HIGH T_c UPDATE

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ARPA

NOTA BENE:

Ru-1212

$RuSr_2GdCu_2O_8$ (Ru-1212) is currently of considerable interest because of recent reports of coexistence of ferromagnetism and bulk superconductivity in this material. A preprint by J. W. Lynn (NIST-Gaithersburg) et al. describes the results of a neutron-diffraction study of the magnetic order in *Ru-1212.* The authors found that the *Ru* moments order antiferromagnetically at T_N = 136(2) K, coincident with the temperature previously reported as the onset of ferromagnetism. Neighboring spins were found to be antiparallel in all three directions of the simple tetragonal *Ru* lattice, with a low-temperature moment of 1.18(6) μ_B along the c axis. The measurements put an upper limit of ~0.1 μ_B for any net zero-field moment, with fields exceeding 0.4 T needed to induce a measurable magnetization. The neutron data therefore do not reveal any ferromagnetic component associated with the *Ru* ordering. The *Gd* ions (with the expected moment of 7 μ_B at the body-centered positions of the *Ru* lattice) order independently at T_N = 2.50(2) K with the same antiferromagnetic structure as the *Ru*.

$RBa_2Cu_3O_{7-\delta}$

According to a preprint by T. Xiang (Beijing) and W. N. Hardy (UBC), the anisotropy in the temperature dependence of the in-plane and c-axis conductivities of high-T_c cuprates in the superconducting state is consistent with a strong in-plane momentum dependence of both the quasiparticle scattering rate and the interlayer hopping integral. The authors applied the cold-spot scattering model proposed by L. B. Ioffe and A. J. Millis [Phys. Rev. B **58**, 11631 (1998)] to the superconducting state and found that the c-axis microwave conductivity σ_c varies approximately as T^3 in an intermediate temperature regime, in good agreement with experimental results for optimally doped *$YBa_2Cu_3O_{7-\delta}$*.

A *^{63}Cu* NMR study of *$YBa_2(Cu_{0.99}Zn_{0.01})_3O_{6.7}$* has been carried out by M.-H. Julien (Grenoble and St. Martin d'Hères) et al. Doping the *YBCO* with nonmagnetic *Zn* impurities produces a considerable broadening of the *^{63}Cu* NMR spectra and leads to an increase of low-energy magnetic fluctuations detected in *^{63}Cu* spin-lattice relaxation measurements. Using a model-independent analysis, the authors conclude that these effects are due to the development of staggered magnetic moments on many *Cu* sites around each *Zn* atom, and that the *Zn*-induced moment in the bulk susceptibility might be explained by this staggered magnetization.

The complex surface impedance of a number of *$GdBa_2Cu_3O_{7-\delta}$* single crystals has been measured at 10, 15, and 21 GHz by R. J. Ormeno et al. (Birmingham) using a cavity-perturbation technique. In measurements at low temperatures, the authors observed a marked increase in the effective penetration depth and surface resistance associated with the paramagnetic and antiferromagnetic alignment of the *Gd* spins. The effective penetration depth has a sharp change in slope at the Néel temperature $T_N \approx$ 2.25 K, and the surface resistance peaks at a frequency-dependent temperature below 3 K.

The x-ray standing-wave technique has been used by A. Kazimirov (Northwestern) et al. to study the lattice location of rare-earth atoms in thin films of *$RBa_2Cu_3O_{7-\delta}$ (R = Gd, Pr).* The films had a thickness of 200 nm and were grown by pulsed-laser deposition (PLD) on *$SrTiO_3$* (001) substrates. The standing wave was generated by kinematic Bragg diffraction. Analysis of the angular dependence leads to information on the degree of site interchange of *R* and *Ba*. The authors found a clear indication of *Pr* substitution for *Ba*.

Bi Cuprates

As noted in a preprint by S. Lupi (Roma) et al., an optical pseudogap has been assumed to open at low T in the anomalous Drude absorption, which models the optical conductivity $\sigma(\omega) \propto \omega^{-1}$ of high-T_c superconductors by a

linewidth $\Gamma \approx 10^3$ cm^{-1} varying with ω. Instead, the authors observed in measurements of $\sigma(\omega)$ of *$Bi_2Sr_2CuO_6$ (Bi-2201)* down to 10 cm^{-1}: (a) a normal Drude term with Γ = 35 cm^{-1} at 30 K, in good agreement with transport data, and (b) a strong band peaked in the far infrared (FIR), likely due to bound charges, whose tail exhibits the ω^{-1} dependence. As the FIR peak softens for $T \rightarrow 0$, it opens a pseudogap-like depression in $\sigma(\omega)$ following ordinary sum rules.

The variation of T_c with hole concentration p in the *La*-doped *Bi-2201* system *$Bi_2Sr_{2-x}La_xCuO_{6+\delta}$* has been investigated by M.-Y. Choi and J. S. Kim (Sungkyunkwan). The authors found that while T_c vs p in the *Bi-2201* system does not follow the systematics found in many other high-T_c cuprates, it does resemble the behavior found in *Zn*-doped cuprates. However, the authors suggest that the strong scatterer in the *Bi-2201* system is a vacancy on the *Cu* site, contrary to the behavior in the *Zn*-doped cuprates.

Two experimental approaches to circumvent the problem of self-heating in current-voltage (I-V) measurements on small mesa samples of *$Bi_2Sr_2CaCu_2O_{8+\delta}$ (Bi-2212)* are described in a preprint by P. J. Thomas et al. (Birmingham). The authors made simultaneous dc and temperature measurements, which allowed corrections for heating to be made. The authors also made short-pulse measurements, where the I-V characteristics and the mesa temperatures could be measured on a μs time scale. These measurements made it possible to derive intrinsic I-V characteristics, even in the presence of appreciable self-heating. Self-heating leads to a significant depression of the apparent energy gap, and accounts, in major part, for the S-shaped characteristics often reported at high currents.

Using bulk samples, H. Fujii (NRIM) et al. investigated the stable region of the *Ca_2PbO_4* impurity phase in *$Bi_{2-x}Pb_xSr_2CaCu_2O_{8+\delta}$ [(Bi,Pb)-2212]/Ag* tapes as a function of oxygen partial pressure and temperature. Following these studies, the authors prepared *(Bi,Pb)-2212* tapes by applying rapid cooling. The authors found that rapid cooling is effective in increasing the critical current density J_c and improving the coupling of grains. The improvements are due to the reduction in the segregation of *Ca_2PbO_4* at the *(Bi,Pb)-2212* grain boundaries.

A mathematical model has been developed by J. Pitel et al. (Bratislava) to predict the critical currents in *Bi-2223 Ag*-sheathed tapes consisting of two groups of filaments with orthogonal c-axis texture (i.e., filaments oriented either parallel or perpendicular to the tape surface). Taking into account the anisotropy of $J_c(B,\theta)$, where θ is the angle of the magnetic flux density **B** relative to the c axis of the filaments, the authors were able to calculate the anisotropy (field-angle dependence) of the overall critical current density I_c(**B**) of the tape. The calculations revealed that the anisotropy in I_c(**B**) could be significantly reduced, but only at the price of a simultaneous decrease in the current-carrying capacity of the tape.

A dip-coating-then-stacking (DIS) process, which is simpler and easier than the oxide-powder-in-tube (OPIT) process, has been developed by Y. S. Sung et al. (NRIM) to fabricate *$Bi_2Sr_2Ca_2Cu_3O_{10+\delta}$ [(Bi,Pb)-2223]* conductors. In the DIS process, multi-core tapes were prepared by stacking several layers of single-side dip-coated *Ag* strips and then wrapping them with *Ag* foil. After burning at 500°C to remove organic materials, the tapes were rolled to increase the packing density of the oxide core, and then were heat-treated twice at 838°C in air with an intermediate pressing. The resulting tapes had transport critical currents of $I_c \sim 73$ A and transport critical current densities of $J_c \sim 1.8 \times 10^4$ A/cm^2 at 77 K and 0 T. Considering the simplicity of the DIS process relative to the OPIT process and the respectable values of I_c and J_c already achieved, the authors suggest that the DIS process is a promising alternative to OPIT for fabricating multi-core *(Bi,Pb)-2223* tape conductors.

Films

Chemical-solution-deposition (CSD) processing for the deposition of *$YBa_2Cu_3O_{7-\delta}$ (Y-123)* on biaxially textured substrates shows promise as a low-cost technique for the fabrication of superconducting tapes without the need for high-vacuum apparatus. A preprint by K. Yamagiwa (SRL-ISTEC) et al. reports success in preparing in-plane-aligned *Y-123* films by CSD processing on *CeO_2*-buffered *MgO* substrates. The *CeO_2* (100) buffer films were deposited on *MgO* (100) single-crystalline substrates by pulsed-laser deposition (PLD). For CSD coating, a homogeneous coating solution having a molar ratio of *Y:Ba:Cu* = 1:2:3 was prepared by dissolving metal naphthenates in toluene. This solution was spin-coated on the *CeO_2*-buffered *MgO* substrate. The precursor films were calcined at 425°C and then fired at various temperatures under low oxygen pressure. All *Y-123* films showed strong (00n) x-ray peaks, indicating c-axis orientation perpendicular to the substrates and in-plane-aligned a/b axes. The zero-resistance T_c of an *Y-123* film was 91.5 K, and J_c was 1.2×10^5 A/cm^2 at 77 K and 0 T. *Y-123* films similarly deposited on *YSZ* (yttria-stabilized zirconia) (100) single-crystalline substrates, however, reacted with the substrate (forming the *$BaZrO_3$* phase) and did not show satisfactory superconducting properties.

A preprint by J. Xu et al. (Chengdu) reports the preparation of highly c-axis-oriented *Y-123* films on *$LaAlO_3$* (100) substrates by a self-template technique. The films had $T_c \geq 90$ K, $\Delta T_c \leq 1$ K, and surface resistance R_S(77 K, 10 GHz) ~ 500 $\mu\Omega$. The best sample had an R_S of 330 $\mu\Omega$ at 77 K and 10 GHz. The self-template method is a two-step process: First, an initial *Y-123* layer is grown at a high substrate temperature T_S in a

three-target dc magnetron sputtering system. Then, after T_S is quickly lowered by 20-50°C, a second *Y-123* layer is grown epitaxially on the first one, up to a total thickness of about 400 nm.

The oxygenation of thin, epitaxial c-axis-oriented $RBa_2Cu_3O_{7-\delta}$ films deposited on closely matched substrates has been studied by A. Kursumovic (IRC-Cambridge) et al.: $YBa_2Cu_3O_{7-\delta}$ on $SrTiO_3$ and $GdBa_2Cu_3O_{7-\delta}$ on $NdGaO_3$. The kinetics of oxygen in-diffusion was studied by resistivity changes during corresponding isothermal annealing in a reduced oxygen atmosphere. The authors found the rate of oxygen uptake to be dependent on film thickness, abruptly increasing after some critical film thickness of about 40 nm. The increase in the rate of oxygen uptake with increasing film thickness continued over several orders of magnitude and then saturated for a film thickness of about 500 nm. AFM (atomic-force-microscope) studies revealed a transition from a dislocation-free to a dislocation-developed microstructure at around the critical film thickness. The authors suggest that these dislocations serve as easy paths for c-axis oxygen diffusion.

Applications

A preprint by J. C. Macfarlane et al. (National Physical Laboratory, Teddington) reports the fabrication and characterization of high-temperature-superconducting resistively shunted superconducting quantum interference devices (HTS R-SQUIDs) consisting of two $YBa_2Cu_3O_{7-\delta}$ *(YBCO)* grain-boundary junctions shunted by gold-film resistors of ~20 μΩ. The small value and stability of the resistor allow narrow-band heterodyne oscillations to be generated between the Josephson oscillations in the individual junctions. The frequency can be precisely controlled in accordance with the ac Josephson effect by adjustment of an external current applied to the *YBCO/Au/YBCO* shunt resistor, and the linewidth is determined in principle only by Johnson noise in the resistor. The authors report measurements of the signal power (~nW), tunability of the center frequency from 5 to 50 GHz, frequency stability, and linewidth of the heterodyne Josephson oscillation. Although the authors observed linewidth broadening due to nonthermal fluctuations, the measured linewidth of ~30 kHz at T = 17 K at a center frequency of 24 MHz is evidently the narrowest reported for Josephson oscillations in an HTS device of this type.

A preprint by M. B. Srinivas (Hyderabad) et al. reports investigations of the properties of liquid nitrogen not only as a coolant but also an insulator in high-temperature superconducting electrical power apparatus. The authors found that while liquid nitrogen exhibits a small dielectric loss at power frequency, this loss is not intrinsic to the liquid but is attributable to the presence of impurities. The authors present extensive measurements of the dielectric loss under a variety of test conditions and conclude that liquid nitrogen is eminently suitable as a dielectric/insulating medium for HTS power apparatus.

Vortices

A preprint by P. Le Doussal (Ecole Normale Supérieure) and T. Giamarchi (Orsay) discusses the question of the generation of topological defects (dislocations) by quenched disorder in two-dimensional periodic systems, such as vortices in type-II superconducting films. The authors extend their earlier work to include effects of freezing and pinning of dislocations at low temperature. They conclude that there is a wide region of length scales, temperature, and disorder where dislocation-free Bragg-glass-like behavior should be observable.

The energy of a tilted vortex trapped on an inclined columnar defect (CD), produced by heavy-ion-beam irradiation, has been calculated by I. Baladié and A. Buzdin (Bordeaux). If the CD radius is larger than the superconducting coherence length, the authors find that in a weak magnetic field, vortices always prefer to be on a tilted CD than to be aligned along the external field. The authors note that the existence of inclined trapped vortices could be revealed by torque measurements and could also lead to anisotropy of the in-plane resistivity and the critical current.

A preprint by R. D. Santiago (San Jose State) et al. reports studies of the vortex states of *Bi-2212* and *Tl-2223* by muon spin resonance (μSR). Using a maximum-entropy technique to analyze the data, the authors extract twin-peak signatures in the main vortex signals. The splitting is qualitatively in agreement with theoretical predictions for d-wave superconductors, but the magnitudes of the splittings are about twice the predicted values.

According to Y. Kopelevich and P. Esquinazi (Leipzig), the vortex lattice does not melt along a material- and sample-dependent boundary in the H-T (field-temperature) plane. Instead, it depins from the underlying crystal matrix and becomes more ordered. The authors assert that when the depinning line is sharp, the difference between the equilibrium magnetization $M_{eq}(H,T)$ of the pinned and unpinned vortex lattice leads to the observed step-like change $\Delta M_{eq}(H,T)$.

Starting from the BCS theory, M. Machida (JAERI and CREST) et al. have developed a microscopic theory for stacks of intrinsic Josephson junctions. The authors derive model equations for the macroscopic longitudinal and transverse dynamics and show that low-energy fluctuations around the Josephson relation are responsible for the longitudinal charge-density modes propagating along the stacking direction. The authors also show that under

certain approximations, their results reduce to the sine-Gordon equation or the Koyama-Tachiki model.

A preprint by L. M. Fisher (Moscow) et al. presents a theory for the onset of vortex penetration into a hard, isotropic, semi-infinite superconductor after rotation of a magnetic field **H** applied parallel to the surface. The authors derive macroscopic equations and apply them for different magnetic histories. The authors find that the vortices entering into the sample are not parallel to the direction of **H**. Instead, the authors argue that the angle between the vortices and **H** can be large, even approaching $\pi/2$.

Scaling exponents describing the roughness of penetrating flux fronts in high-T_c superconductors are determined theoretically in a preprint by A. E. Khalil (Xavier). The theory is based on the solution of a nonlinear diffusion equation describing the penetration of vortex lines into a type-II superconductor. The author notes that the results of simulations are in good agreement with recent experimental magneto-optical observations in $YBa_2Cu_3O_{7-\delta}$.

Theory

According to a preprint by M. E. Flatté (Iowa), the recently observed properties of quasiparticle resonant states near impurities on the surface of *Bi-2212* demonstrate that in-plane Andreev processes are either absent or phase-incoherent. The author's analysis of the spectral and spatial details of the electronic structure near a *Zn* impurity also suggest an effective magnetic component of the impurity potential. The author proposes further experiments to clarify whether the effective moments of nearby impurities are correlated.

Using the linearized Bogoliubov-de Gennes equation, L. Marinelli (Harvard) et al. have studied the quasiparticle spectrum of a two-dimensional d-wave superconductor in the mixed state $H_{c1} << H << H_{c2}$ both analytically and numerically. The authors found that for a Bravais lattice of vortices the spectrum remains gapless when a magnetic field is turned on.

The theory of scanning tunneling spectroscopy of low-energy quasiparticle (QP) states in vortex lattices in d-wave superconductors has been developed by A. S. Mel'nikov (Nizhny Novgorod), taking into account effects caused by an extremely large extension of QP wavefunctions in the nodal directions and the band structure in the QP spectrum. The author analyzes oscillatory structures in the STM spectra, which correspond to Van Hove singularities.

Exotic objects in chiral superfluids and superconductors are discussed in a preprint by G. E. Volovik (Helsinki University of Technology and Landau Institute). These are (a) vortices with fractional quantum numbers (N = 1/2 in chiral superfluids and N = 1/2 and 1/4 in chiral superconductors), which play the role of Alice strings in relativistic theories, and (b) the hedgehog in the isospin field, which is the counterpart of the Dirac magnetic monopole. These objects of different dimensions are topologically connected, and the combined object is called a nexus in relativistic theories. In chiral superconductors, the nexus has magnetic charge emanating radially from the hedgehog, while the half-quantum vortex plays the role of the Dirac string.

A diagrammatic expansion method around the atomic limit (U >> t) for the U-t-t' Hubbard model at half filling and finite temperature has been applied in a preprint by Ph. Brune and A. P. Kampf (Augsburg). By using a continued-fraction representation, the authors ensure that the one-particle Green's function has the correct analytic properties. From an analysis of the spectral function $A(\mathbf{k},\omega)$, the authors find an energy dispersion relation with a $d_{x^2-y^2}$-wave modulation of the energy gap in the insulating phase. This anisotropy compares well with experimental ARPES results on insulating cuprates.

A theory for inelastic neutron scattering (INS) and nuclear magnetic resonance (NMR) experiments in the pseudogap regime of the underdoped high-T_c cuprates has been developed by H. Westfahl Jr. (Illinois-Urbana) and D. K. Morr (Illinois-Urbana and Los Alamos). The authors find that superconducting phase fluctuations greatly affect the temperature and frequency dependence of the spin susceptibility χ'' probed by both experimental techniques. This result explains the appearance of a resonance peak, observed in INS experiments, below a temperature $T_0 > T_c$. In the same temperature regime, the authors find that the ^{63}Cu spin-lattice relaxation rate $1/T_1$, measured in NMR experiments, is suppressed. The authors note that their results are in qualitative agreement with available experimental data.

Universal finite-temperature properties of the 3D XY model, extended to anisotropic type-II superconductors, and universal quantum critical properties in 2D are outlined in a paper by T. Schneider and J. M. Singer (Zürich). The authors review: (a) the mounting evidence for 3D XY behavior in optimally doped cuprate superconductors and the 3D-to-2D crossover in the underdoped regime, (b) finite-size limitations imposed by inhomogeneities, (c) experimental evidence for a 2D XY quantum critical point in the underdoped limit, where the superconductor-to-insulator transition occurs, and (d) emerging implications and constraints for microscopic models.

Using the exact cluster diagonalization and recent quantum Monte Carlo simulations, A. S. Alexandrov (Loughborough) has analyzed the dynamic properties of small polarons and

bipolarons formed by short-range (Holstein) and long-range (Fröhlich) electron-phonon interactions. The exact results agree well with the canonical Holstein theory for a cluster and with the Lang-Firsov theory for a lattice. The author finds that (bi)polarons exist in itinerant Bloch states at temperatures well below the characteristic phonon frequency, no matter which values the parameters of the system take. The author also notes that the bipolaron theory provides a parameter-free expression for T_c, describing the T_c of many cuprates without any fitting parameters.

As noted in a preprint by F. Venturini (W-M-I, Garching) et al., while the low-frequency electronic Raman response in the superconducting state of the cuprates can be largely understood in terms of a d-wave energy gap, a long-standing problem has been an explanation for the spectra observed in A_{1g} polarization orientations. The authors present calculations suggesting that the peak position of the observed A_{1g} spectra is due to a collective spin-fluctuation mode.

An experiment to determine whether there are superconducting pairing fluctuations in the pseudogap regime of the high-T_c materials has been proposed by I. Martin and A. Balatsky (Los Alamos). In the proposed experimental setup, two samples above T_c should be brought into contact at a single point, and the differential ac conductivity should be measured in the presence of a constant applied bias voltage V between the samples. The authors argue that pairing fluctuations will produce a randomly fluctuating Josephson current with zero mean but that the current-current correlator will have a characteristic frequency given by the Josephson frequency $\omega_J = 2eV/\hbar$. The authors also predict that the differential ac conductivity should have a peak at the Josephson frequency with a width determined by the phase-fluctuation time.

A fully self-consistent microscopic model to study the retardation and correlation effects of the barrier within a Josephson junction has been formulated by P. Miller and J. K. Freericks (Georgetown). The junction is described by a series of planes, with electronic correlation included through a local self-energy for each plane. The authors calculate the figure of merit for a Josephson junction, i.e., the product of the critical current I_c and the normal-state resistance R_n for junctions with different barrier materials. Although semiclassical calculations predict that these two quantities are determined by the transmission probabilities of electrons in such a way that their product I_cR_n is constant for a given superconductor at fixed temperature, the authors' self-consistent solutions for different types of barrier do not have this property. The authors suggest some forms of barrier that could increase the I_cR_n product and hence improve the frequency response of a Josephson device.

The quantum-measurement process by a single-electron transistor or a quantum point contact coupled to a quantum bit has been studied by Y. Makhlin (Karlsruhe and Landau Institute) et al. The authors find a unified description of the statistics of the monitored quantity, the current, in the regime of strong measurement; they expect this description to apply for a wide class of quantum measurements. The probability distributions for the current and charge in different stages of the process are derived. In the parameter regime of strong measurement, the current develops a telegraph-noise behavior, which can be detected in the noise spectrum.

Other Activities

The dependence of the transport properties of square Josephson-junction arrays upon the direction of the applied dc current has been studied experimentally and numerically by V. I. Marconi (Bariloche) et al. The authors present: (a) computational simulations of current-voltage curves at finite temperatures for a single vortex in a square ($L \times L$) array ($f = Ha^2/\phi_0 = 1/L^2$) and (b) experimental measurements in 100×1000 arrays in a low magnetic field corresponding to $f \approx 0.02$. The authors find that the transverse voltage vanishes only in the directions of maximum symmetry of the square lattice: the [10] and [01] directions (parallel bias) and the [11] direction (diagonal bias). For orientations different from these symmetry directions, the transverse voltage depends strongly on the angle ϕ of the current.

Flux distributions in an *Y-123* thin film with artificial granularity (a hexagonal-close-packed lattice of 50 μm disks) have been observed by M. R. Koblischka (Oslo) et al. using magneto-optical imaging. At low magnification, flux patterns generated exclusively by the intergranular currents flowing in the intergranular area (effective medium) are directly observed. Two-dimensional flux-density profiles reveal the intergranular current density. Observations at high magnification reveal flux penetration and pinning within the individual disks, and the authors then can identify and study the different contributions of the intergranular and intragranular current densities to the flux patterns. The authors show that their model sample reproduces several features observed in *Ag*-sheathed *(Bi,Pb)-2223* tapes.

Both ferromagnetic- and superconducting-like magnetization hysteresis loops have been observed by Y. Kopelevich (Leipzig) et al. in highly oriented pyrolytic graphite (HOPG) samples below and above room temperature. The authors also found that both behaviors are very sensitive to low-temperature heat treatment. The authors discuss why magnetic impurities do not appear to be the reason for the observed phenomena.

The weight of a pile of pellets of *Bi-2212* superconductor has been studied by H. Reiss (ABB Alstom Power Technology) when cooling it in liquid nitrogen. The results were compared

with those for normal or nonconductors, in standard volumes and under the same temperature and heat-transfer conditions. Two different experiments were performed: (a) measurement of apparent weight when dipping samples housed in a sample holder into the coolant under thermal equilibrium and (b) measurement of the total weight of the cryostat, cryogenic liquid, sample holder, and samples. Both experiments yielded a small increase of the superconductor sample weight. Application of an external magnetic field eliminated the observed effect, suggesting a possible correlation of superconductivity with gravity. A thorough discussion of errors is included. The author invites colleagues at other laboratories to check his results.

Overview

A paper analyzing microwave-cavity-perturbation methods and showing how they can be used to study the dynamic magnetic and dielectric response in the GHz frequency range has been prepared by Z. Zhai et al. (Northeastern). Using pure *Nb* superconducting cavities, the authors are able to measure relative changes with exceptionally high precision and sensitivity. The authors briefly describe how this method has been used to investigate magnetodynamics in the spin-chain material Sr_2CuO_3, dielectric loss peaks in the spin-ladder compound $Sr_{14}Cu_{24}O_{41}$, and dimensional resonances in $SrTiO_3$ (21 refs.).

Contributed by John R. Clem

Contents:

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TECHNOLOGY NEWS

(Also see Applications section of Nota Bene.)

This section describes progress in manufacturing, product development, and technology transfer in the high-T_c superconductivity field. Please send your contributions (product development information, news regarding technology transfer efforts, or any information you would like to share about your corporation or laboratory) to the editor.

Successful completion of the first 225 kV-rated superconducting coaxial cable prototype with cryogenic insulation was announced by Pirelli Cavi e Sistemi SpA, in the context of its research and development agreement with Electricité de France. The Pirelli-EDF cooperation started in October 1997 and is the first project in Europe aimed at the development of a high-capacity HTS cable system. The project foresees the feasibility study, construction, experimentation, and long-term test of a complete prototype system including a 50 m cable length. The purpose of the project is to demonstrate the industrial feasibility of HTS cables suitable for electrical power transmission.

The superconducting cable prototype has been developed and manufactured by Pirelli at its dedicated pilot HTS cable manufacturing facility using HTS wire supplied by American Superconductor Corporation (ASC). The cable is of the cold dielectric coaxial design, and matches the requirements of European transmission networks. The prototype cable, 20 m long, can carry up to 2600 A alternating current with superconductor electrical losses of less than 1 W/m. Its electrical insulation is designed to withstand an alternating voltage of 225 kV between phases. In a three-phase transmission system, this HTS cable would enable a transmitted power of 1000 MVA, a level that would today only be achieved at 400kV with conventional cable technology. In 1987 Pirelli started its R&D activity in the HTS superconductivity field and at the end of 1998 successfully completed the qualification of a 115 kV, 400 MVA warm dielectric superconducting cable, developed in the context of an agreement with the Electric Power Research Institute (EPRI) under the US Department of Energy (DOE) Superconductivity Partnership Initiative. Subsequently, in October 1998, the DOE awarded a contract to Pirelli to install three 120 m, 24 kV/2400 A, HTS warm dielectric cables in the network of Detroit Edison – the first HTS system operating in a real network and will replace the existing conventional cable system comprising nine copper-conductor cables.

Concurrently, Pirelli Cavi e Sistemi is developing advanced cold dielectric coaxial superconducting cable systems in Italy, Germany, and France. The objective is to manufacture, install, and demonstrate various types of HTS cables in commencement of commercialization. For further information, contact Marco Nassi, R&D Manager, Superconducting Technologies, Pirelli Cavi e Sistemi, Viale Sarca 222, I-20126 Milan, Italy; telephone +39 02 6442 3676; telefax +39 02 6442 9431; e-mail marco.nassi@pirelli.com.

Three 100-foot long cables have been delivering power to three of Southwire's manufacturing facilities at its Carrolton, Georgia, headquarters since early January of this year, signaling a major step toward commercialization of the technology. Intermagnetics General Corporation, one of the component providers for the Southwire project, hailed the unveiling of this practical use of HTS cables as a milestone in the effort to commercialize HTS applications for the electric utility industry. The company is proceeding with the next phase of HTS development – bringing the cost of HTS in line with the price-performance levels needed to make it commercially viable to manufacture superconducting equipment such as transformers, cable, motors, generators, and fault current controllers. Intermagnetics is also working with industry and government partners on prototype superconducting transformers and current controllers, as well as other devices that are now in varying stages of development and testing. These projects are expected to lead to commercialization over the next three to five years. For information, contact Intermagnetics General Corporation, 450 Old Niskayuna Road, P.O. Box 461, Latham, NY 12110-0461; telephone (518) 782-1122. Or contact Gary Leftwich, Senior Communications Specialist; telephone (770) 832-4884; e-mail gary_leftwich@southwire.com.

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B. A. Albiss, M. K. Hasan, M. A. Al-Akhras, I. A. Al-Omari, A. Shariah, J. Shobaki, K. A. Azez, and H. Ozkan, "Dissipative Behavior and γ-Irradiation of Silver-Sheathed $Bi_{1.8}Pb_{0.4}Sr_2Ca_2Cu_3O_X$ Tape." To be published in Physica C (in press). Department of Physics, Jordan University of Science and Technology, P.O. Box 3030, Irbid 22110, JORDAN; telefax +962 2 295 123; e-mail qaseer@just.edu.jo. Key words: *Bi*-based tape, critical current, magnetoresistance, γ irradiation. 74.60.Ge; 74.60.Jg.

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COMING EVENTS

*(An * indicates a previously listed event. Also see complete listing of upcoming conferences and workshops at our Web site http://www.iitap.iastate.edu/htcu/comevents.html.)*

March 27 - 30, 2000: 7th International Symposium on Trends and Applications of Thin Films (TATF'2000), Nancy, France. Organized by the French Vacuum Society. Will focus on the newest trends and

applications of thin films – super-hard and complex coatings; thin films for sensors; surface characterization and process control; and nanostructures, multifunctional coatings, and optoelectronics. Short courses will include plasma processes for film growth, stress formation in thin films, and characterization methods. Exhibition of related equipment and services. Contact SFV/ref TATF2000, 19 rue du Renard, F-75004 Paris, France; telephone +33 1 53 01 9030; telefax +33 1 42 78 6320; e-mail sfv@vide.org; Web site http://vide.org/tatf2000.htm.

**June 20 - 22, 2000:* 11th International Cryocooler Conference (ICC11), Keystone Resort and Conference Center, Keystone, Colo. Technical program will consist of oral and poster sessions. Invited technical topics include Stirling and Pulse-Tube cryocoolers, J-T and G-M cryocoolers, new cryocooler concepts, cryocooler component developments, modeling and test techniques, performance and life test data, applications and integration issues, space flight cryocoolers, and low cost cryocoolers. Oral and poster sessions. For information, contact Rodney L. Oonk, ICC11, Ball Aerospace Systems Division, P.O. Box 1062, Boulder, CO 80306-1062; telephone (303) 939-4449; telefax (303) 939-6307; e-mail iccchair@cryocooler.org.

**July 23 - 25, 2000:* International Symposium on Local Lattice Distortions (LLD2K), AIST Tsukuba Research Center, Ibaraki, Japan. Intensive discussions on physics related to local lattice distortions, with the aim of establishing its role in exotic properties of strongly correlated systems such as high-Tc superconductivity, colossal magnetoresistance, and related topics. Topics include local lattice distortions associated with stripes, charge and orbital ordering, lattice anomalies, phase transitions, excited states, and impurities. For further information, contact LLD2K Secretariat, Electrotechnical Laboratory, 1-1-4 Umezono, Tsukuba, Ibaraki, 305-8568, Japan; telephone +81 298 54 5072; telefax +81 298 54 5085; e-mail lld2k@etl.go.jp; Web site http://www.etl.go.jp/~lld2k/.

Sept. 25 - 30, 2000: Third International Conference on Stripes and high-T_c superconductivity (STRIPES2000), University of Rome "La Sapienza," Rome, Italy. Follows previous conferences held during Dec. 1996 and June 1998. Intends to bring together active researchers in the field of stripes and high-T_c superconductivity in order to discuss the latest experimental and theoretical developments, and implication of the stripe phenomena to the future technology. Main topics include stripes formation in perovskites, pairing and stripes, advanced experiments for probing stripe phases, and superconductivity in low dimensions. Meeting will cover various aspects of natural and artificial stripes and charge-ordering phenomena in the cuprates, manganites, nickelates, and other related materials. Topics include stripes in a doped antiferromagnetic lattice, stripes in a polarized electron gas, coexistence of stripes and superconductivity, polaron ordering and lattice-charge instabilities, stripes and Wigner metal-insulator transitions, pairing-mediated by spin fluctuations, pairing-mediated charge fluctuations, superconducting fluctuations in striped phases, superconductivity in mesoscopic metals, superlattice of quantum stripes, and mechanisms for T_c amplification. Various experimental techniques to probe the stripes will be discussed, which include neutron, electron, and x-ray scattering; NMR/NQR, μSR, and high-frequency probes; x-ray and optical spectroscopy; and photoemission. The scientific program of the conference will include invited and contributory talks and some poster presentations. **Abstract deadline, May 30, 2000; preregistration deadline, June 15, 2000.** Conference chair: Antonio Bianconi. For information, contact Anna De Grossi, Conference Secretary, Piazzale Aldo Moro 2, I-00185 Rome, Italy; telephone +39 06 49914343; telefax +39 06 49914387; Web site http://www.bianconi.net.

FYI

(High-T_c Update takes no responsibility for want ads listed in this section.)

Position open: BICC General Superconductors is seeking a Senior Scientist/Engineer to work in its superconductivity group. The successful applicant will be responsible for the advanced development of *Bi-2223* tapes and research into new, cost-effective, high-current conductors with lower ac losses. Candidates should have at least two years of experience in the materials and engineering aspects of superconductors. Ideally, they will have a Ph.D. in a related subject and experience in processing of *Bi-2223* tapes. Applicants must be fluent in English, have a good record of scientific publications, be able to work effectively within a small team, and possess excellent interpersonal and project management skills. BICC General Superconductors is a commercial supplier of *Bi-2223* tapes and HTS current leads. Financial support for relocation will be available to the right candidate. Applications should be made in writing (or e-mail), including full C.V. and salary details, to Linda Bunkell, Administration Manager, BICC General UK Cables Ltd. Technology, Wrexham LL13 9XP, United Kingdom; e-mail lbunkell@biccgeneral-eu.com. For further information about the vacancy, contact Chris Friend, Technical Manager, phone +44 1978 662612; e-mail cfriend@biccgeneral-eu.com; Web site www.bicc-sc.com.

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