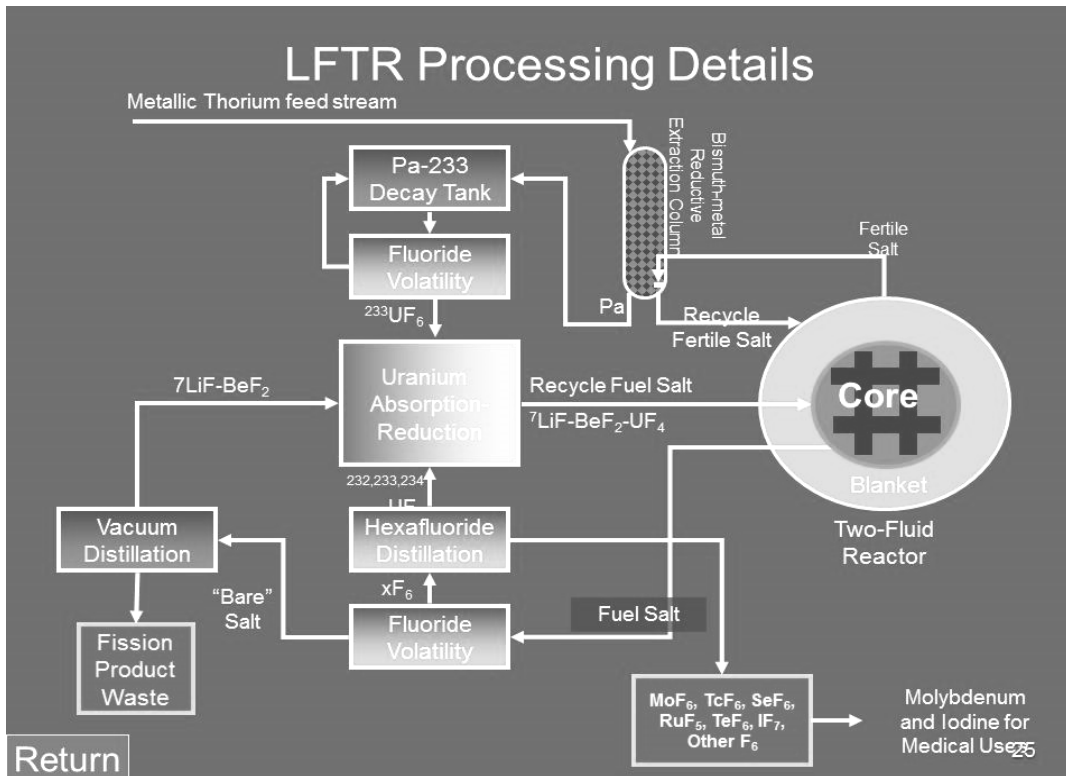
Peter Murray, Singularity Hub, Singularity University, 12/11/12

<http://singularityhub.com/2012/12/11/norway-begins-four-year-test-of-thorium-nuclear-reactor/>

Editor's Note - - Environmental Liquid Fluoride Thorium Reactor (LFTR) Advantages

1. The LFTR produces energy cheaper than from coal.
2. The LFTR produces about 3% of the waste of a light water reactor of the same power and much of this "waste" can be extracted and sold within 10 years. Moreover, this waste need only be sequestered from the environment for 300 years, a far less daunting task than the 300,000 years required for today's LWR (regular nuclear reactor) waste.
3. The LFTR uses an inexhaustible supply of inexpensive thorium fuel.

Visit the Library pdf page of the Energy From Thorium Foundation for tons of free pdf papers. - TV



A Norwegian company is breaking with convention and switching to an alternative energy it hopes will be safer, cleaner and more efficient. But this isn't about ditching fossil fuels, but rather about making the switch from uranium to thorium. Oslo based Thor Energy is pairing up with the Norwegian government and US-based (but Japanese/Toshiba owned) Westinghouse to begin a four year test that they hope will dispel doubts and make thorium the rule rather than the exception. The thorium will run at a government reactor in Halden.

Thorium was discovered in 1828 by the Swedish chemist Jons Jakob Berzelius who named it after the Norse god of thunder, Thor. Found in trace amounts in rocks and soil, thorium is actually about three times more abundant than uranium.

The attractiveness of thorium has led others in the past to build their own thorium reactors. A reactor operated in Germany between 1983 and 1989, and three operated in the US between the late sixties and early eighties. These plants were abandoned, some think, because the plutonium produced at uranium reactors was deemed indispensable to many in a Cold War world.

Thorium is 'fertile,' unlike 'fissile' uranium, which means it can't be used as is but must first be converted to uranium-233. A good deal of research has been conducted to determine if fuel production, processing and waste management for thorium is safe and cost effective. For decades many have argued that thorium is superior to the uranium in nearly all of the world's nuclear reactors, providing 14 percent of the world's electricity. Proponents argue that thorium reacts more efficiently than uranium does, that the waste thorium produces is shorter lived than waste from uranium, and that, because of its much higher melting point, is meltdown proof. An added plus is the fact that thorium reactors do not produce plutonium and thus reduce the risk of nuclear weapons proliferation.

Some experts maintain that the benefits of thorium would be maximized in molten salt reactors or pebble bed reactors. The reactor at Halden is not ideal for thorium as it is a 'heavy water' reactor, built for running uranium. But it is also a reactor that has already received regulatory approval. Many thorium supporters argue that, rather than wait for ideal molten salt or pebble bed reactors

tests should be performed in approved reactors so that their benefits can be more quickly demonstrated to the world.

But is thorium really cheaper, cleaner and more efficient than uranium? And if so, do the added benefits really warrant the cost and effort to make the switch? Data is still pretty scarce, but at least one report is urging us to not believe the hype.

Through their National Nuclear Laboratory the UK's Department of Energy & Climate Change released a report in September that stated: "thorium has theoretical advantages regarding sustainability, reducing radiotoxicity and reducing proliferation risk. While there is some justification for these benefits, they are often overstated." The report goes on to acknowledge that worldwide interest in thorium is likely to remain high and they recommend that the UK maintain a "low level" of research and development into thorium fuel.

The place where thorium is proven either way could be China. The country is serious about weaning itself off of fossil fuels and making nuclear power their primary energy source. Fourteen nuclear power reactors are in operation in China today, another 25 under construction, and there are plans to build more. And in 2011 they announced plans to build a thorium, molten salt reactor. So whether it be Norway, the UK, China, or some other forward-thinking countries, we'll soon find out if thorium reactors are better than uranium ones, at which point more countries may want to join the thorium chain reaction.

Breakthrough Energy Technologies Presented at SPESIF (COFE) 2012

**Integrity Research
Institute, Press Release,
March 26, 2012,**
www.futureenergy.org

The recent **Space, Propulsion & Energy Sciences International Forum (SPESIF)** and Conference on Future Energy (COFE5) held at the University of Maryland's Riggs Alumni Center on February 29 - March 2, 2012 had two amazing breakthrough technologies presented.

The opening night featured two presentations on low energy nuclear reactions (LENR), including Dr. David Nagel from George Washington University

on the science and business of LENR. The follow-up presentation remotely by Sterling Allan from New Energy Congress was proof that a breakthrough has occurred in this hotly contested field. Referring to his recent trip to Greece, Sterling reported on the **Defkalion** company's progress in producing a sustained heat output in the kilowatt range with a proprietary catalyst. The webcasted presentations are also online at www.futureenergy.org in an Adobe Connect format which launches automatically. There was some trouble with the March 1st presentations since a Mac was used for

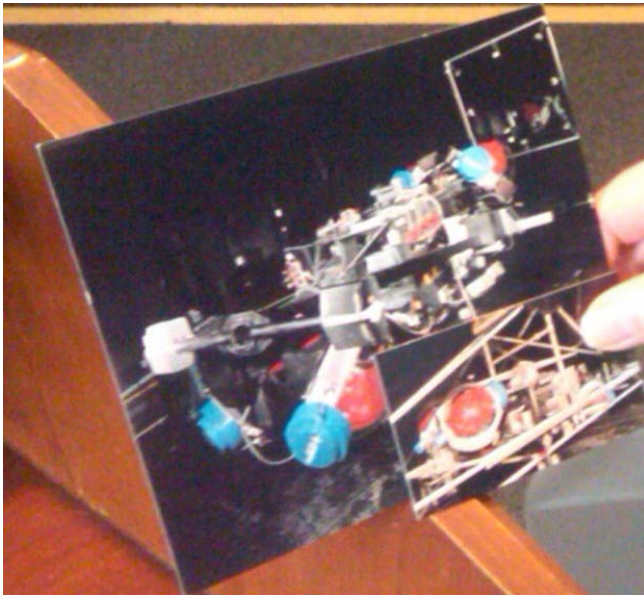
Pumping Gas Through Casimir Cavities

United States Patent Haisch et al.	Patent No.: US 7,379,286 B2 Date of Patent: May 27, 2008
QUANTUM VACUUM ENERGY EXTRACTION	
Inventors: Bernard Haisch, Redwood City, CA (US); Garret Moddel, Boulder, CO	

13

the first few of them but most of them over the three days include the PowerPoint slideshow and concurrent audio and video. The best presentations of a true breakthrough the next day consisted of Dr. Garret Moddel from the University of Colorado and also Mike Gamble from Boeing. Garret discussed his experimental investigation into the **zero-point energy emission** from noble gases flowing through Casimir cavities, which is a test of his patent #7,379,286, coinvented with Dr. Bernard Haisch from Calphysics Institute. To their surprise, Helium had a more robust output of radiation in the microwatt range than the heavier Xenon, measured with a pyrometer. Their unusual theory of constricting a gas atom quantum mechanically and then looking for a release of energy actually worked, showing that zero-point energy can be utilized to produce energy!

Of course the reabsorption of the lost energy from the quantum vacuum completes the engine cycle according to the patent disclosure, which also resembles the Josef Papp engine (patent #4,428,193) in many ways. Our institute expects a resurgence in the orders for the next edition of our book, [Zero Point Energy: the Fuel of the Future](#), as a result of Dr. Moddel's experimental confirmation of a zero-point energy emission from a Casimir cavity.



Boeing's Inertial Propulsion device used for years on their Satellites.

Mike Gamble's presentation was more tangible with an analysis of the Dean Drive style of inertial (mechanical) propulsion converted to electromagnetic equivalence. However, the breakthrough announcement came at the end as to the reason for his investigation: Boeing has been using a "scissoring gyroscope" style of inertial propulsion for satellite maneuvering for years! This confirmation of a controversial method of force production is a first for any major corporation. (IRI recommends our "[Inertial Propulsion Patent Collection](#)" and other related reports for those unacquainted with this simple but effective way to produce a unidirectional force.) Mike also mentioned that it was so old by now that Boeing didn't mind if he mentioned it to the public. He even let me

photograph his pictures of the company's test model, which is quite large. It is now clear from Gamble's presentation that the physics and mechanical engineering textbooks need to be rewritten to include this amazing breakthrough, which has quietly ushered in an alternate method for force production, even in space, that can be solar-powered and electrically driven.

Several of the presentations included local talent as well: University of Maryland researchers Prof. Cui, Chiang, and Prof. Pomerantseva, a National Science Foundation senior scientist. Dr. Paul Verbos, a former FDA research scientist, Judy Kosovich, a US DOE senior scientist Dave Goodwin, who was also the recipient of the "2012 Integrity In Research Award" for his unique contributions to emerging energy science. The keynote address was by Dr. George Miley who has just completed his amazing autobiography which will be published by IRI in the fall. Outstanding presentations were also done by Osamu Ide, Don Reed, Charles Lundquist, Anthony Fresco, James Putnam, Clive Woods, Philip Bouchard, Hamilton Carter, and Robert DeBiase. All these presentations were recorded and webcasted and are available at futureenergy.org free of charge to all. We want to again thank our sponsors for generously supporting our conference: Arcos Cielos Research Center, Global Gateway Foundation, Ivan Kruglak and Marc Plotkin.

Energy on the go

A new lithium cell could soon be powering everything from phones to electric cars, says **MacGregor Campbell**

In association with



"It's such a big potential game-changer, we'd be crazy not to do the work and find out"

Better batteries mean greater range and boosted fortunes for electric cars

a more practical target is between 500 and 1700 Wh/kg, says Wilcke. To unlock even this potential, a number of chemical and engineering problems must be solved, says Jeff Chamberlain of the Electrochemical Energy Storage department at Argonne National Laboratory in DuPage County, Illinois.

One problem is that over many discharge-recharge cycles, the lithium electrode becomes covered with spikes of electroplated lithium. These can detach, playing no further part in reactions, or travel across the electrolyte and short the battery.

Lithium is also highly reactive. It must be isolated from water, for example, and readily degrades electrolytes and electrodes to form by-products that clog up the porous carbon and wreck the cell.

Progress is being made. 2012 has seen improved charge-discharge cycles in lithium-air cells by two groups, one a collaboration between Hanyang University in Seoul, South Korea, and the Sapienza University of Rome, Italy (*Nature Chemistry*, doi.org/jv3), and the other a team at the University of St Andrews, UK (*Science*, doi.org/jv4).

At St Andrews, Peter Bruce and his colleagues replaced the carbon electrode with porous gold and changed the electrolyte to create a cell that, they showed, repeatedly created and destroyed lithium peroxide. "We have created a cell that works. It's not commercial because the weight and cost are too high," he says. "We must look for alternatives that are lighter and cheaper."

Chamberlain reckons that rechargeable lithium-air batteries are probably 10 to 20 years from the market. Bruce won't put a date on success but says: "It is such a big potential game-changer, we'd be crazy not to do the work and find out." ■

Electric cars are fine for that quick trip to the shops, but longer journeys can leave drivers worrying if they have enough charge to get home. Batteries that "breathe" air could be the solution, if some fundamental challenges can be solved.

One big issue for portable energy is weight. For cars, petrol is hard to beat: it boasts about 12,000 watt-hours per kilogram, though much is wasted as heat. Typical batteries, on the other hand, hardly compare. Lithium-ion batteries manage about 160 Wh/kg, while other formats, such as lithium-sulphur, can reach twice that. Such low energy densities mean electric vehicles must pack on more weight in order to store - or generate - the energy needed for long hauls.

For now, lithium-ion batteries are the workhorses of everything from smartphones to electric cars. But another lithium technology promises still greater performance. It has a negative electrode made of lithium metal and a positive electrode of oxygen contained in porous carbon. This arrangement would make the

battery lighter than its rivals and provide much higher energy density.

Lithium-air is, at present, a long shot, but many labs and companies are working to harness it. "In a car you need decent power density - we think Li-air has the potential," says Winfried Wilcke, head of IBM's Battery 500 project, which aims to create a battery that can power a car for 500 miles (800 kilometres) on a single charge.

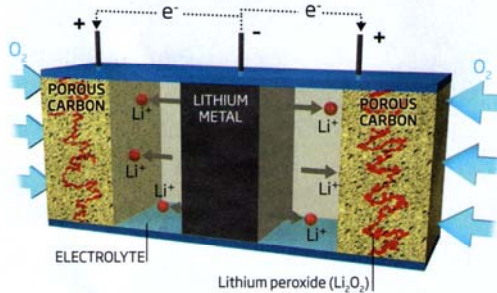
In a Li-air cell, lithium from the negative electrode travels as ions through an electrolyte (see diagram).

At the positive electrode, these combine with oxygen from air and electrons that have passed around an external circuit to form lithium peroxide (Li₂O₂). Recharging reverses the process: oxygen returns to the air, and lithium is "electroplated" back onto the anode.

This format could theoretically deliver up to 12,000 Wh/kg, though

Lithium-air battery

When it's in use, the lithium-air battery creates lithium peroxide (red) on the cathode. Recharging breaks it down again. It sounds simple but making it work over many charging cycles is proving difficult



This article was sponsored by Statoil. All content was commissioned and edited independently by New Scientist

Energy Harvesting Now

Electronic Products 2012 Ad promoting “free power” and “free energy sources” (wow!)

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LTC3588	Piezoelectric energy harvesting power supply	🌀 🔥
LT®3652/HV	Power tracking 2A solar battery charger	☀️ 🔥
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Energy Recovery

American Chemistry Council, "from Chemistry to Energy", 2012

ENERGY RECOVERY

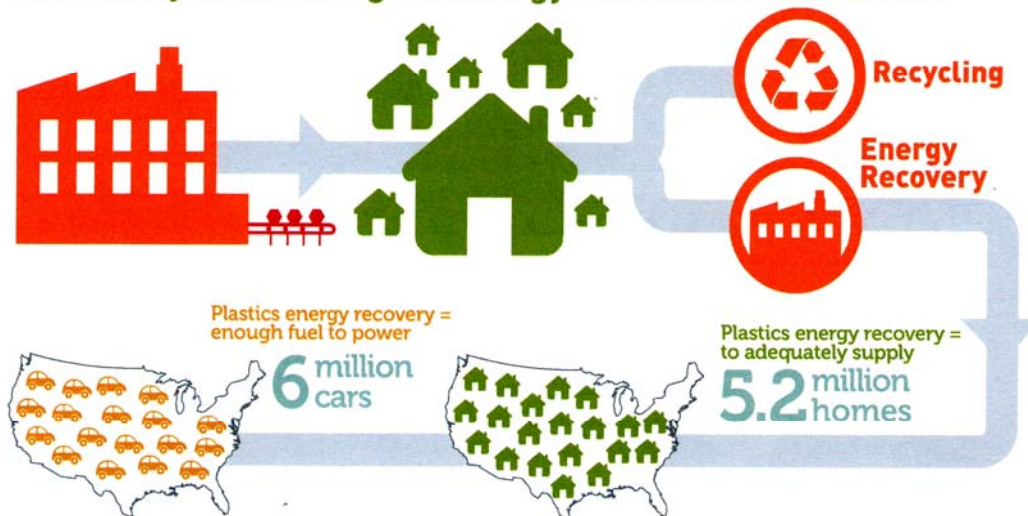


Chemistry is creating energy solutions for a strong, secure and sustainable future.

Chemistry is transforming waste into a valuable energy resource through advanced energy recovery technologies. Recovering this abundant energy complements recycling and reduces waste that would otherwise be sent to landfills.

Although traditional recycling rates in the U.S. are growing and must continue to do so, tons of high energy-content products, like non-recycled plastics and other materials, are buried in landfills every day – wasting a valuable energy source. Modern energy recovery facilities can process waste with fewer emissions than conventional fuels processed in most power plants, while innovative plastics-to-oil technologies convert plastics into alternative fuels.

Chemistry is unlocking the energy in discarded materials:



POLICY PRIORITIES

- ✓ Our nation's energy policy must harness all domestic energy sources, including recovering energy from waste
- ✓ Definitions of renewable energy should be broadened to include non-recycled and other recurring wastes
- ✓ Regulations and permitting processes should not discourage the establishment of new energy recovery capacity



ENERGY RECOVERY IS GOOD FOR COMMUNITIES

- Energy recovery can reduce landfilled waste by 90%
- Communities with energy recovery typically deliver higher recycling rates than those without
- Energy recovery prevents 40 million metric tons of greenhouse gases in the form of carbon dioxide equivalents to be released in the environment

chemistrytoenergy.com/energy-recovery

Wind Turbine Provides Water in Desert

Science Illustrated, Spring, 2012

SCIENCE UPDATE

■ Around 24,000 years ago, large holes appeared in the ozone layer as bromine was released into the atmosphere via a volcanic eruption. It could happen again.

INCREDIBLE
— but true!

Wind turbine provides water in desert

New turbine generates power and water

TECHNOLOGY French engineering company Eole Water has developed a new type of wind turbine that can produce pure drinking water seemingly out of thin air. The wings power a generator that produces power, a fraction of which is used to suck air in through the nose of the turbine and condense the humidity in the air back into water. This water is then collected and flows through a stainless-steel pipe into a storage tank located at the bottom of the wind turbine. There, it is filtered and purified, producing fresh drinking water.

Eole has erected a 79-foot-tall turbine in the desert near Abu Dhabi in the United Arab Emirates. This prototype can produce more than 16 gallons of water an hour, but, ultimately, the company expects the new turbine type to deliver up to 265 gallons of

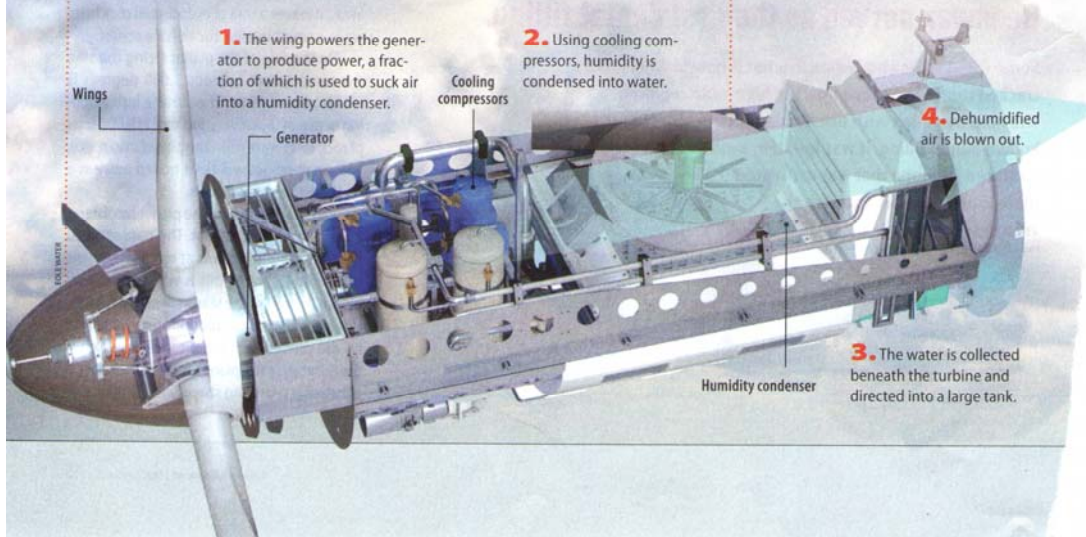


A new type of wind turbine can produce both power and water for people living in remote regions, such as deserts.

water a day, depending on humidity, temperature and wind speed. The wind turbine is expected to help supply small communities that have limited resources of both power and water.

Drinking water is extracted from the air

The new wind turbine generates power in the traditional way, but it can also produce drinking water condensed from the air.



Round beer glasses make us drink more

We consume more alcohol when drinking out of a glass with rounded sides, compared to one with straight sides, says scientist Angela Attwood from the University of Bristol. It took test subjects almost twice as long to empty a glass with straight sides.

Robot outpaces Usain Bolt

Inspired by the cheetah, U.S. scientists have developed the world's fastest robot — it's speedier than even Usain Bolt. When Bolt set his 100-meter world record, he ran at a top speed of 28 mph. The robot bests him at 28.3 mph.

Fathers become less virile

Fathers who sleep close to their children produce less testosterone, say U.S. scientists. Their conclusion was based on data collected by studying 362 fathers in the Philippines.

Solar and Thermal Energy Harvesting Textile Composites for Aerospace Applications

Defense Tech Briefs, December, 2012, p. 23

Technology Focus: Materials & Coatings

Solar and Thermal Energy Harvesting Textile Composites for Aerospace Applications

Energy harvesting devices in the form of fibers could be woven into lightweight, strong textiles for integration with structural composites.

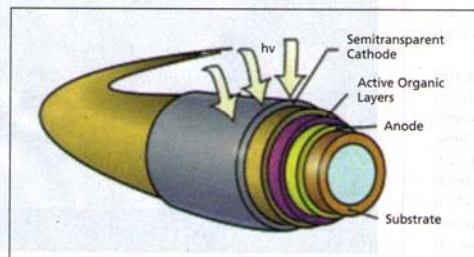
Air Force Office of Scientific Research, Arlington, Virginia

The proposed research focuses on developing novel energy harvesting devices that can be integrated with load-bearing structures in an air vehicle (e.g. a UAV). Several ambient energy sources are available on a UAV: light, heat, and vibration. The amount of energy available from light and heat exceeds that in vibration, so this work focuses on the first two modes of harvesting.

The approach is to create energy harvesting devices in the form of long fibers that eventually could be woven into lightweight, high-strength, multifunctional textiles for seamless integration with aerospace structural composites. The fiber form factor is a powerful paradigm for these energy conversion devices, since it can lead to improved light trapping in the organic photovoltaic (PV) cells, and allow for a high density of thermocouple junctions without the use of costly patterning techniques, significantly enhancing the cost-benefit performance.

The initial focus was on modeling and experimentally demonstrating prototype devices consisting of single fibers capable of the thermoelectric (TE) and PV modes of energy conversion. The results obtained were highly encouraging, and have opened up several exciting new research directions. In a solar cell geometry, the active organic layers and metallic electrodes are formed concentrically around a fiber core, and light is coupled in through the outer electrode. This structure is quite different from the conventional planar PV cells, and requires special considerations in its design and for predicting its optoelectronic performance.

Fresh advances in modeling OPV devices on fibers include the application of multilayer dielectric coatings to fiber



In the **Photovoltaic Fiber Structure**, very thin active organic layers and metallic electrodes are deposited concentrically around a fiber core, and light is coupled in through the outer electrode.

bundles. This architecture maximizes light in-coupling in individual fibers, and takes advantage of photon recycling in multi-fiber arrays. The modeling combines ray-tracing and transfer-matrix simulations at multiple length scales. Each component of the model has been independently validated by experiments.

Improved power conversion efficiency of planar OPV cells was demonstrated using a metal-organic-metal layer structure. Importantly, these devices now match the efficiency of conventional ITO-based cells, which were improved. The ITO-free device exhibits a slightly lower short circuit current density (JSC), but compensates with a higher open circuit voltage (VOC). Further analysis of how JSC varies with anode thickness reveals that the device performs unexpectedly better than the far-field transmittance of the anode would suggest. The enhanced performance is due to the microcavity effects dominating the thin-film OPV cell, in which the far-field optical transmission of the electrode is less important than its ability to place the antinode of the optical field close to the donor-acceptor junction in the organic layers. Detailed optical modeling enables mapping of the performance of a wide range of electrode mate-

rials, and predicts that silver is not far from the conventionally employed ITO with respect to the JSC values it can allow.

Conversion of heat to electricity (thermoelectric generation) can be accomplished by connecting two dissimilar materials (metals or semiconductors) in a series of junctions, and sandwiching the junctions between a hot source and a cold sink. The voltage produced by the junction is proportional to the temperature gradient between the hot and cold sides.

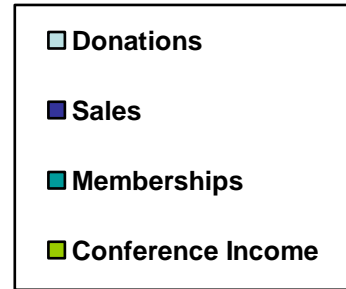
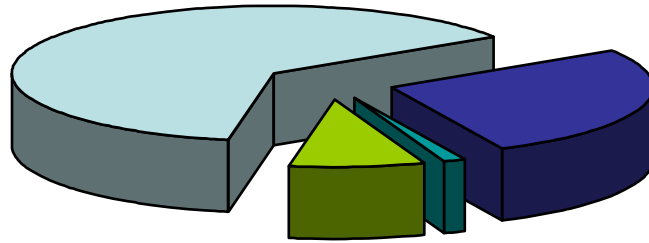
The conventional series-connected junction geometry can be reproduced in the form of thin-film segments deposited along fibers. Weaving these fibers can position the junctions as required for power generation. The TE generator is optimized by maximizing the temperature gradient, minimizing the thermal conductivity, and maximizing the Seebeck coefficient and electrical conductivity.

Woven thermoelectric generators have been demonstrated utilizing several TE fibers at once. Several fiber diameters have been explored, varying also the TE segment length and weave density, and spanning square inches. For smaller fibers, increased weave density, and greater temperature gradients, the power density increases dramatically. The thinness and flexibility of these mats suggests that multilayer TE fabrics can be used to efficiently span temperature gradients using individual layers tuned to work at their maximum ZT point.

This work was done by Max Shtein and Kevin Pipe of the University of Michigan, and Peter Peumans of Stanford University for the Air Force Office of Scientific Research. For more information, download the Technical Support Package (free white paper) at www.defensetechbriefs.com/tsp under the Materials & Coatings category. AFOSR-0004

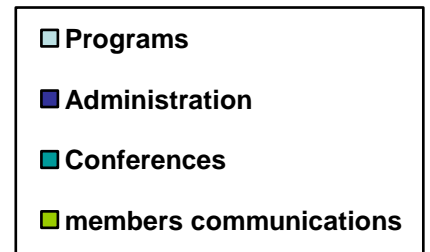
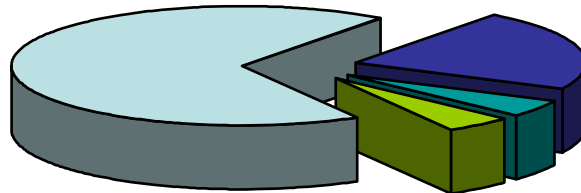
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