c&en

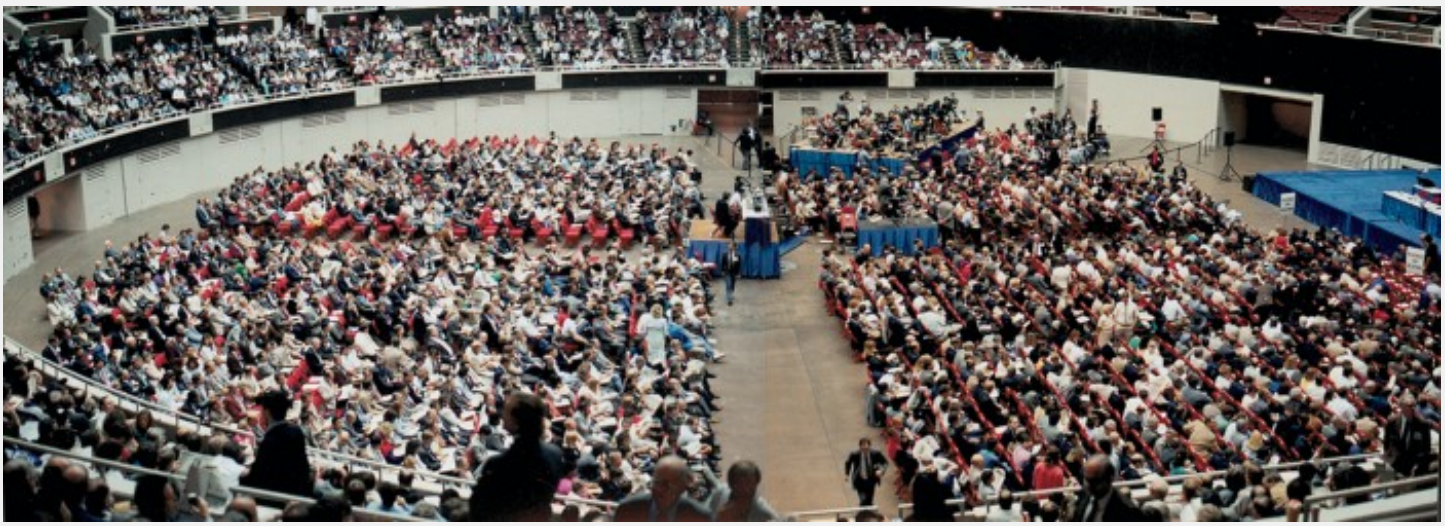
Volume 94 Issue 44 | pp. 34-39
Issue Date: November 7, 2016

COVER STORY

Cold fusion died 25 years ago, but the research lives on

Scientists continue to study unusual heat-generating effects, some hoping for vindication, others for and an eventual payday

By **Stephen K. Ritter**



Some 7,000 people attended a hastily organized cold fusion session at the ACS national meeting in Dallas in 1989, hopeful that word of the newly announced phenomenon was true.

Credit: James Krieger/C&EN

Howard J. Wilk is a long-term unemployed synthetic organic chemist living in Philadelphia. Like many pharmaceutical researchers, he has suffered through the drug industry's R&D downsizing in recent years and now is underemployed in a nonscience job. With extra time on his hands, Wilk has been tracking the progress of a New Jersey-based company called **Brilliant Light Power <http://brilliantlightpower.com>** (BLP).

In brief

In 1989, the scientific world was turned upside down when two researchers announced they had tamed the power of nuclear fusion in a simple electrolysis cell. The excitement quickly died when the scientific community came to a consensus that the findings weren't real—"cold fusion" became a synonym for junk science. In the quarter-century since, a surprising number of researchers continue to report unexplainable excess heat effects in similar experiments, and several companies have announced plans to commercialize technologies, hoping to revolutionize the energy industry. Yet, no one has delivered on their promises. In the pages that follow, C&EN explores several possible conclusions: The claims are correct, but need

more time to develop; those making the claims are committing an elaborate ruse; or it really is junk science that won't go away.

The company is one of several that are developing processes that collectively fall into the category of new energy technologies. This movement is largely a reincarnation of cold fusion, the short-lived, quickly dismissed phenomenon from the late 1980s of achieving nuclear fusion in a simple benchtop electrolysis device.

In 1991, BLP's founder, Randell L. Mills, announced at a press conference in Lancaster, Pa., that he had devised a theory in which the electron in hydrogen could transition from its normal ground energy state to previously unknown lower and more stable states, liberating copious amount of energy in the process. Mills named this curious new type of shrunken hydrogen the hydrino, and he has been at work ever since to develop a commercial device to harness its power and make it available to the world.

Wilk has studied Mills's theory, read Mills's papers and patents, and carried out his own calculations on the hydrino. Wilk has gone so far as to attend a demonstration at BLP's facility in Cranbury, N.J., where he discussed the hydrino with Mills. After all that, Wilk says he still can't tell if Mills is a titanic genius, is self-delusional, or is something in between.

This story line is a common refrain for the researchers and companies involved. It all got started in 1989, when electrochemists Martin Fleischmann and Stanley Pons **made the stunning announcement <http://pubs.acs.org/doi/pdf/10.1021/cen-v067n014.p004>** at a press conference at the University of Utah that they had tamed the power of nuclear fusion in an electrolysis cell.

When the researchers applied a current to the cell, they thought deuterium atoms from heavy water that had penetrated into the palladium cathode were fusing to form helium atoms. The excess energy from the process dissipated as heat. Fleischmann and Pons said this process could not be caused by any known chemical reaction, and the nuclear reaction term "cold fusion" was attached to it.

From hopes raised to hopes dashed: the story of cold fusion's rise and fall, told in headlines ripped from the pages of C&EN.

Click to expand the full list. ▼

Want more? A list of recent books on cold fusion and related phenomenon.

Click to expand the full list. ▼

By Steven B. Krivit:

“Hacking the Atom: Explorations in Nuclear Research, Vol. 1, (1990–2015)” <http://stevenbkrivit.com/>

“Fusion Fiasco: Explorations in Nuclear Research, Vol. 2, (1989–1990)” [coming soon] <http://stevenbkrivit.com/>

“Lost History: Explorations in Nuclear Research, Vol. 3, (1912–1927)” [coming soon] <http://stevenbkrivit.com/>

By Brett Holverstott:

“Randell Mills and The Search For Hydrino Energy” <http://www.brettholverstott.com/>

By Mats Lewan:

“An Impossible Invention: The True Story of the Energy Source that Could Change the World” <https://animpossibleinvention.com/>

Click to collapse. ▲

After months of investigating Fleischmann and Pons’s puzzling observations, however, the **scientific community came to a consensus <http://pubs.acs.org/isubscribe/journals/cen/81/i34/html/8134sci3.html>** that the effect was inconsistent or nonexistent and that the scientists had made experimental errors. The research was summarily condemned, and cold fusion became a synonym for junk science.

Cold fusion and making hydrinos both hold the holy-grail promise of generating endless amounts of cheap, pollution-free energy. Scientists were frustrated by cold fusion. They wanted to believe it, but their collective wisdom told them it was all wrong. Part of the problem was they had no generally accepted theory to guide them and explain the proposed phenomenon—as physicists like to say, no experiment should be believed until it has been confirmed by theory.

Mills has his own theory, but many scientists don't believe it and think the hydrino improbable. The research community has stopped short of the public dismissal it gave cold fusion and has tended to just ignore Mills and his work. Mills has reciprocated by trying to stay out from under the shadow of cold fusion.

In a photo from 2012, Michael McKubre, one of the original cold fusion researchers, inspects a component of SRI International's Micromass 5400 mass spectrometer, an instrument dedicated to measuring ^{3}He and ^{4}He produced in palladium-deuterium and palladium-hydrogen LENR.

Credit: SRI International

In the meantime, the field of cold fusion was rebranded as low-energy nuclear reactions, or LENR, and survives. Some scientists continue to try to explain the Fleischmann-Pons effect. Still others have dismissed the notion of fusion but are investigating other possible processes that can explain the anomalous excess heat effects. Like Mills, they've been lured in by the potential commercial opportunities. Their primary interest is in generating energy for industrial, household, and transportation needs.

The handful of companies that have emerged in the attempt to get these new energy technologies to market have a business model the same as any technology start-up: Identify a new technology, attempt to patent the idea, raise investor interest and secure funding, build prototypes and have demonstration events, and announce timelines for when working devices might be available for sale. In this new energy world, however, expired promises are the norm: None have made it to the last step of delivering a working device as advertised.

A new theory

Mills grew up on a Pennsylvania farm, earned an undergraduate degree in chemistry from Franklin & Marshall College and a Harvard University medical degree, and studied electrical engineering at Massachusetts Institute of Technology. While a student, he began developing what he calls "**The Grand Unified Theory of Classical Physics <http://brilliantlightpower.com/atomic-theory>** ," which he says provides a new model of atoms and molecules that shifts away from quantum theory and is based on classical physics.

It's commonly accepted that hydrogen's solo electron is whizzing around its nucleus in its most energetically favorable, ground-state atomic orbital—you simply can't bring hydrogen's electron closer to its nucleus. But Mills says you can.

"If hydrinos existed, they would have been detected by others in laboratories or in nature years ago."
—**Howard J. Wilk,** synthetic organic chemist

Erik Baard, a journalist who has **written stories about Mills <http://www.villagevoice.com/news/quantum-leap-6420156>** , once noted how shocking it is to say the model of hydrogen is up for debate: “Telling physicists that they’ve got that wrong is like telling mothers across America that they’ve misunderstood apple pie.”

One of those physicists is Andreas Rathke, a former research fellow at the European Space Agency, who is described on the agency’s website as having “debunked a high number of crackpots.” In 2005, Rathke analyzed Mills’s theory and published a paper in which he concluded it was flawed and incompatible with everything physicists knew (New J. Phys. 2005, DOI: **10.1088/1367-2630/7/1/127 <http://dx.doi.org/10.1088/1367-2630/7/1/127>**).

Currently a researcher at Airbus Defence & Space, Rathke says he hasn’t followed the Mills story since about 2007 because there was no unambiguous sign of excess energy in reported experiments. “And I doubt there have been any experiments published at a later time that pass scientific scrutiny,” Rathke tells C&EN.

“I think there is general agreement that the theory Dr. Mills has put forward as the basis for his claims is inconsistent and not capable of making experimental predictions,” Rathke continues. “Now, one could ask the question, ‘Could he have been lucky and stumbled upon some energy source that experimentally just works by following a wrong theoretical approach?’ ”

In the 1990s, a few researchers, including **a team from the National Aeronautics & Space Administration’s Lewis Research Center <http://www.grc.nasa.gov/WWW/sensors/PhySen/docs/TM-107167.pdf>** , did report independently replicating the Mills approach and generating excess heat. The NASA team wrote in a report that the results “fall far short of being compelling” and did not mention anything about hydrinos.

The researchers offered possible electrochemical processes that might explain the heat, including irregularities in the electrochemical cell, possible unknown exothermic chemical reactions, or the recombination of split-apart hydrogen and oxygen atoms of water. These are the same arguments made by scientific critics of the Fleischmann-Pons experiments.

However, the NASA team did say that researchers should leave the door open, just in case Mills really was on to something.

Mills is a mile-a-minute talker who can go on forever spilling out technical details. Besides predicting the hydrino, Mills says his theory can perfectly predict the location of every electron in a molecule using his bespoke Millsian molecular modeling software, even in molecules as complex as DNA. With standard quantum theory, scientists struggle to predict the exact behavior of anything much more complex than a hydrogen atom. Mills further says his theory also explains why the universe is expanding at an accelerating rate, something cosmologists have yet to fully wrap their arms around.

Mills also says hydrinos are created from burning hydrogen in stars such as our sun and are evident in the spectral lines of starlight. Hydrogen is recognized as the most abundant element in our universe, but Mills goes further to claim that hydrinos are the missing dark matter in the universe. Those proposals come as a bit of a surprise to astrophysicists: “I have never heard of a hydrino,” says the University of Chicago’s **Edward W. (Rocky) Kolb <http://astro.uchicago.edu/~rocky>** , an expert on the **dark universe <http://www.nature.com/nature/outlook/dark-universe/index.html>** .

Mills has reported isolating hydrinos and characterizing them using standard spectroscopic methods such as infrared, Raman, and nuclear magnetic resonance. In addition, he says hydrinos can react in the way hydrogen might to form new types of compounds “with amazing properties.” These include conductive materials that Mills says would revolutionize electronic devices and batteries.

Even though popular opinion is against him, Mills’s ideas seem less far-fetched when compared with other unusual components of the universe. For example, a muonium is a known, short-lived exotic entity made of an antimuon particle (a positive, electronlike particle) and an electron. Chemically, muonium behaves like a hydrogen isotope, but it’s nine times as light as hydrogen.

The hydrino SunCell

No matter where hydrinos fit in on the scale of believability, Mills told C&EN a decade ago that BLP had moved past the scientific verification stage and was interested only in

discussing commercial applications. Over the years, BLP has collected more than $110 million from investors to see what it can do.

> "There are results that you just can't explain away. Whether it's cold fusion, low-energy nuclear reactions, or something else—the names are all over the place—we still don't know."
> —**David J. Nagel,** professor, George Washington University; former research manager at the Naval Research Laboratory

BLP's approach to creating hydrinos has taken on different manifestations over time. In an early prototype, Mills and his R&D team used tungsten or nickel electrodes with a lithium or potassium electrolyte solution. An applied electric current splits the water into hydrogen and oxygen, and under the right conditions, lithium or potassium then acts as a catalyst to absorb energy and collapse hydrogen's electron orbit. The energy released in going from the ground atomic state to a lower energy state comes off as a brilliant emission of light in a high-temperature plasma. The associated heat is then captured to create steam to power an electric generator.

BLP is currently testing a device called the **SunCell <http://brilliantlightpower.com/suncell>** in which hydrogen (from splitting water) and an oxide catalyst are introduced into a spherical carbon reactor along with dual streams of molten silver. An electric current applied to the silver ignites a hydrino-forming plasma reaction. Energy from the reaction is then trapped by the carbon, which acts as a "blackbody radiator." When the carbon heats up to thousands of degrees, it reemits the energy as visible light that is captured by photovoltaic cells, which convert the light to electricity.

When it comes to commercial development, Mills at times comes off looking paranoid and at other times like a shrewd businessman. Mills has trademarked "Hydrino." And because his issued patents claim the hydrino as an invention, BLP asserts that it owns all intellectual property rights involving hydrino research. BLP therefore forbids outside experimentalists from doing even the most basic hydrino research, which could confirm or deny hydrinos, without first signing an IP agreement. "We welcome research partners; we want to get others involved," Mills says. "But we do need to protect our technology."

Mills instead has commissioned validators who say they can corroborate that BLP's

The latest of BLP's prototypes, called the SunCell, which debuted on Oct. 26, produces hydrinos from hydrogen in the spherical carbon reactor (at top) and traps the energy using photovoltaic cells (not shown) that surround the sphere to produce electricity; the reactor and photovoltaic array will be covered by a housing. According to Mills, "the power can be extraordinary, bursts of millions of watts in a volume of a coffee cup."

Credit: BLP

inventions work. One of the validators is Bucknell University electrical engineering professor **Peter M. Jansson**

> "Why would anyone have continued research or scientific interest after 27 years on any topic that was reported to be a mistake?"
> —**Melvin H. Miles,** electrochemist

<http://www.bucknell.edu/engineering-college-of/academic-departments/electrical-and-computer-engineering/faculty-and-staff/peter-mark-jansson.html> , who is paid for his evaluations of BLP technology through his consulting company, Integrated Systems. Jansson says that being compensated for his time "does not in any way cloud my judgment as an independent investigator of scientific discoveries." He adds that he debunks most "new discoveries" he checks out.

"BLP scientists are doing real science, and to date, I have found no errors in their scientific methods or approaches," Jansson says. "Over the years, I have witnessed many BLP devices clearly capable of creating excess energy at meaningful levels. I think it may take some period of time for the scientific community to absorb, digest, and accept the possibility of lower energy states of hydrogen. I think Dr. Mills has made a compelling case." Jansson adds that commercial viability remains a challenge for BLP, but the way forward is being held up by business issues, not scientific ones.

Meanwhile, BLP has hosted several demonstrations of its latest prototypes for investors since 2014, posting videos on its website after the fact. But these events do not provide clear evidence one way or the other as to whether the SunCell is legitimate.

In July, after one recent demonstration, the company announced that the anticipated cost of operating the SunCell is so low—about 1 to 10% of that for any other existing form of power—that the company "intends to provide autonomous individual power for essentially all stationary and motive applications untethered to the grid or any fuels infrastructure." In other words, the company plans to build and then lease SunCells or other devices to customers and charge a per diem usage fee, allowing people to go off the power grid and stop buying gasoline or diesel while paying just a fraction of what those things now cost.

"This is the end of the age of fire, the internal combustion engine, and centralized power and fuels," Mills says. "Our technology is going to make all other energy technology obsolete. Our concerns about climate change are going to be eliminated." He adds that it looks like BLP could be in production, at first with megawatt stationary units, and generating revenue by the end of 2017.

What's in a name?

Despite the uncertainty surrounding Mills and BLP, their story is just one part of the ongoing new energy saga. After the dust settled on the original Fleischmann-Pons announcement, the two researchers began figuring out what was right and what was wrong. They were joined by dozens of other collaborators and independent researchers.

Many of these scientists and engineers, often using money out of their own pocket, have been less concerned about commercial opportunities but rather have focused on basic science: electrochemistry, metallurgy, calorimetry, mass spectrometry, and nuclear diagnostics. They continue to rack up experiments showing excess heat gain, defined as the ratio of energy put out by a system to the energy required to operate it. In some cases, nuclear anomalies such as producing neutrons, α-particles (helium nuclei), isotope shifts of atoms, and transmutation of one element to another have been reported.

But in the end, most of these researchers are just looking for an explanation and would be happy if even a modest amount of heat generated turns out to be useful in some way.

"LENR is real experimentally, and not understood theoretically," says **David J. Nagel <https://www.ece.seas.gwu.edu/david-nagel>** , an electrical and computer engineering professor at George Washington University and a former research manager at the Naval Research Laboratory. "There are results that you just can't explain away. Whether it's cold fusion, low-energy nuclear reactions, or something else—the names are all over the place—we still don't know. But there's no doubt that you can trigger nuclear reactions using chemical energy."

Nagel prefers to call the LENR phenomenon "lattice-enabled nuclear reactions" because whatever is happening takes place within the crystal lattice of an electrode. The original branch of the field focuses on infusing deuterium into a palladium electrode by turning on

the power, Nagel explains. Researchers have reported such electrochemical systems that can output more than 25 times as much energy as they draw.

> "We were willing to be wrong. We were willing to invest time and resources to see if this might be an area of useful research in our quest to eliminate pollution."
> —**Thomas F. Darden,** CEO, Cherokee

The other main branch of the field uses a nickel-hydrogen setup, which can produce greater than 400 times as much energy as it uses. Nagel likes to compare these LENR technologies to that of the **International Thermonuclear Experimental Reactor <https://www.iter.org/>** , a multination high-temperature fusion experiment based on well-understood physics—merging deuterium and tritium—being carried out in southern France. At a cost exceeding $20 billion, this 20-year project has set a goal of generating 10 times as much energy as it consumes.

Nagel says the LENR field continues to grow internationally, and the biggest hurdles remain inconsistent results and lack of funding. For example, some researchers report that a certain threshold must be reached for a reaction to start. The reaction may require a minimum amount of deuterium or hydrogen to get going, or the electrode materials may need to be prepared with a specific crystallographic orientation and surface morphology to trigger the process. The latter is a common issue with heterogeneous catalysts used in petroleum refining and petrochemical production.

Nagel acknowledges that the business side of LENR has had problems too: Prototypes being developed have been "relatively crude," he says, and there has yet to be an LENR-based company to offer a working product or make any money.

Rossi's E-Cat

One of the notable examples of attempts to commercialize LENR comes from engineer **Andrea Rossi <http://andrea-rossi.com>** of **Leonardo Corp. <http://ecat.com>** , based in Miami. In 2011, Rossi and his colleagues announced at a press conference in Bologna, Italy, that they had built a tabletop reactor, called the Energy Catalyzer, or E-Cat, that produces excess energy via a nickel-catalyzed process. To substantiate his discovery, Rossi has held E-Cat demonstrations for potential investors and members of the media

and commissioned **independent validation tests <https://arxiv.org/abs/1305.3913>** .

Rossi (kneeling) works on one of the modular units of a 1-MW Energy Catalyzer designed to power large buildings.
Credit: Ecat.com

Rossi posits that his E-Cat features a self-sustaining process in which electrical power input initiates fusion of hydrogen and lithium from a powdery mixture of nickel, lithium, and lithium aluminum hydride to form a beryllium isotope. The short-lived beryllium decays into two α-particles with the excess energy given off as heat; some of the nickel is reported to turn into copper. Rossi says no waste is created in the process, and no radiation is detected outside the apparatus.

Rossi's announcement initially gave many scientists the same queasy feeling as did cold fusion. One reason many people are having trouble believing Rossi is his checkered past. In Italy, he was convicted of white-collar criminal charges related to his earlier business ventures. Rossi says those convictions are behind him and he no longer wants to talk

about them. He also once had a contract to make heat-generating devices for the U.S. Army. But the delivered devices did not work according to specifications.

In 2012, Rossi announced completion of a 1-MW system that could be used to heat or power large buildings. Rossi also anticipated that, by 2013, he'd have a factory annually producing 1 million 10-kW household units about the size of a laptop computer. But neither the factory nor the household units have materialized.

In 2014, Rossi licensed his technology to a company called Industrial Heat, which was formed by private equity firm **Cherokee <http://cherokeefund.com>** , a company that focuses on buying real estate and has a goal of cleaning up old industrial sites for redevelopment. In 2015, Cherokee Chief Executive Officer Tom Darden, who trained as an environmental scientist and a lawyer, described Industrial Heat as "a funding source for LENR inventors."

Darden said Cherokee started Industrial Heat because the investment firm believed that LENR technology was worth pursuing. "We were willing to be wrong. We were willing to invest time and resources to see if this might be an area of useful research in our quest to eliminate pollution," he said.

In the meantime, Industrial Heat and Leonardo have had a falling out, and both are now suing each other in court over violations of their agreement. Rossi would have received a total of $100 million if a yearlong test of his 1-MW system was successful. Rossi says he completed the test, but Industrial Heat disagrees and has expressed concerns that the device doesn't work.

George Washington's Nagel says that Rossi's E-Cat brought a groundswell of hope to the LENR field. Nagel told C&EN in 2012 that he didn't think Rossi was a fraud, "but I do not like some of his approaches to testing." Nagel thought Rossi should have been more thorough and transparent. Yet, at the time, Nagel also said he thought LENR devices would be offered for sale by 2013.

Rossi continues his research and has announced development of other prototypes. But he gives away few details about what he is doing. Rossi tells C&EN that the industrial 1-MW plants are in construction already and he has obtained the "necessary certifications"

for selling the systems. The household devices are still waiting for safety certification, he notes.

Nagel says now that the excitement from Rossi's initial announcement has died down, the LENR status quo has returned. The likely availability of commercial LENR generators is now at least a few years away, Nagel says. Even if a device clears the hurdles of reproducibility and usefulness, he adds, its developers face an uphill battle of regulatory approval and customer acceptance.

But Nagel remains optimistic. "LENR might be commercialized well ahead of its understanding, as were X-rays," he says. For that reason, Nagel has just outfitted a lab at George Washington to start a new line of nickel-hydrogen experiments.

Scientific legacies

Many of the researchers who continue to work on LENR are accomplished scientists and are now retired. It hasn't been easy for them because, for years, their papers have been returned unreviewed from mainstream journals and their abstracts for talks at scientific conferences have tended to go unaccepted. They are becoming more anxious about the status of the field because they are running out of time—whether to secure their legacy in scientific history if LENR proves correct or just to have peace of mind in knowing their instincts haven't failed them.

"It was unfortunate that cold fusion was initially publicized in 1989 as a new fusion energy source instead of simply as a new scientific curiosity," says electrochemist Melvin H. Miles. "Perhaps research could then have proceeded normally with more careful and accurate studies of the many variables involved."

A retired researcher at the Naval Air Warfare Center in China Lake, Calif., Miles at times collaborated with Fleischmann, who died in 2012. Miles says he thinks Fleischmann and Pons were right all along. Yet, even today he doesn't know how a commercial energy source could be constructed for the palladium-deuterium system, despite his many experiments that have produced significant excess heat correlated with helium production.

In July, Miles used his kitchen as lab space to run an experiment similar to the original Fleischmann-Pons experiment. In the setup shown, which includes a palladium wire cathode in deuterated water and potassium nitrate solution nested inside a homemade copper calorimeter, all sitting in a constant-temperature water bath (Walmart-purchased aquarium at left), Miles observed excess heat generated that is associated with deuterium fusion.

Credit: Courtesy of Melvin Miles

"Why would anyone have continued research or scientific interest after 27 years on any topic that was reported to be a mistake?" Miles asks. "I am convinced that cold fusion will eventually be recognized as another important discovery that was very slow to gain acceptance, and a new theoretical framework will emerge to explain the experimental results."

Nuclear physicist Ludwik Kowalski, an emeritus professor at Montclair State University, agrees cold fusion got off to the wrong start. "I am old enough to remember the effect the initial announcement had on the scientific community, and on the general public," Kowalski says. At times, he collaborated with LENR researchers, "but my three attempts

to validate the sensational claims yielded only negative results."

Kowalski thinks the social stigma against the research created as part of the initial fallout developed into a bigger problem, **one that is unbecoming to the scientific method <http://pages.csam.montclair.edu/~kowalski/cold5.htm>** . Whether or not the claims of LENR researchers are valid, Kowalski believes a clear yes or no answer is still worth seeking. But it will not be found as long as cold fusion researchers "are treated as cranks and pseudoscientists," Kowalski says. "No progress is possible, and no one benefits from not publishing results of honest investigations and not independently testing them in other laboratories."

Time will tell

Even if Kowalski gets a yes to his question and LENR researcher claims are validated, the path to commercialization is fraught with challenges. Not all start-up companies, even ones with sound technology, are successful for reasons that are not scientific in nature: capitalization, cash flow, cost, manufacturing, insurance, and competitive energy pricing, to name a few.

A clear yes or no answer is still worth seeking. But it will not be found as long as cold fusion researchers "are treated as cranks and pseudoscientists."
—**Ludwik Kowalski,** emeritus professor, Montclair State University

For example, consider Sun Catalytix. The company spun off from MIT is one example of a start-up built on strong science that fell victim to commercial pressures before it hit its stride. The company was created to commercialize an artificial photosynthesis process developed by chemist **Daniel G. Nocera <http://nocera.harvard.edu/Home>** , now at Harvard, to economically and efficiently convert water into hydrogen fuel with sunlight and inexpensive catalysts.

Nocera envisioned <http://cen.acs.org/articles/89/i48/Electrofuels-Bump-Solar-Efficiency.html> that hydrogen generated in this way could power a simple fuel cell to provide energy to homes and villages in poor regions of the world without access to a power grid, making modern conveniences available and improving quality of life. But the process needed significantly more capital and more time to develop than the company

initially thought. After four years, Sun Catalytix abandoned its commercialization effort, turned to making flow batteries, and then was bought in 2014 by Lockheed Martin. Sun Catalytix no longer exists.

It's unclear whether the companies pursuing LENR and related technologies have stuttered primarily because of similar business hurdles. For example, Wilk, the organic chemist who has been following Mills's progress, is becoming a little bit obsessed trying to sort out if BLP's commercialization efforts are based on something real or make-believe. He simply wants to know, does the hydrino exist?

In 2014, Wilk asked Mills if he had ever isolated hydrinos, and although Mills had previously written in research papers and patents that he had, Mills replied that he hadn't and that it would be "a really, really huge task." But Wilk doesn't see it that way. If the process generates liters of hydrino gas as he has calculated, it should be obvious. "Show us the hydrino!" Wilk pleads.

Wilk says Mills's world, and by extension the world of others involved in LENR, reminds him of one of Zeno's paradoxes, which suggests that motion is an illusion. "Every year they make up half the remaining distance to commercialization, but will they ever get there?" Wilk can think of four possible explanations for BLP: Mills's science is actually right, it's a complete fraud, it's just simply bad science, or it's what Chemistry Nobel Laureate Irving Langmuir called pathological science.

Langmuir coined the term more than 50 years ago to describe a psychological process in which scientists unconsciously veer away from the scientific method and become so engrossed in what they are doing they develop an inability to be objective and see what is real and not real. Pathological science is "the science of things that aren't so," Langmuir said. In some cases, it is embodied in areas of research like cold fusion/LENR that simply will not go away, even when given up on as false by a majority of scientists.

"I hope they're right," Wilk says about Mills and BLP. "I really do. I'm not out to debunk them, just to get at the truth." For the sake of the argument—"if pigs could fly," as Wilk puts it, he says he'll accept their data, their theory, and other predictions that can be derived from them. But he has never been a true believer. "I think if hydrinos existed, they would have been detected by others in laboratories or in nature years ago and would be

used by now."

All the discussions about cold fusion and LENR end that way: They always come back to the fact that no one has a commercial device on the market yet, and none of the prototypes seem workable on a commercial scale in the near future. Time will be the ultimate arbiter.

Chemical & Engineering News
ISSN 0009-2347

Comments

Gregory Smith (Mon Nov 07 09:43:32 EST 2016)
Good Grief. Surprised and disappointed you are even covering this.

The one thing Mills is unarguably good at is finding optimistic investors.

For anyone still tempted to invest in this... If someone has already spent $100 million over 25 years with no net effect other than increasing their own bank account, why would you want to trust them with more money?
» **Reply**