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What's New in the World of Superconductivity (June, 2009)

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Power

National Institute of Standards and Technology (June 17, 2009)

Researchers at the National Institute of Standards and Technology have discovered that by reducing the mechanical strain at crystal grain boundaries, the performance of high-temperature superconductors can be significantly improved. This discovery may lead to a lower cost and significantly improved performance of superconductors in applications ranging from power transmission to advanced physics research. Since grain boundaries tend to block the current flow, overcoming the effect of granularity on wire performance has been a major challenge in the development of long-length, high-quality HTS wires. While the development of thin films has greatly improved the performance of YBCO-coated conductors, grain boundaries still limit the performance of even these highly aligned superconductor films. The NIST researchers found that strain plays a key role in the reduction of current flow over grain boundaries in YBCO. When this strain was removed by compressing the grain boundaries, the superconducting properties of the film improved dramatically. These new observations of the effect of strain on current flow in thin-film superconductors will likely advance the development of these materials, possibly lowering their costs. The group's research has been accepted for publication by *Physical Review Letters*
Source:
"NIST discovers how strain at grain boundaries suppresses high-temperature superconductivity"
National Institute of Standards and Technology (June 17, 2009)
http://www.nist.gov/eeel/electromagnetics/htc_061609.cfm

NMR

Bruker BioSpin (June 1, 2009)

Bruker BioSpin has announced the commercial launch of its new 1-GHz ultra-high field AVANCE™ 1000 NMR spectrometer, the central component of which is a 23.5-T standard bore (54 mm) superconducting magnet. The device has already been used to record 1-GHz NMR spectra at Bruker's ultra-high field (UHF) magnet factory in Karlsruhe, Germany. The successful demonstration confirmed the capabilities of this novel high-end instrument. The first AVANCE 1000 system will be delivered to the 'Centre de RMN à Très Hauts Champs' in Lyon, France in July 2009. Bruker is currently accepting orders for other UHF systems, with an anticipated delivery time of 18 – 24 months after order placement. The system is priced at approximately

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US $16 million.
Source:
"Bruker Announces AVANCE 1000, the World's First 1 Gigahertz NMR Spectrometer"
Bruker BioSpin press release (June 1, 2009)
http://www.bruker-biospin.com/avance1000.html

Quantum Computer

California Institute of Technology (June 19, 2009)

Researchers at the California Institute of Technology have created a new tool for measuring quantum mechanical behaviors, such as superposition and entanglement, in the large collections of atoms that form ordinary objects. The group used microfabrication techniques to create a nanoelectromechanical system (NEMS) resonator; this system consists of a 2-μm long, 0.2-μm wide silicon-nitride beam that resonates at a high frequency when a voltage is applied. A superconducting qubit, also known as a single-Cooper-pair box, was then placed at a distance of about 300 nm from the resonator. This superconducting qubit has two quantized energy states (a ground state and an excited state) that can be controlled by applying microwave radiation, thereby creating an electric field. Because the NEMS resonator and the superconducting qubit are placed so close together, their behavior is tightly linked, allowing the NEMS resonator to be used as a probe to detect the energy state of the qubit. This same device coupling should also enable measurements in the reverse direction (i.e., the superconducting qubit should be able to measure discrete energy levels in the vibrating resonator), allowing demonstrations of nanomechanical quantum superpositions and entanglement. The group's research was published in the June 18 issue of *Nature*.
Source:
"Mechanics: Ordinary meets Quantum"
California Institute of Technology press release (June 19, 2009)
http://media.caltech.edu/press_releases/13271

Yale University (June 28, 2009)

Researchers at Yale University have created a rudimentary solid-state quantum processor. Using a two-qubit superconducting chip, the group has successfully run elementary algorithms, such as a simple search. The group's results represent the first demonstration of quantum information processing using a solid-state device. At present, the qubits can be maintained for about a microsecond. The researchers will next attempt to increase the amount of time that the qubits maintain their quantum states, enabling more complex algorithms to be run. They will also work to increase the number of qubits connected to the quantum bus that is presently being used to transmit information between the qubits. The group's research was published on June 28 in *Nature*'s advanced online publication.
Source:
"Scientists create first electronic quantum processor"
Yale University press release (June 28, 2009)
http://opa.yale.edu/news/article.aspx?id=6764

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Communication

Superconductor Technologies Inc. (June 15, 2009)

Superconductor Technologies Inc. (STI) and GE Global Research, a subsidiary of General Electric, have jointly submitted two proposals to the Advanced Research Projects Agency – Energy (ARPA-E) branch of the U.S. Department of Energy. The proposals were made in response to a call for concept papers requiring funding. The first proposal concerns the adaptation of STI's proprietary cryocooler technology for use in next-generation wind turbines. STI would lead the development program, with GE Global Research providing technical assistance in establishing device specifications and product integration requirements. The second proposal is for an extension of a previously announced collaboration to jointly develop a successful commercial production process for second-generation HTS tapes, with targeted applications in superconducting devices for power generation and electric power grid applications. Specifically, the project would seek to adapt STI's proprietary HTS material deposition process to the production of HTS tapes at a viable cost level. GE Global Research would again provide technical assistance in establishing performance requirements and refining STI's manufacturing process for the production of HTS tapes. Both proposals are now being reviewed by ARPA-E.

Source:
"Superconductor Technologies Submits Dept. of Energy Proposals With GE Global Research"
Superconductor Technologies Inc. press release (June 15, 2009)
http://phx.corporate-ir.net/phoenix.zhtml?c=70847&p=irol-newsArticle&ID=1298873&highlight

Superconductor Technologies Inc. (June 23, 2009)

Superconductor Technologies Inc. (STI) has announced a total investment of $11.26 million in cash from several U.S-based institutional investors for the purchase of 3,752,005 shares of STI Common Stock. STI plans to use the approximately $10.58 million in net proceeds for general working capital purposes. The offering is scheduled to be closed on or around June 23, 2009.

Source:
"Superconductor Technologies Announces $11.26 Million Registered Direct Offering"
Superconductor Technologies Inc. press release (June 23, 2009)
http://phx.corporate-ir.net/phoenix.zhtml?c=70847&p=irol-newsArticle&ID=1301350&highlight

Accelerator

CERN (June 19, 2009)

CERN has reported that the Large Hadron Collider (LHC) remains on schedule for a restart this fall, although the event will likely occur 2 – 3 weeks later than originally anticipated. The additional delay is being caused by further testing in sector 4-5, the sector adjacent to the sector (3-4) where a faulty splice in a high-current cable caused the incident that led to the shut-down of the device last September. Measurements in sector 4-5 at 80 K have suggested that at least one suspicious splice might exist in the sector; as a result, this sector is being

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warmed to confirm the test results obtained at 80 K. If the results are indeed confirmed, any suspect splices in this sector will be repaired. In addition, validating the 80-K measurements will enable the splice resistance in the last three sectors to be measured at 80 K, avoiding the time needed for re-warming. The completion of these measurements will determine the exact date of start-up this fall. Numerous other improvements and installations are being simultaneously made to ensure a long and safe operational life.
Source:
"CERN reports on progress towards LHC restart"
CERN press release (June 19, 2009)
http://press.web.cern.ch/press/PressReleases/Releases2009/PR09.09E.html

Basic

University of Texas at Austin (June 8, 2009)

Researchers at The University of Texas at Austin have fabricated the thinnest superconducting metal layer ever to be created: a superconducting sheet of lead only two atoms thick. Using advanced materials synthesis techniques, the group layered a two-atom thick sheet of lead on top of a thin silicon surface. The resulting lead sheets were highly uniform and did not contain any impurities. Of note, the electrons in this thin superconducting layer can only move in two dimensions, or one "quantum channel". Despite this constraint in electron movement, the lead remains a good superconductor. This achievement is expected to lay the groundwork for future advancements in superconductor technologies. Dr. Ken Shih, a Professor of Physics at the university, commented, "To be able to control this material—to shape it into new geometries—and explore what happens is very exciting. My hope is that this superconductive surface will enable one to build devices and study new properties of superconductivity." The properties of the group's thin film were reported in the June 5 issue of *Science*.
Source:
"Thinnest superconducting metal created"
University of Texas at Austin press release (June 8, 2009)
http://www.utexas.edu/news/2009/06/08/superconductors/

Princeton University (June 29, 2009)

Researchers at Princeton University have made a surprising discovery regarding how electron behavior influences the conduction of electricity in high-temperature superconductors. The researchers have determined that the strength of electron pairing alone does not control the temperature at which these materials become superconducting. Instead, the range of angles over which the electrons are able to form superconducting pairs also appears to influence the critical temperature, with optimal results occurring when the electrons are able to form pairs over a wide range of angles. As part of a research effort to understand peak transition temperatures, the researchers used scanning tunneling microscopy to measure the strength of electron pairing in samples of cuprate superconductors with different levels of doping. Surprisingly, the researchers found that the strength of the electron pairing was equal in

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underdoped samples with a lower transition temperature and in optimally doped samples with a high transition temperature. To explain these results, the group developed a new technique that would allow them to measure the angles over which electron pairing occurred in the different samples. As a result, the group found that the transition temperature seems to be controlled by the range of angles over which superconducting pairing occurs, with the highest transition temperatures occurring in materials with the largest range of electron pairing angles. The researchers plan to continue investigating the details of this pairing mechanism more fully to determine why some electron pairs forming at certain angles are ineffective for superconductivity. The group's research was published in the June 26 issue of *Science*.

Source:

"Research offers new insights, and a new angle, on high-temperature superconductivity"
Princeton University press release (June 29, 2009)
http://www.princeton.edu/main/news/archive/S24/62/99S21/index.xml?section=topstories

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