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SupraMagnetics Awarded $1.75 Million in SBIR Funding

SupraMagnetics Inc., based in Plantsville, CT, has announced that it has been awarded two one-year Small Business Innovation and Research (SBIR) Phase II grants from the DOE to develop low-cost, high-J_c LTS materials for applications at both low and high magnetic fields. One award funded a program $861,724 to develop a low-cost, powder-in-tube (PIT) Nb_3Sn conductor for high-energy physics magnet applications above 12 T, and the other funded $903,966 to develop an extrudable artificial pinning center (APC) NbTi superconductor with ferromagnetic nickel pins for use with undulator magnets. Undulator magnets require very high I_c's at low magnetic fields, where APC conductors excel.

PIT Nb_3Sn Approach a Simple Two-step Process

The program to develop a low-cost PIT Nb_3Sn superconductor will use a conductor architecture developed by SupraMagnetics that utilizes octagonal subelements. Each octagonal PIT subelement includes a low-cost Cu_5Sn_4 intermetallic as the tin source.

The octagonal conductor assembly allows design flexibility to introduce uniformly, oxide dispersion-strengthened copper components within the conductor matrix. The introduction of the octagonal design approach is intended to improve the mechanical characteristics of Nb_3Sn superconductors for high-field magnet applications such as NMR spectrometers.

"The main and key objective in Phase I of this program was to introduce 1 to 2% titanium into the Nb_3Sn A15 layer," stated Leszek Motowidlo, President of SupraMagnetics. "Another objective was to demonstrate the feasibility of fabricating a multifilament conductor design with titanium additions via the PIT approach. Both objectives were successfully achieved.

"With regards to lowering the cost of Nb_3Sn in Phase II, our goal is to achieve a cost reduction of a factor of two in comparison to advanced performing processes, such as internal-tin. Advanced three-step internal-tin approaches require expensive machining steps that include mono-element preparation and processing followed by two restacks, and are thus far more complex than the PIT Nb_3Sn approach we are developing, which is a simple two-step process."

Motowidlo: Octagonal Subelements Improve Uniformity

Motowidlo also elaborated on the use of octagonal subelements in the PIT method: "The octagonal subelements, when assembled into a restack copper tube, result in square voids regularly spaced between the subelements that allow for the insertion of copper, oxide dispersion-strengthened copper or any other high strength alloy. The eight-sided subelement provides for a more stable assembly, resulting in more uniform processing characteristics compared to hexagonal elements.

"The octagonal assembly enables the introduction of high strength components uniformly dispersed within the matrix, and this in turn increases the tensile strength of the wire or strand. The strand will provide additional strength to a high-field coil, which is typically over-banded with high-strength materials to prevent movement due to strong Lorentz-type forces within the winding pack."

Approach to Conductor Architecture Enables NbTi Pinning Centers

The goal of the project to develop an extrudable NbTi superconductor for undulator magnets is to enhance J_c performance at low magnetic fields within a scalable process. Another application of SupraMagnetics' octagonal design approach to conductor architecture is to allow for the insertion of ferromagnetic pinning centers within the NbTi matrix. The approach is expected to provide a scalable manufacturing process and enhance J_c by a factor of three at magnetic fields in the range of 1 to 2 T.

"Successfully achieved Phase I milestones that lead to the receipt of this Phase II award include the demonstration of 10,822 A/mm^2 at 2 T, which is about a factor of two higher than commercial NbTi at an equivalent magnetic field," stated Motowidlo. "Another milestone was the demonstration of an extrudable APC process, which will allow scalability to manufacture long lengths of strand.

"The application of the octagonal design approach in this case enables the insertion of copper-clad nickel pinning centers into the voids between the NbTi octagonal subelements. Through this approach, expensive gun-drilling of the NbTi ingot to insert copper clad nickel pins is avoided.

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"In the Phase I work, the flux lattice-pin spacing was not optimum for J_c characteristics. This provides us an opportunity to further increase the J_c by nearly a factor of three, an increase of 15,000 to 18,000 A/mm^2, for NbTi material by matching the nickel pin spacing to the flux lattice appropriately. In addition, the volume fraction of the pinning centers will be adjusted.

"Earlier work has shown that the order parameter is more completely suppressed utilizing nickel pinning centers as compared to, for example, copper or niobium pinning centers. Nickel pinning centers represent a stronger pin.

"We can also minimize the proximity effect on the superconducting properties of the NbTi itself by optimizing the pin diameter to pin spacing ratio. At the lower applied magnetic fields, where undulator magnets are designed, the J_c performance in commericial NbTi is not sufficient to provide the safety margin needed to prevent conductor quenching during operation in elevated temperature environments from heat induced by various sources, such as synchrotron radiation."

SupraMagnetics Involved in Bi2212 Program

SupraMagnetics is a privately owned company formed in 2004 for the advancement, development, and manufacture of superconductors. While LTS development and manufacture is the primary focus of the company, SupraMagnetics is also working on HTS Bi2212 round multifilament conductor developments.

"SupraMagnetics has an ongoing program over the last two years to develop Bi2212 for applied magnetic field applications above 15 T," commented Motowidlo. "We are working with Ohio State University (OSU) on the project.

"The effort includes developing a conductor with improved engineering J_e as well as the intrinsic J_c properties. In addition to partnering with OSU on Bi2212, SupraMagnetics has had ongoing partnerships with other institutions, particularly for low temperature material developments. We are open to new partnerships with other companies and institutions." ❍

Grid Logic Awarded $5 Million for FCL Program

Grid Logic, Inc., based in Metamora, MI, has reportedly received $5 million through Michigan's Clean Energy Advanced Manufacturing (CEAM) program, a combined $3.5 million grant and $1.5 million loan, to develop a superconducting fault current limiter (FCL) that company officials apparently hope will be cheaper than existing commercial FCLs. The funding will be used to begin production of a prototype FCL.

Grid Logic Among Nine CEAM Recipients

Grid Logic was among nine companies awarded $20 million through the CEAM program, which is intended to help small businesses in Michigan to diversify into manufacturing renewable energy systems and components. Funding for the CEAM program comes from the 2009 American Recovery and Reinvestment Act (ARRA).

Grid Logic is a provider of Smart Grid equipment and services for electric power systems. The company designs and manufactures high-efficiency devices that protect, stabilize and improve the efficiency of the electric utility grid.

Grid Logic reportedly expects to expand its workforce and move into a larger facility as part of the FCL program. The company declined to comment on the specific properties of their superconducting FCL. ❍

ITER's Motojima Discusses Fusion Reactor's Status

The superconducting ITER fusion reactor, to be constructed at Cadarache, France, recently

underwent delays to the expected arrival date of the first plasma, marking the start of operations, from 2018 to 2019, and the point at which the reactor would begin producing energy, from 2026 to 2027 (see *Superconductor Week*, Vol 24, No 13). The EU is currently funding 45% of the project's construction costs, and has reportedly previously called for more construction time to minimize technical risk.

"When the ITER Organization (IO) proposed the first schedule, it was considered by some members to be very aggressive," stated ITER Director-General Osamu Motojima. "When members verified the schedule with industry, it was found to be too high-risk and the associated costs too high.

"We are not currently attempting to shift our sources of funding away from the EU. The sharing of costs and thus also the sharing of contributions were the result of our five-year negotiations.

"It was understood during these negotiations that the nation to host the reactor would make a significant financial contribution due to the technological and economic advantages it would enjoy through hosting the project. The level this contribution would represent also grew as a result of a bidding competition between the EU and Japan to secure hosting rights."

Motojima: Overruns due to Price Increases Fall on DAs

The project has also faced cost overruns, with the current price tag estimated to be somewhere between €5 billion ($6 billion) and €10 billion ($12 billion). Among the reasons cited for the rising costs include dated cost estimates drawn before some design changes were implemented, the expansion of the number of ITER parties and corresponding increases in logistics costs, and increases in the cost of concrete and steel.

"Increases in commodity prices are not felt within IO but instead are borne by the Domestic Agencies (DA), particularly the EU's, as they are responsible for such contributions in kind," clarified Motojima. "The EU is in the process of obtaining resources at much higher costs than originally foreseen."

Motojima Cites Advantages to Current ITER Structure

There have been reports of internal criticism of the ITER structure, specifically targeting the level of power wielded by the seven DAs. Each DA is responsible for procuring parts for the reactor from industry, but some apparently feel that this is to the detriment of the central agency's ability to manage the project.

"The ITER project is indeed structured in a way such that responsibilities are shared and the central organization, IO, has only 10% of the funds needed to construct the machine," said Motojima. "However, this has allowed the members to choose technical and scientific areas of competence in which they can make a contribution. It has also allowed a spreading of the risks over the seven DA's instead of centralizing them in the IO.

"The choices made by the DAs reflect their industrial policies and their intentions to develop the competencies they need to be able to construct the demonstration (DEMO) reactor. The improvements that IO tries to implement with respect to procurements concentrate on the better integration of DA and IO competencies and responsibilities. One new element that reflects this are the so-called integrated product teams."

ITER's integrated product teams are staffed by IO and the DAs, with each focusing on an aspect of the project. In 2008, three teams were set up for the vacuum vessel, blanket, and the power supply. Following the success of these teams, five more were introducted in 2009, focused on heating and current drive, instrumentation and control, cryogenics, the fuel cycle and electric power supply. ❍

OXI Claims Increased Profits

in Mid-Year Report

Oxford Instruments plc (OXI) has released its half-year results for the six months leading to September 30, claiming £113.2 million ($181 million) in revenues in 2010, up 22% from £92.8 million ($148 million) for the same period in 2009. The company also claimed a nearly five-fold increase in pre-tax profits over the year ago, reporting £10.6 million ($17 million) in 2010 versus £2.8 million ($4.5 million) in 2009. Company share prices rose 2.3%, from £5.05 ($8.07) to £5.17 ($8.26), on the day of the announcement.

Demand for SC Wire Up

OXI's Industrial Products sector, which contains its industrial analysis, magnetic resonance and superconducting wire businesses, saw revenue rise in the period to £43.3 million ($69 million), over the £30.9 million ($49 million) reported in the year-ago period. The division, which suffered £700,000 ($1.12 million) in losses in the first half of 2009, reported £2 million ($3.2 million) in profits in the current period.

OXI asserted that part of the Industrial Products sector's shift to profitability was due to increased demand for superconducting wire, particularly from MRI manufacturers. One factor cited by the company is the recent introduction of new, higher magnetic field versions of MRI scanners requiring up to three times as much superconducting wire for each instrument.

The company reported to an increased order intake, which it reported at £141.3 million ($226 million), up 5.5% over the year ago, when the company reported £133.9 million ($214 million). Among other highlights, OXI stated that it reduced its debt from £10.4 million ($17 million) at the end of March to £3.9 million ($6.23 million) at the end of September (see *Superconductor Week*, Vol 24, No 2).

OXI Sees Highest Growth Rates in Chinese Market

"Our order book is at a record high and current levels of customer interest indicate that demand will continue to be strong for the remainder of the current financial year," stated Nigel Keen, Chairman of OXI. "We are actively pursuing acquisition targets that have the potential to enhance value and our technical capabilities."

OXI also claimed that its sales had grown by 52% in the Chinese market, asserting that this was the fastest growth rate in any market it experienced in the period. Sales to China totaled 13% of OXI turnover.

Earlier this year, OXI received an order for a high field, 14 T split-pair superconducting magnet from the Diamond Light Source (DLS) (see *Superconductor Week*, Vol 24, No 9). More recently, the company has received orders for superconducting magnets from two neutron scattering facilities, the High Flux Isotope Reactor (HFIR) at the DOE's Oak Ridge National Lab (ORNL) and another facility under the Australian Nuclear Science and Technology Organisation (ANSTO) (see *Superconductor Week*, Vol 24, No 15). ❍

AIST Advocates use of SC in MS Instruments

Researchers with the National Institute of Advanced Science and Technology (AIST), in Tsukuba, Japan, together with the University of Tsukuba and Osaka Prefecture University, have asserted that superconducting molecule detectors using sensitivity to phonons to detect molecules may remove many of the negative aspects of relying on conventional molecule detectors for mass spectrometry (MS). The researchers constructed a kinetic-energy-sensitive mass spectrometer that could separate homonuclear diatomic ions (e.g., $14N_{22+}$ and $16O_{22+}$) from monatomic ions with the same equal mass/charge-number ratio (m/z) values (e.g., $14N_{+}$ and $16O_{+}$), which has never been distinguished by conventional MS instruments.

"The research was funded ¥190 million ($2.3 million) by the Japan Science and Technology Agency (JST) as part of the JST-SENTAN project," stated Masataka Ohkubo, Researcher at AIST involved in the research on superconducting MS systems. "We are currently being funded ¥39 million ($470,000) for R&D involving a molecule detection system with a superconducting sensor and superconducting readout. This project will be underway for the next 4 years, and is being funded by the Japan Society for the Promotion of Science, and was provided as a grant-in-aid for scientific research.

"We used Nb-based tunnel junctions and nanostrip devices with NbN or Nb for the demonstration spectrometer. The superconductors employed are conventional LTS, but have their nanostructure optimized for molecule detection. The macrosize nano-devices have been modified to optimize both detection performance and provide high-throughput analysis."

Ohkubo: New MS Tech being Transferred to Private Company

Ohkubo said that researchers were in the process of transferring technology to the private sector: "We are now transferring technology to a company to build a superconducting MS product, and they hope to release it in three years. Superconducting molecule detection technology has generally advanced to the point where it is ready for commercialization. Our government-based institute cannot sell products directly, necessitating the transfer of the technology to private enterprises.

"We currently have three prototype superconducting MS instruments: a double-focusing sector-type MS, a matrix-assisted laser desorption/ionization (MALDI) time-of-flight (TOF) MS, and an electrospray ionization (ESI) TOF MS. These models are designed for a wide variety of molecules, from simple diatomic molecules to protein complexes. The MALDI and ESI processes can ionize proteins.

"The superconducting molecule detectors can be installed within conventional MS instrument geometry by replacing the conventional RT detectors, such as microchannel plates and electron multipliers. Our current superconducting molecule detection system includes a superconducting molecule detector, a cryogen-free 0.3 K or 4 K cryostat, and an RT semiconductor-based analog and field programmable gate array (FPGA)-based digital signal processing (DSP) system."

Ohkubo: Fundamental Limits to Conventional MS Detectors

Ohkubo also said that conventional MS detectors had a number of fundamental limitations: "Conventional molecule detectors for MS rely on secondary electron emission for molecule incidents on the detector surface. This detection mechanism leads to fundamental limits for mass analysis, particularly with regards to detection efficiency reduction for high mass molecules, the lack of separation between ions with different charge states, an m/z, and a lack of separation among multiple neutral fragment molecules.

"Superconductivity offers another way to detect molecules by using sensitivity for phonons created upon the molecular incident. Superconducting sensors have a sensitivity for deposited kinetic energy instead of the multiplication of a secondary electron emitted from the detector surface.

"The kinetic energy of ions accelerated by a constant voltage difference is independent of mass. Thus, given the superconducting molecule sensors, mass-independent detection efficiency can be realized using the sensitivity to the deposited kinetic energy. Nano-structured superconducting sensors can discriminate different charge states, an ability that can solve the problem of peak overlap between different charge states at the same m/z, for example, doubly-charged nitrogen-molecule ions and singly-charged nitrogen atom ions, m/z=14.

"In addition, kinetic energy sensitivity realizes direct mass separation among multiple fragments created by dissociation without ionization. The dissociation is important for tandem MS instruments that enable molecular structural analysis. Conventional molecule detectors cannot separate different neutral molecules, called neutral loss in the MS community."

Ohkubo: System has Sub-ns Response Time, Sensitivity to Proteins

Ohkubo added that the 1 mm macrosize nano SC detectors they tested had a 1 ns response time: "We realized a response time of better than 1 ns for a single molecule impact, which is critical for TOF measurement in TOF MS. This response time was realized in collaboration with the National Research Council's Institute of Cybernetics and the National Institute of Information and Communications Technology (NICT).

"An SC detector recorded 360 ps, comparable or better than electron multiplier detectors, together with high sensitivity for high-mass biomolecules such as immunoglobulin multimers. A large sensitive area was achieved by arraying pixels or adjusting nano-structure for practical use.

"We also accidentally found that the superconducting detectors covered by a 700 nm-thick SiO_2 layer are still sensitive to molecule incidents. Phonons can propagate in the SiO_2 layer and reach the superconductor, breaking Cooper-pairs.

"This means that the SC detectors can operate even when the whole detector-surface is covered by molecules, resulting in a very long lifetime. In contrast, the detection sensitivity of the conventional detectors degrades significantly when the surface is contaminated.

"A minimum detector size of about 200 µm will be needed for practical MS use, and 1 cm is preferable. We are pursuing these detector sizes as part of the current project.

"MS instruments normally require two types of detectors, one for linear-mode and another for reflectron-mode. The linear-mode has a high sensitivity but a low mass resolution, while the reflectron-mode has a high mass resolution but a lower sensitivity. We are currently constructing an MS instrument equipped with two superconducting detectors: one with a superconducting tunnel junction (STJ) for the linear position and another with a superconducting nanostripline detector (SSLD) for the reflectron position. The STJ and SSLD detectors are fitted to the properties of the two positions." ❍

HZB Researchers Claim Common Magnetic Origin for Iron HTS

Researchers with Helmholtz-Zentrum Berlin (HZB) have claimed to have found evidence for a common magnetic origin for superconductivity in iron chalcogenide and pnictide superconductors. Other institutions involved in the research include Tulane University, Renmin University in Beijing, China, Institut Laue-Langevin (ILL) in Grenoble, France, the University of New Orleans (UNO), the National Institutes of Science and Technology (NIST), the University of Maryland, Johns Hopkins University, and Oak Ridge National Lab.

"Use of the beamtime was provided through HZB, which is financed by the city of Berlin and the German Federal Government, and further support was provided by the Deutsche Forschungsgemeinschaft, a German research foundation," added Dimitri Argyriou, Researcher at HZB involved in the study. "Work at Tulane is supported by a National Science Foundation (NSF) grant for materials and equipment and a DOE grant for personnel costs. Work at the Advanced Matertials Research Institute (AMRI) at UNO was supported by a Defense Advanced Research Projects Agency (DARPA) grant.

"Work at NIST is in part supported by a NSF grant. Work at Johns Hopkins University's Institute

for Quantum Matter is supported by the DOE.

"An important part of our results is that we were able to provide the mechanism responsible for superconductivity, namely a magnetic mode at the (π,π) position, and show that it is common to both pnictides and chalcogenides. This suggests that the physics behind the magnetically-driven superconductivity is very similar, if not identical, for both families."

Researchers Worked with $Fe_{1.02}Te_{1-x}Se_x$

The researchers worked with the iron chalcogenide $Fe_{1.02}Te_{1-x}Se_x$, structurally the simplest of the Fe-based superconductors. Although the Fermi surface in iron chalcogenides is similar to iron pnictides, the parent compound $Fe_{1+y}Te$ exhibits an antiferromagnetic order with an in-plane magnetic wave vector (π,0). The magnetic order in chalcogendies contrasts with pnictide parent compounds where the magnetic order has an in-plane magnetic wave vector (π,π) that connects hole and electron parts of the Fermi surface.

Despite these differences, both the iron pnictide and chalcogenide superconductors exhibit a superconducting spin resonance around (π,π). A central question in this burgeoning field is therefore how (π,π) superconductivity can emerge from a (π,0) magnetic instability. The researchers also reported a magnetic soft mode evolving from a (π,0)-type magnetic long-range order, associated with weak charge carrier localization.

"The fact that the antiferromagnetic structure has different propagation vectors in undoped parent pnictide and chalcogenide compounds is significant in itself," stated Argyriou. "The second item of significance is the fact that despite this, the magnetic resonance appears at the same position for both.

"Superconductivity in chalcogenides appears only when the (π,0)-type magnetic long-range order is suppressed and resonance at (π,π) becomes dominant over short-range correlations at (π,0). This suggests that the resonance at (π,π) is indeed significant with respect to superconductivity.

"Among the next steps in this research is the need to establish in a quantitative manner the spectral weight associated with both order parameters as a function of composition. Further, we need to have a detailed understanding of the (π,0) excitation spectrum in order to asses if these excitations are best described by an itinerant or localized model." ❍

Cobham Adds Sumitomo Manufacturer Info to Software Tool

Cobham Technical Services, a subsidiary of Cobham plc based in Leatherhead, UK, has reportedly modified its QUENCH electromagnetic software tool for modeling the quenching process in superconducting materials to include a library containing comprehensive manufacturer-supplied material characterization data for Sumitomo Electric Industries' DI-BSSCO bismuth-based superconducting wire. The addition will expand the capabilities of Cobham's QUENCH software, which is designed to simplify the design and prototyping stages of applying HTS.

The QUENCH tool for modeling the superconducting quenching process is available as part of Cobham's Opera CAE software suite for low frequency electromagnetic simulation. QUENCH offers multi-physics modeling that couples the electromagnetic and thermal modeling processes, and results can be post-processed to provide users with views and analyses of the potentially damaging effects of quench propagation as the wire heats up and becomes resistive. ❍

Deadline Approaches for SC Industry Award Nominations

The deadline for nominations for the Superconductor Industry Person of the Year and

Lifetime Achievement Awards is November 27th. For more information on the awards and nominee criteria, please visit: http://superconductorweek.com/cms/index.php/2010-SCIPOY.html. In order to make a nomination, please submit the name of the individual you wish to nominate, the affiliated institution, and any particular research or achievement that prompted the nomination to scipoy@superconductorweek.com. 2010 marks the first time Superconductor Week has awarded the Superconductivity Industry Awards since 2006. ❍

Superconductor Week
Commercialization · Markets · Products
Business Developments · R&D · Cryogenics
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U.S. Superconductivity Patents

Gravity Gradiometer

Technological Resources PTY. Ltd

2010-08-31

U.S. Patent No. US7784343

A gravity gradiometer is disclosed which has a sensor in the form of bars which are supported on a mounting which has a first mount section and a second mount section. A first flexure web pivotally couples the first and second mount sections about a first axis. The second mount has a first part, a second part and a third part. The parts are connected by a second flexure web and the parts are connected by a third flexure web. The bars are located in housings and form a monolithic structure with the housings respectively. The housings are connected to opposite sides of the second mount section. The bars are connected to their respective housings by flexure webs. Transducers are located in proximity to the bars for detecting movement of the bars to in turn enable the gravitational gradient tensor to be measured.

SC Cable Line

2010-08-31

U.S. Patent No. US7786385

A SC cable line includes a heat insulation pipe for a fluid for transporting a fluid having a temperature lower than an ordinary temperature and a SC cable housed in the heat insulation pipe for a fluid. The SC cable including a cable core in a heat insulation pipe for a cable is housed in the heat insulation pipe for a fluid to make a temperature difference between the inside and outside of the heat insulation pipe smaller than that in a situation of laying in an atmosphere. In addition, the SC cable has a double heat insulation structure formed with the heat insulation pipe for a cable and the heat insulation pipe for a fluid. Therefore, the SC cable line can effectively reduce heat intrusion from the outside into the cable.

SC Machine Stator

American Superconductor Corporation

2010-08-31

U.S. Patent No. US7786645

A stator for an electrical machine includes a back iron including a substantially cylindrical annular structure having an inner surface and an axis. A plurality of supports are fabricated of non-magnetic material, each support extending parallel to the axis of the annular structure along the inner surface of the annular structure, each support including a primary base and at least two primary support members. The primary bases substantially conform to the inner surface of the back iron with the primary support members extending radially inward from the primary base towards the axis of the annular structure. A stator winding is positioned between the at least two primary support members and between the primary base of the support and the axis of the annular structure.

Ferroelectric Phase Shift Controller

Omega-P, Inc.

2010-08-31

U.S. Patent No. US7786675

The present invention relates to methods and systems for fast ferroelectric tuning of RF power used in a particle accelerating system. By adjusting the voltages fed to the ferroelectric phase shift controller, the amplitude and phase of the RF power wave are altered, thus changing the coupling of the power generating circuit and the SC cavity. By altering this coupling rapidly, maximum power transfer efficiency can be achieved, which is important given the large amounts of power shunted through the particle accelerating system. In one embodiment, the ferroelectric tuner is optimally made of a magic-T waveguide circuit element and two-

phase shifters, although other implementations of the system may be utilized as well.

Signal Inversion in SC Logic Gates

Northrop Grumman Systems Corporation

2010-08-31

U.S. Patent No. US7786748

In one embodiment, the disclosure relates to a single-flux quantum logic gate capable of providing output from one of the two inputs, which is also known as the A and NOT B gate. The logic gate includes a first input gate and a second input gate for respectively receiving a first input pulse and a second input pulse. An output gate is wired in parallel with the first input gate. A first Josephson junction and a second Josephson junction are connected to the first input gate and the second input gate, respectively. A cross-coupled transformer is also provided. The cross-coupled transformer diverts the first pulse from the output gate if the second pulse is detected at the second input gate. In an optional embodiment, the first Josephson junction has a first I_c which is selected to be less than the I_c of the second Josephson junction.

Multiphase Clock for SC Electronics

Hypres, Inc.

2010-08-31

U.S. Patent No. US7786786

A multiphase clock circuit is presented in which bit errors are propagated only for the duration of the clock cycle in which a bit error occurs. The clock circuit recovers automatically from bit errors and is capable of operating at a high frequency with high clock precision. The multiphase clock circuit can also generate a plurality of clock pulse streams, each pulse stream at the same clock frequency, with fixed phase relationships among the streams. The multiphase clock circuit includes a master clock signal of frequency fc which is applied to a divide by N frequency divider circuit for producing a base clock signal of f_c/N. The base clock signal is sequentially applied to the data input of a series chain of N clocked data flip-flops (DFFs) each of which is simultaneously clocked by a clock signal of frequency f_c to produce N clock signals of base frequency f_c/N and separated from each other by a constant time delay of $T=1/f_c$.

Adiabatic Quantum Computing

D-Wave Systems Inc.

2010-08-31

U.S. Patent No. US7788192

A method for quantum computing using a quantum system comprising a plurality of qubits is provided. The system can be in any one of at least two configurations at any given time including one characterized by an initialization Hamiltonian HO and one characterized by a problem Hamiltonian HP. The problem Hamiltonian HP has a final state. Each respective first qubit in the qubits is arranged with respect to a respective second qubit in the qubits such that they define a predetermined coupling strength. The predetermined coupling strengths between the qubits in the plurality of qubits collectively define a computational problem to be solved. In the method, the system is initialized to HO and is then adiabatically changed until the system is described by the final state of the problem Hamiltonian HP. Then the state of the system is read out by probing an observable of the ÃX Pauli matrix operator.

Method for Producing Composite Cable

General Cable Superconductors Limited

2010-09-07

U.S. Patent No. US7788893

A cable winding machine for winding together a multiple number of subconductors into a composite cable includes holding means for holding a first subconductor in the machine direction, and in a predetermined orientation of the first subconductor about its longitudinal axis as it moves through the machine; a first rotating member arranged and rotate the second subconductor around the first subconductor as the second subconductor moves through the machine and one or more further rotating members arranged to hold further subconductors aligned in the machine direction and in a predetermined orientation about their longitudinal axes and rotate the further subconductors around the subconductors wound with one another in the first winding stage of the machine.