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What's New in the World of Superconductivity (October, 2010)

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Power

American Superconductor Corporation (October 5, 2010)

American Superconductor Corporation (AMSC) has introduced a new brand name for its proprietary second-generation HTS wire. Previously known as "344 superconductors," the new brand name—Amperium™—reflects the wire's ability to conduct more than 100 times the electrical current (or "amperage") of a copper wire with the same dimensions. A single Amperium wire is capable of carrying enough power to serve the needs of approximately 10,000 U.S. homes. This high power density enables a dramatic reduction in the footprint and cost of large-scale electrical equipment, such as power cables and wind generators.

AMSC expects the demand for Amperium wire to increase significantly in the near future. The Korea Electric Power Company (KEPCO) expects the widespread deployment of superconductor power cables in the Korean power grid beginning around 2012-2013, and LS Cable Ltd. (Korea) has already utilized Amperium wire to manufacture the first power cable system for Korea's commercial grid. In the U.S., Amperium wire is being used by Nexans to produce an extension of the superconductor power transmission cable system that has been operating in the Long Island Power Authority's (LIPA) primary power corridor since April 2008. The Tres Amigas SuperStation, which aims to connect America's three power grids, is also expected to use Amperium wire. Other anticipated applications include FaultBlocker™ surge-suppressing power cables and fault current limiters for city grids, electric generators for AMSC's SeaTitan™ superconductor wind turbines, large electric motors, and degaussing systems for the U.S. Navy.

Source:
"American Superconductor Introduces Amperium™ Wire"
American Superconductor Corporation press release (October 5. 2010)
http://phx.corporate-ir.net/phoenix.zhtml?c=86422&p=irol-newsArticle_Print&ID=1478979&highlight

American Superconductor Corporation (October 6, 2010)

American Superconductor Corporation (AMSC) has received the world's largest order for HTS wire: LS Cable Ltd. (Korea) has placed an order for 3 million meters of Amperium™ wire to be used in alternating current (AC) and direct current (DC) superconductor cable projects. AMSC will begin shipments of Amperium wire to LS cable starting in 2012. Jong-ho Son, President of LS Cable, commented, "Our objective is to be the leading provider of superconductor power cables for electric utilities worldwide. This Amperium wire contract helps ensure we will have the wire we need to complete the superconductor cable projects we have underway with KEPCO in Korea and also take on commercial project opportunities globally such as Tres Amigas in the U.S." The present contract builds on a long-standing relationship

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between AMSC and LS Cable, in which the two companies have agreed to collaborate on the deployment of more than 50 circuit kilometers of superconductor power cables (including distribution and transmission voltages as well as AC and DC systems) in commercial power grids by the end of 2015. AMSC President and Chief Operating Officer Dan McGahn commented, "With this commercial wire order, American Superconductor has officially begun to tap into what we believe will be a multi-billion-dollar HTS market."
Source:
"American Superconductor Receives 3 Million Meter Amperium™ Wire Order from Korea's LS Cable Ltd."
American Superconductor Corporation press release (October 6, 2010)
http://phx.corporate-ir.net/phoenix.zhtml?c=86422&p=irol-newsArticle_Print&ID=1479536&highlight

American Superconductor Corporation (October 12, 2010)

American Superconductor Corporation (AMSC) had announced the launch of its SolarTie Grid Interconnection Solution, which combines AMSC's D-VAR® STATCOM solutions and PowerModule™ power converter systems to realize a utility-scale grid interconnection system designed specifically for megawatt-scale solar photovoltaic power plants. The SolarTie solution is one of the most robust power inverter systems on the market, with a base rating of 1.4 megawatts and a turn-on voltage of up to 1,000 volts. The SolarTie solution provides dynamic reactive compensation, enabling instantaneous detection, accurate responses and immediate results; these effects insure efficient energy production and precise grid management. As part of the solution, AMSC will also provide grid-management support through its Network Planning and Applications Group.

Dan McGahn, AMSC President and Chief Operating Officer, commented, "Over the course of the past decade, AMSC has established itself as a leader in the renewable energy market with a wide range of solutions. In fact, our power technologies are now enabling nearly 10 % of the world's wind generated electricity. We are proud to utilize this tremendous experience base to field a highly optimized, high power grid interconnection solution for PV solar power plant developers. AMSC's SolarTie solution sets a new standard for the industry by simplifying implementation, reducing project cost and enhancing plant reliability." Industry analysts expect the market for SolarTie solutions to be approximately US $2 billion by 2015.
Source:
"AMSC Launches Its SolarTie™ Grid Interconnection Solution for Photovoltaic Power Plants"
American Superconductor Corporation press release (October 12, 2010)
http://phx.corporate-ir.net/phoenix.zhtml?c=86422&p=irol-newsArticle_Print&ID=1481362&highlight

Bruker Energy & Supercon Technologies Inc. (October 19, 2010)

Bruker Energy & Supercon Technologies, Inc. (BEST) has entered into a one-year sponsored research agreement with the Center for Advanced Power Systems at Florida State University (FSCU-CAPS). The financial terms of the agreement were not disclosed. The collaboration will focus on the continued development of BEST's shielded iron core inductive superconducting fault current limiter (iSFCL). Specifically, the alternating current (AC) loss characteristics of BEST's HTS tapes will be investigated, AC losses in iSFCL-relevant geometries and components will be modeled and minimized, and the low-iron iSFCL concept (which differs significantly from that of traditional saturated iron core SFCLs) will be studied. Dr. Klaus Schlenga, Chief Technology Officer of BEST, commented, "FSU-CAPS is very experienced in the integration of novel high power equipment, such as advanced superconducting devices, power electronics, and novel rotating machines into power systems. FSU-CAPS has established a unique test and

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demonstration facility with one of the largest real-time digital power systems simulators integrated with high-powered 5-megawatt class AC and DC test beds for hardware in the loop simulation. The collaboration between FSU-CAPS and BEST is expected to result in advances in iSFCL technology with minimized AC losses and a utility-friendly implementation of a new generation of power conditioning systems."

Source:

"Bruker Energy & Supercon Technologies Enters Into iSFCL Collaboration Agreement with the Center for Advanced Power Systems at Florida State University"

Bruker Energy & Supercon Technologies Inc. press release (October 19, 2010)

http://www.bruker-est.com/pr101019.html

Magnet

Bruker Daltonics (October 29, 2010)

Bruker Daltonics has announced that it has been selected by the National High Magnetic Field Laboratory (NHMFL) at Florida State University to design and build the world's first 21.0 Tesla Fourier Transform Ion Cyclotron Resonance (FT-ICR) magnet. Bruker will design the magnet in collaboration with NHMFL scientists. The contract for the magnet, which is being funded by the National Science Foundation, is valued at over $10 million; delivery of the magnet is scheduled for the first half of 2013. FT-ICR technology enables the highest resolution mass spectrometers available and is used for the analysis of extremely complex mixtures including petroleum, metabolites, and large biological molecules such as proteins. At present, the highest field FT-ICR system available operates at 15 T. Consequently, the new 21.0 T system represents a dramatic improvement of 40% in mass resolution and more than 90% in mass accuracy. The magnet for the system will have a 110-mm room-temperature horizontal bore and will be cooled using Bruker's UltraStabilized™ cooling technology and shielded using Bruker's UltraShield™ technology. The superconducting wire required for the construction of the magnet has already been ordered from Bruker Energy & Supercon Technologies, Inc.

Source:

"National High Magnetic Field Laboratory at Florida State University Selects Bruker to Build World's First 21.0 Tesla FT-ICR Magnet"

Bruker Daltonics press release (October 29, 2010)

http://phx.corporate-ir.net/phoenix.zhtml?c=121496&p=irol-newsArticle&ID=1489094&highlight

Medical

Bruker Corporation (October 21, 2010)

Bruker has successfully installed its BioSpec® 170/25 system at the CEA NeuroSpin research center in France. The system represents the world's first horizontal ultra-high magnetic field 17.2 Tesla MRI system, with a magnet bore diameter of 25 cm. The MRI scanner will be used for cutting-edge preclinical in vivo imaging of small animals, enabling molecular imaging at a microscopic scale or functional and connectivity neuroimaging at a higher spatial resolution. Such research can then be translated into clinical applications with important benefits for human healthcare. The MRI magnet itself is based on Bruker's UltraStabilized™

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sub-cooling technology, enabling ultra-high fields for MRI applications with excellent homogeneity and stability. Professor Denis Le Bihan, Director of NeuroSpin, commented, "This unique instrument will give us, for the first time, access to the working of the whole brain at the cellular level, an important step to understand the neural code."
Source:
"Bruker Announces Successful Installation of Record-Setting Ultra-High Field 17 Tesla Preclinical MRI System at the NeuroSpin Research Center in France"
Bruker press release (October 21, 2010)
http://www.bruker-biospin.com/pr101021.html

National Institute of Standards and Technology (October 14, 2010)

Researchers at the National Institute of Standards and Technology (NIST) and the German National Metrology Institute have used NIST's miniature atom-based magnetic sensors to monitor a human heartbeat, confirming the device's potential for biomedical applications. The study is the first to use these mini-sensors under conditions resembling a clinical setting. The actual experiments were performed at the Physikalisch Technische Bundesanstalt (PTB) in Germany; this building is said to have the world's best magnetic shielding, which is critical for the high-precision measurements. The mini-sensor, consisting of a tiny container containing about 100 billion rubidium atoms in a gaseous form, a low-power infrared laser, and optics, was placed about 5 mm above the left chest of a person lying face up on a bed. The sensor successfully detected the weak but regular magnetic pattern of the heartbeat. The same signals were recorded using the "gold standard" for magnetic measurements—a superconducting quantum interference device (SQUID). A comparison of the signals confirmed that the NIST mini-sensor was able to correctly measure the heartbeat and identify many typical signal features. While the mini-sensor generated more signal interference, it offers the advantage of operating at room temperature (unlike SQUIDs, which must be cooled and require complicated and expensive supporting apparatus). These new results suggest that the NIST mini-sensors could be used to make magnetocardiograms as a supplement or alternative to electrocardiograms. The work has been described in *Applied Physics Letters*.
Source:
"NIST mini-sensor traces faint magnetic signature of human heartbeat"
National Institute of Standards and Technology press release (October 14, 2010)
http://www.nist.gov/pml/div688/magnetic_101310.cfm

Electronics

National Institute of Standards and Technology (October 27, 2010)

The National Institute of Standards and Technology (NIST) has begun shipping a new 10-volt standard to users worldwide. The programmable system measure both direct current (DC) and alternating current (AC) voltages. The system measures voltages using superconducting integrated circuits based on quantum phenomena and simple equations. The superconducting integrated circuits contain about 300,000 Josephson junctions, with every junction producing exactly the same voltage. Measurements are made based on the Josephson effect: when microwave radiation of a known frequency is applied to the circuit, the Josephson junctions generate a voltage that can be calculated based on the frequency of the radiation and two fundamental constants of nature. The new 10-volt standard offers unique advantages over previous

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generations of standards, including a higher immunity to interference, output stability, and a simple setup and operation for DC metrology and the production of AC waveforms for the accurate calibration of AC signals with frequencies up to a few hundred hertz. The first system was shipped to the Kennedy Space Center in Florida; additional orders have been received from standards laboratories in Brazil and Taiwan.
Source:
"NIST ships first programmable AC/DC 10-volt standard"
National Institute of Standards and Technology press release (October 27, 2010)
http://www.nist.gov/pml/quantum/20101026_volt.cfm

Quantum Computer

University of California at Santa Barbara (October 4, 2010)

Researchers at the University of California at Santa Barbara (UCSB) have taken an important step in the construction of a quantum computer. Until now, solid state entanglement research has only been performed using two qubits; the researchers at UCSB, however, were able to conduct experiments using three qubits. The group is studying superconducting quantum circuits and their potential uses in quantum computing. In their most recent work, which was published in *Nature*, the group fabricated and operated a device with three coupled phase qubits, using them to produce entangled quantum states. Matthew Neeley, a graduate student at UCSB, explained, "Entanglement is one of the strangest and most counterintuitive features of quantum mechanics. It is a property of certain kinds of quantum states in which different parts of the system are strongly correlated with each other. This is often discussed in the context of bipartite systems with just two components. However, when one considers tripartite or larger quantum systems, the physics of entanglement becomes even richer and more interesting… Entanglement is a resource that gives quantum computers an advantage over classical computers, and so producing multipartite entanglement is an important step for any system with which we might hope to construct a quantum computer." A research group at Yale University has also published similar results. Together, these two groups have provided the first work showing three coupled superconducting qubits.
Source:
"Quantum computing research edges toward practicality in UCSB physics laboratory"
University of California at Santa Barbara press release (October 4, 2010)
http://www.ia.ucsb.edu/pa/display.aspx?pkey=2336

Accelerator

Brookhaven National Laboratory (October 15, 2010)

The Relativistic Heavy Ion Collider (RHIC) and the NASA Space Radiation Laboratory at the U.S. Department of Energy's Brookhaven National Laboratory will soon be receiving a new beam source. The new facility, known as the Electron Beam Ion Source (EBIS), will produce and accelerate beams with greater versatility than the currently used system, allowing research using new kinds of previously unavailable ions. The EBIS will work by trapping atoms or ions within an electrically charged chamber inside a 1.5-meter-long cylindrical superconducting magnet. The voltage holds the charged ions in the chamber while an electron beam generated at one end passes through, systematically stripping electrons off the

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trapped atoms. Once the desired number of electrons has been removed, the voltage is turned off and the beam is released from the trap. The ion beams then move through two small linear accelerators to boost the beam energy to the level required for injection into the next accelerator. The EBIS is expected to begin providing helium ions to NASA researchers this fall, with the first uranium collisions expected to occur at RHIC in late winter or spring 2011.
Source:
"New beam source for Brookhaven accelerators"
Brookhaven National Laboratory press release (October 15, 2010)
http://www.bnl.gov/bnlweb/pubaf/pr/PR_display.asp?prID=1184

Basic

University of British Columbia (October 14, 2010)

Research at the University of British Columbia (Canada) has indicated that high-temperature superconductivity in copper oxides is linked to a phenomenon called 'incoherent excitations', providing insight into the electronic response that occurs in these materials before they become superconducting. The study is the first to measure the behavior of electrons as independent well-defined particles in a superconductor and their evolution into ill-defined, many-body entities. Associate Professor Andrea Damascelli, Canada Research Chair in Electronic Structure of Solids with the Department of Physics and Astronomy, explains, "We've never been able to directly quantify the nature of electron behavior within these materials across the entire phase diagram—the transition from non-superconducting to superconducting behavior. A combination of advanced spectroscopic techniques and access to very pure cuprate crystals produced at UBC have allowed us to measure what's going on below the surface of a high-temperature superconducting material through the entire progression of different phases." The researchers were able to measure a rapid loss of quasiparticle integrity in the material's electron behavior upon entering the cuprates' underdoped phase, implying that some important concepts of Fermi liquid models breakdown upon the entrance of the material into this phase and suggesting that other theoretical directions must be sought to explain superconductivity. The research was recently published in *Nature Physics*.
Source:
"'Incoherent excitations' govern key phase of superconductor behavior: UBC research"
University of British Columbia press release (October 14, 2010)
http://www.science.ubc.ca/news/473

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