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What's New in the World of Superconductivity (July, 2008)

Power

American Superconductor Corporation (July 1, 2008)

American Superconductor Corporation has announced the receipt of multiple orders for its Static VAR Compensator (SVC) solution. This latest series of orders includes the addition of five new customers from a diverse range of industrial fields. AMSC's SVC solution, which was acquired during AMSC's acquisition of Power Quality Systems, Inc. (PQS) in 2007, combines PQS's proprietary thyristor switch technology with AMSC's advanced controls technology to create a scalable SVC system that can be used at both the transmission and distribution voltage levels to enhance power reliability and quality. Recent customers who have purchased an SVC solution include a North Carolina electric utility, a Texas gas utility, a metal recycler, and a distributed independent electrical generator.

Source:
"AMSC Announces Increasing Adoption of Its SVC Solution for Industrial Applications"
American Superconductor Corporation press release (July 1, 2008)
http://phx.corporate-ir.net/phoenix.zhtml?c=86422&p=irol-newsArticle_Print&ID=1170888&highlight

Zenergy Power (July 21, 2008)

Zenergy Power plc has completed the successful installation and operation of the world's first commercial full-scale HTS induction heater at the manufacturing facilities of Weseralu GmbH & Co. KG ('Weseralu'), in Germany. The HTS induction heater is specifically designed for heating large aluminum billets for use in the production of numerous products in the automotive, aerospace, and machine building industries. The HTS induction heater, which is now fully operational, requires only 450 kW of power to function at full volume (conventional heaters, for comparison, require 1 MW), generating an energy savings of 55 %. The HTS heater also requires less maintenance than conventional induction heaters and reduces carbon dioxide emissions by 300 tonnes each year (equivalent to 150 households). Mr. Hagemann, owner and managing director of Weseralu, commented, "Zenergy's HTS technology represents a quantum leap for our industry and I am delighted to be the first in the world to utilize this technology. I am confident that it will prove advantageous on an economic and ecologic basis in comparison to any existing billet heating equipment. Additionally, the HTS induction heater offers Weseralu unprecedented temperature homogeneity in our aluminum billets during the heating process in contrast to conventional technology, which will afford the company even more meaningful financial benefits through the increased productivity it generates from the considerable electricity savings we expect to enjoy from the unit."

Source:
"Successful Operation of World's First Commercial Full Scale HTS Induction Heater"
Zenergy Power press release (July 21, 2008)

http://www.zenergypower.com/images/press_releases/2008-07-21-ih-weseralu.pdf

American Superconductor Corporation (July 29, 2008)

American Superconductor Corporation announced the delivery of critical components for an HTS degaussing coil system to the U.S. Office of Naval Research (ONR) and the Naval Surface Warfare Center, Carderock Division (NSWCCD) Ship Engineering Station in Philadelphia. Initial testing onboard the USS Higgins, an 8,000-ton destroyer, has also been successfully completed. The system, which utilizes AMSC's HTS wire and magnet cable technology, will continue to undergo testing in U.S. Navy sea trials over the next two years. Degaussing systems are utilized in naval ships to cloak their magnetic signatures. Conventional systems utilize multiple tons of copper wire in a network of electrical cables installed around the circumference of the ship's hull. HTS degaussing systems provide the same functionality as conventional systems but are much more efficient and less invasive to the ship. The U.S. Navy predicts that HTS degaussing systems will enable a 50 – 80 % reduction in the total system weight (compared with conventional degaussing systems) as well as a reduced total ownership cost. In addition, a 90 % reduction in total installed cable lengths is expected.

Source:
"American Superconductor and U.S. Navy Initiate Testing of an HTS Degaussing System on USS Higgins"
American Superconductor Corporation press release (July 29, 2008)
http://phx.corporate-ir.net/phoenix.zhtml?c=86422&p=irol-newsArticle_Print&ID=1180520&highlight

Communication

Superconductor Technologies Inc. (July 29, 2008)

Superconductor Technologies Inc. (STI) has entered into a collaborative effort with the U.S. Department of Energy's Los Alamos National Laboratory (LANL) to apply STI's HTS materials expertise to LANL's research initiative to develop HTS coated conductors for power transmission lines. As part of this collaboration, STI and LANL will deliver joint presentations at the DOE 2007 Annual Superconductivity for Electric Systems Peer Review; their scheduled presentations are entitled, "Progress in Reactive Coevaporation on IBAD" and "Growth of YBCO Thin Films by Reactive Coevaporation".

Source:
"Superconductor Technologies and Los Alamos National Laboratory Collaborate On Superconductor Materials for Next Generation Commercial Power Transmission Networks"
Superconductor Technologies Inc. press release (July 29, 2008)
http://phx.corporate-ir.net/phoenix.zhtml?c=70847&p=irol-newsArticle&ID=1180484&highlight

Basic

National High Magnetic Field Laboratory (July 10, 2008)

Researchers at the National High Magnetic Field Laboratory, in collaboration with researchers at the University of British Columbia (Canada) and the University of Cambridge (UK), have gained insight into the formation of superconducting electron pairs in copper-oxide materials. Using high magnetic fields generated by a 45-Tesla hybrid magnet, the scientists were able to break through the masking effects of superconductivity and probe the underlying electronic structure of copper oxide superconductors. As a result, important information was obtained regarding the "pockets" in the electronic structure of these materials where doped carriers gather. The group's observations also suggested that magnetism persists even after the majority of the material has begun to superconduct, indicating an interplay between magnetism and superconductivity. Whether these two phenomena compete or cooperate remains unknown. The group's results were published in the July 10 issue of Nature.

Source:
"Scientists sneak a peek under the veil of superconductivity"
National High Magnetic Field Laboratory press release (July 10, 2008)
http://www.magnet.fsu.edu/mediacenter/news/pressreleases/2008/2008july10.html

Massachusetts Institute of Technology (July 18, 2008)

Researchers at the Massachusetts Institute of Technology (MIT) believe they have identified a mysterious state of matter linked to high-temperature superconductivity. The group has been focusing on the state of matter that exists at temperatures just above the temperature at which materials become superconductive. This state is known as the pseudogap. The MIT group's results suggest that the pseudogap is not a precursor to superconductivity, as has been theorized, but a competing state. If confirmed, this new view could completely change the way physicists view superconductivity. The researchers studied several samples of bismuth superconductor with different levels of doping and found evidence suggesting that the pseudogap represents a charge-density wave. While such a possibility has been previously suggested, the MIT group's results represent the first systematic study of a "checkerboard" pattern that appears when a range of materials are imaged using scanning tunneling microscopy. The doping dependency of this checkerboard pattern is regarded as strong evidence of a charge-density wave. The research, which was published online in the July 6 edition of Nature Physics, was funded by the National Science Foundation and the Research Corporation.

Source:
"MIT physicists shed light on key superconductivity riddle"
Massachusetts Institute of Technology press release (July 18, 2008)
http://web.mit.edu/newsoffice/2008/super-conduct-0718.html

Rutgers University (July 21, 2008)

Researchers at Rutgers and Columbia Universities have gained new insight into the origins of superconductivity by studying exotic chemical compounds containing neptunium and plutonium. While such superconductors are impractical for commercial applications, they can provide important information regarding the factors that govern a material's transition to superconductivity. Neptunium and plutonium belong to the actinide series of elements. In these materials, which are known as heavy electron superconductors, the active electrons are located in "f-orbitals"; in contrast, the active electrons are located in "d-orbitals" in copper and iron-based superconductors. The f-electron materials tend to have relatively low superconducting temperatures, but they are easier to make and

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may be easier to understand. Importantly, magnetism seems to play a central role in driving Cooper pairing in these new materials, unlike the situation in other superconductors. Heavy electron superconductors have numerous atomic-sized magnets, known as "spins"; when electrons move through these spins, they usually slow down and move sluggishly, as if they were extremely heavy. In most heavy electron superconductors, the electrons must slow down and become heavy before they can become superconducting; in the high-temperature versions of these materials, however, the electrons become heavy and superconducting simultaneously. To explain this phenomenon, the group has proposed a new type of electron pairing in which pairs of electrons team up with a spin; the spin is thought to bring the pair of electrons closer together, and stronger pairing translates to superconductivity at higher temperatures. The researchers hope that these ideas will also be applicable to d-electron materials, possibly enabling superconductivity at a temperature much closer to room temperature. The group's findings will be published in the journal Nature Physics.
Source:
"Exotic materials using neptunium, plutonium provide insight into superconductivity"
Rutgers University press release (July 21, 2008)
http://news.rutgers.edu/medrel/news-releases/2008/07/exotic-materials-usi-20080721

Helmholtz Association of German Research Centres (July 24, 2008)

Researchers at Forschungszentrum Jülich, a member of the Helmholtz Association of German Research Centres, have successfully and precisely measured atomic spacings down to a few picometers using a new ultrahigh-resolution electron microscopy method. This accomplishment will enable decisive parameters determining the physical properties of materials, including superconductors, to be determined directly at an atomic level using microscopy. As part of the investigations used to test this new technique, the configuration of atoms in the orthogonal grain boundaries of an oxide superconductor ($YBa_2Cu_3O_7$) was examined. Using microscopic images taken under different conditions, the researchers successfully used computers to calculate the quantum-mechanical wave function of the electrons, which can be used as a basis for determining the exact positions of the atoms. The researchers found that the relatively heavy atomic species in the compound (barium, copper, and yttrium) were systematically displaced a few picometers from their ideal positions in the grain boundary, followed by the lighter oxygen atoms. These observations explain the attenuation of superconducting properties that is seen when electrical current flows over such a grain boundary. This phenomenon is utilized in the construction of SQUIDS, which exploit the magnetic field dependency of this disturbance to measure minute magnetic fields, such as brain waves. Knut Urban, the lead researcher, commented, "This is the beginning of a new physics of materials which enables researchers to determine physical parameters and properties in the nano range through highly precise measurements of the atomic spacings. This will also provide clues on how these properties may be manipulated in order to gain new functions and better functional performance." The achievement was reported in the July 25th issue of Science.
Source: "Electron microscopy enters the picometer scale"
Helmholtz Association of German Research Centres press release (July 24, 2008)
http://www.fz-juelich.de/portal/index.php?cmd=show&mid=615&index=163

University of California – Davis (July 30, 2008)

Researchers at the University of California – Davis, the Los Alamos National Laboratory

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(LANL), and the University of California – Irvine have made an important advance in understanding how the electrons in heavy electron materials become superconducting. The researchers have found a simple method of calculating the temperature at which a new state of matter, the Kondo liquid, emerges. Heavy electron materials contain both free-moving electrons that make them conductors and a "Kondo" lattice of localized electrons. When the temperature of the material is lowered below a certain point, the localized electrons lose their magnetism and become collectively "entangled" through quantum mechanical effects with the conduction electrons, which become heavy and form the Kondo liquid. At even lower temperatures, these heavy electrons become either magnetic or superconducting. By reviewing 30 years of existing data on heavy electron materials plus new data collected at LANL, the lead researcher—Yi-feng Yang, a postdoctoral fellow at UC Davis— was able to establish a connection between single impurities and lattice behavior in these materials. The group then found that the crucial temperature at which the Kondo liquid emerges depends on the coupling of individual local spins to the conduction electrons. The discovery is expected to help researchers establish the organizing principles of heavy electron superconductivity. The group's study was published in the July 31 issue of Nature.

Source:
"New insight on superconductors"
University of California – Davis press release (July 30, 2008)
http://www.news.ucdavis.edu/search/news_detail.lasso?id=8725

(Akihiko Tsutai, Director, International Affairs Division, ISTEC)

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