VOL. 12, NO. 14 DMS/BES/DOE
JULY 15, 1998 ARPA NSF

NOTA BENE:

Tl-2201

The interlayer tunneling (ILT) mechanism [see P. W. Anderson, *The Theory of Superconductivity in the High-T_c Cuprates* (Princeton University Press, Princeton, NJ, 1997)] predicts that superconductivity is created by interlayer pair tunneling, in contrast to conventional superconductivity, where superconductivity is first created by pairing within each plane. The ILT model has been subjected to a stringent test by A. A. Tsvetkov (Groningen and Lebedev Physical Institute) et al. in a paper to be published in *Nature*. Measurements of the c-axis penetration depth λ_c in *$Tl_2Ba_2CuO_{6+\delta}$ (Tl-2201)* using both interlayer plasma frequency measurements and scanning SQUID microscopy of interlayer Josephson vortices yield $\lambda_c \approx 17$ μm, which can be used to compare the interlayer Josephson coupling energy E_J with the condensation energy E_{cond}. The ILT theory predicts that $\eta = E_J/E_{cond} \sim 1$, a value far outside the range of the experiments, which yield $\eta \approx 0.0024$.

A preprint by B. W. Kang (Kansas) et al. reports studies of the mixed-state Hall effect in *$Tl_2Ba_2CuO_{6+\delta}$ (Tl-2201)* thin films with oxygen content tuned from underdoped to overdoped. Two sign reversals observed in both underdoped and optimally doped samples disappear simultaneously when the sample is slightly overdoped. These results contradict predictions of the time-dependent Ginzburg-Landau (TDGL) and microscopic theories, but confirm that both Hall sign reversals are determined by electronic band structure. The authors' results show that the Hall sign in the underdoped region may be either hole-like or electron-like in the superconducting state.

Vortices

As reported by S.-W. Han (Missouri-Columbia) et al., spin-polarized neutron reflectivity can be used to probe the density of vortices parallel to the surface of thin-film superconductors, thereby permitting the study of vortex-surface interactions. The experiments were performed on a 6000 Å thick c-axis film of *$YBa_2Cu_3O_{7-\delta}$* with the magnetic field applied parallel to the surface.

A preprint by D. T. Fuchs (Weizmann Institute) et al. reports that *$Bi_2Sr_2CaCu_2O_{8+\delta}$ (Bi-2212)* crystals with electrical contacts positioned far from the edges were studied by transport measurements, cut into narrow-strip geometry, and remeasured. The strips showed a dramatic drop in resistance, enhanced activation energy, and nonlinear behavior due to strong surface barriers. The surface barriers also dominate the resistive drop at the first-order phase transition. Because the surface barriers are avoided in large crystals, the authors were able to probe the solid phase and find good agreement with recent predictions of Bragg-glass theory.

The elasticity of a perpendicular flux lattice in a layered superconductor with Josephson coupling between layers has been studied by T. R. Goldin and B. Horovitz (Ben-Gurion). The authors find that for vortex displacements ρ the energy contains $\rho^2 \ln\rho$ terms, so that elastic constants cannot be strictly defined. Instead the authors define effective elastic constants by a thermal average. The tilt moduli have terms $\propto \ln T$, which for $\lambda_J \ll a$, where λ_J is the Josephson length and a is the flux-line spacing, lead to $\langle\rho^2\rangle \propto T/|\ln T|$. The expansion parameter indicates that the dominant low-temperature phase transition is either layer decoupling at high fields ($\lambda_J \gg a$) or melting at low fields ($\lambda_J \ll a$).

Electrical transport measurements by A. Mazilu (Illinois-Chicago) et al. in heavy-ion-irradiated *$YBa_2Cu_3O_{7-\delta}$* thick films reveal a clear maximum of the critical current when the magnetic field is approximately equal to the magnetic field at which all columnar defects are occupied. The authors stress that this result directly indicates that the vortex mobility is greatly reduced when no vacant columns are available. The authors note that this effect is a vestige of the Mott-insulator phase predicted for the vortex system at zero temperature.

A preprint by A. K. Pradhan et al. (SRL-ISTEC) reports on the observation of a first-order melting transition of the flux-line lattice in a twinned $NdBa_2Cu_3O_{7-\delta}$ single crystal by transport (for both **H**||c and **H**||ab) and magnetization measurements. The position in the B-T plane of the kink and hysteresis in resistance coincides with that of the magnetization jump. The results demonstrate the existence of a first-order melting transition in an *RBCO* system containing rare-earth magnetic ions.

The magnetic field and temperature dependence of the Raman response, superfluid density, and NMR relaxation rate in the vortex state of a d-wave superconductor arising from the Doppler shift of extended quasiparticle states have been calculated by I. Vekhter (Guelph) et al. At low temperatures, the authors observe scaling with the variable $TH^{-1/2}$, and they obtain explicit forms of the scaling functions. The authors also derive a universal frequency-dependent scaling relation for the Raman response, and they discuss the breakdown of the single-relaxation-rate approach to the NMR response.

Two-dimensional XY models with both resistively shunted junction (RSJ) and time-dependent Ginzburg-Landau (TDGL) dynamics have been simulated by B. J. Kim et al. (Umeå). The authors found that the vortex response is well described by the Minnhagen phenomenology for both types of dynamics.

Regular square arrays of *Ni* and *Ag* dots with typical diameter and thickness approaching low-T_c superconducting length scales were prepared by Y. Jaccard et al. (UC-San Diego). The authors then studied the transport properties of *Nb* films, grown on top of these dots, in a wide temperature and magnetic-field range. The *Ni* dots were found to act as pinning centers, thereby producing oscillations in the field dependence of the resistance and critical current of the *Nb* film. The periodicity of the oscillations corresponded to the matching field of the dots' lattice spacing. However, such an oscillatory behavior was found to be absent for arrays of nonmagnetic *Ag* dots. Comparison between the two types of arrays suggests a magnetic origin of the enhanced pinning effect.

The transport properties of a superconducting *Pb/Cu* microdot with a 2×2 antidot cluster have been studied by T. Puig (Leuven) et al. The authors measured the superconducting-normal (S/N) phase boundary, critical currents, and current-voltage characteristics of this structure. The S/N phase boundary as a function of B and T reveals an oscillatory structure caused by the limited number of possible vortex configurations that can be realized in the antidot cluster.

The magnetoresistance of ultrathin insulating films of *Bi* has been studied by N. Markovic et al. (Minnesota) using magnetic fields applied parallel and perpendicular to the plane of the sample. Deep in the strongly localized regime, the magnetoresistance is negative and independent of field orientation. As the film thicknesses increase, however, the magnetoresistance becomes positive, and a difference between values measured in perpendicular and parallel fields appears, which is a linear function of the magnetic field and is positive. The authors suggest that this is due to vortices present on the insulating side of the superconductor-insulator transition.

$RBa_2Cu_3O_{7-\delta}$

A preprint by I. I. Mazin (NRL) presents a band version of the Fehrenbacher-Rice model that explains all existing experiments addressing the superconducting and transport properties of the $R_{1-x}Pr_xBa_2Cu_3O_{7-\delta}$ system, including the recent observation of superconductivity at full substitution $(PrBa_2Cu_3O_{7-\delta})$.

The effects due to Nd^{3+}/Ba^{2+} ion substitution in $Nd_{1+x}Ba_{2-x}Cu_3O_y$ single crystals have been studied by A. A. Martin (MPI-Stuttgart) et al. using Raman scattering from coupled phonon - crystal-field (CF) excitations. In three series of experiments (y ~ 7.0, varying x; y ~ 6.0, varying x; x = 0, varying y), the authors observed different but consistent changes of the superconductivity-induced B_{1g} phonon softenings with temperature. These changes suggest that the superconducting gap in the underdoped region continues to increase with respect to the phonon energy, even if T_c decreases. The authors also observed variations in the CF excitation energies, which are discussed in terms of structural changes and charge transfer between reservoirs (e.g., in the chains) and the oxygen ions in the CuO_2 planes.

It has been found by H. S. Chauhan and M. Murakami (SRL-ISTEC) that the formation of a fine dispersion of *Nd*-rich $Nd_{1+x}Ba_{2-x}Cu_3O_y$ clusters is possible in the $NdBa_2Cu_3O_y$ matrix when *Nd-Ba-Cu-O* superconductors are melt-processed in a reduced oxygen atmosphere, which leads to a dramatic increase of flux pinning. Since the amount of *Nd-Ba* substitution depends upon the growth conditions, the authors stress that it will be possible to control flux pinning through the control of processing conditions.

Magnetization and magneto-transport studies have been performed by A. K. Pradhan et al. (SRL-ISTEC) on high-quality $NdBa_2Cu_3O_{7-\delta}$ single crystals grown by the traveling solvent floating zone method in a reduced oxygen partial pressure. The authors conclude that the interplay between the naturally present twin planes and the substitutional *Nd-Ba* sites is responsible for high pinning in this material, especially in the high-field region.

A paper by M. Kläser (Karlsruhe) et al. reports comparative studies of oxygen diffusion in $RBa_2Cu_3O_{7-\delta}$

(R = Y, Er, Dy) with different impurity levels grown in crucibles made of Y_2O_3-stabilized ZrO_2 and $BaZrO_3$. The diffusion coefficients were determined by *in-situ* measurements of the electrical conductivity using a four-point method during oxygenation at various oxygen partial pressures in the temperature range 390-550°C. In this range, the authors determined the diffusion coefficient to be between 3.7×10^{-9} cm^2/s and 6.6×10^{-8} cm^2/s, independent of the rare-earth atom or the impurity level. The temperature dependence of the diffusion coefficient was found to obey an Arrhenius law for all crystals, indicating that oxygen diffusion in $RBa_2Cu_3O_{7-\delta}$ is purely a thermally activated process.

Bi Cuprates

The self-energy $\Sigma(\mathbf{k},\omega)$ is the fundamental function describing the effects of many-body interactions on an electron in a solid. M. R. Norman (Argonne) et al. have shown that by making certain reasonable assumptions, the self-energy can be directly determined from angle-resolved photoemission data. The authors demonstrate this method on data for the high-temperature superconductor $Bi_2Sr_2CaCu_2O_{8+\delta}$ *(Bi-2212)* in the normal, superconducting, and pseudogap phases.

The superconducting properties and microstructures of *Pb*-doped *Bi-2212* spherical particles prepared by containerless solidification and subsequent annealing have been investigated by Y. Hishinuma (Tsukuba) et al. After solidification, the spherical particles are in an amorphous state, which can be transformed into the *Bi-2212* phase by annealing at temperatures above 800°C. The *Pb*-doped spherical particles show improved flux-pinning behavior, which the authors believe to arise from modification of the modulation structure.

The structure of grain boundaries between grains of different phases in *BSCCO* ceramics has been investigated by N. D. Zakharov (MPI-Halle) et al. using high-resolution transmission electron microscopy (HRTEM). Regular interphase grain boundary structures were found and corresponding atomic-scale models derived. Two interphase tilt boundaries, *2212/2201* and *2212/1212,* were investigated in detail. Such boundaries are characterized by a periodic structure providing alternating areas of good and less good conditions for supercurrent flow.

A novel method for the unambiguous determination of the self-field critical current of superconducting silver-sheathed $(Bi,Pb)_2Sr_2Ca_2Cu_3O_{10+\delta}$ *[(Bi,Pb)-2223/Ag]* tape has been developed by J. Herrmann (CSIRO) et al. The method is based upon measurements of the distribution of the perpendicular magnetic field component above current-carrying tapes using scanning Hall-probe magnetometry. From the evolution of the sheet current density distribution across the tape width with increasing transport current, a characteristic current I* can be identified, above which additional current is distributed homogeneously over the entire *(Bi,Pb)-2223* and *Ag* volumes, and which represents a realistic estimate of the intrinsic critical current. I* is the current corresponding to full penetration of the transport current into the volume of the superconductor, but it does not depend, as is the case for the determination of the transport critical current from current-voltage characteristics, on other experimental parameters such as the choice of an electric field criterion.

The ac power losses of monofilament and multifilament *Bi-2223/Ag* composite tapes have been investigated by N. Savvides (CSIRO) et al. to determine the effect of mechanical strain on the loss and to identify the loss mechanisms. Self-field losses were measured at 77 K and 60 Hz as a function of ac current amplitude (0-100 A) for tapes in their as-prepared or virgin state and after being subjected to applied strain by temperature cycling or bending to small radii of curvature (R = 1-50 mm). For good quality tapes the experimental data are well described by the Norris equation $P \propto I_m^n$ for the dependence of the power loss P on the amplitude I_m of the ac transport current, with n = 3 for monofilament and n = 4 for multifilament tapes. Applied strain causes the loss to increase by several orders of magnitude and the exponent n to decrease below the Norris values. At strains very much greater than the irreversible strain limit, the loss becomes purely ohmic (i.e., I^2R loss) and n = 2. Examination by SEM of the transverse cross section reveals cracks that sever the filaments and extended regions where the superconductor has delaminated from the silver sheath.

Measurements of the resistivity of granular samples of $Bi_{1.84}Pb_{0.34}Sr_{1.91}Ca_{2.03}Cu_{3.06}O_{10}$ are reported by S. Çelebi (Karadeniz Technical University) et al. The authors also measured the critical current and the irreversibility line of the specimen. A related paper by S. Bolat (Karadeniz Technical University) et al. reports ac susceptibility measurements in granular $Bi_{1.6}Pb_{0.4}Sr_2Ca_3Cu_{4-x}Ag_xO_{12}$ (x = 0-1.0), which show that the critical current density decreases as the amount of *Ag* doping increases.

Other Cuprates

Crystal-field (CF) transitions within the ground-state J-multiplet $^4I_{9/2}$ of Nd^{3+} in $Nd_{2-x-y}Ce_xLa_yCuO_4$ ($0 \le x \le 0.2$; y = 0.5, 1) have been observed by M. Gutmann (ETH Zurich and PSI) et al. From the CF parameters the authors found evidence for a negative charge enhancement in the CuO_2 planes upon doping with *Ce*. They also found two electronically inequivalent sites in the *Ce*-doped samples corresponding to undoped and doped microregions. The

authors also determined the volume fraction of the two components and concluded that the metal-insulator transition can be explained by the formation of a two-dimensional percolative network of the doped microregions.

Films

A preprint by N. Savvides et al. (CSIRO) reports on the deposition and properties of tapes consisting of $YBa_2Cu_3O_{7-\delta}$ *(YBCO)* films deposited onto Hastelloy substrates precoated with biaxially aligned *YSZ* and CeO_2 buffer layers. The oxide buffer films, 300 nm thick, were deposited at room temperature using magnetron IBAD (ion-beam-assisted deposition). The $YBa_2Cu_3O_{7-\delta}$ films, 200-400 nm thick, were deposited at 750°C by unbalanced magnetron sputtering. The *YBCO* tapes had (103) pole $\Delta\phi = 24°$, $\Delta\omega = 2°$, and $J_c(77K) = 3 \times 10^5$ A/cm^2. Similar *YBCO* films deposited on $SrTiO_3$ and *MgO* (100) substrates had $\Delta\phi = 0.5$-$2.3°$, $\Delta\omega = 0.1$-$0.6°$, and $J_c(77K) = (1\text{-}4) \times 10^6$ A/cm^2.

The effect of a degraded surface layer on the differential conductance of *YBCO*/metal junctions has been studied by P. Seidel (Jena) et al. The authors found that the resistance changes when an external bias voltage is applied can be explained via the alteration of the oxygen content near the interface. The authors introduce a theoretical model to account for the observed effects.

Smooth $NdBa_2Cu_3O_{7-\delta}$ *(NBCO)* films have been grown by Y. Li et al. (SRL-ISTEC) by pulsed laser deposition (PLD) using a large *NBCO* single crystal instead of a sintered ceramic pellet as the target. Although *NBCO* films grown at optimum conditions from either a single-crystal or sintered target both possess excellent superconducting properties, with zero-resistance T_c = 91-94 K and critical current density $J_c > 3 \times 10^6$ A/cm^2 at 77 K, the films prepared from the single-crystal target had greatly improved surface quality. High-resolution scanning electron microscopy showed that the droplet density on the film surface was reduced by a factor of 10^4 by using a single-crystal target, i.e., from 10^6-10^7/cm^2 to 10^2-10^3/cm^2. The authors conclude that PLD using a single-crystal target is an easy and practical technique for growing smooth superconducting films for device applications.

Raman scattering experiments have been carried out by A. Fainstein et al. (Bariloche) on oxygen-deficient $GdBa_2Cu_3O_X$ *(GBCO)* thin films (x = 6.53, 6.7, 6.8, and 6.93) as a function of photoexcitation and annealing-induced oxygen disorder. Raman lines, associated with copper and oxygen vibrations of atoms at the ends of *Cu-O* chains, are used as markers for the existence of short chain fragments. The dynamics of chain conjunction and fragmentation were monitored via the peak intensity dependencies upon photoexcitation time and annealing temperature. The results provide evidence for the role of photoassisted oxygen ordering in persistent photoconductivity and photoinduced superconductivity.

Correlations between the microstructure and electrical properties in $YBa_2Cu_3O_{7-\delta}$, $GdBa_2Cu_3O_{7-\delta}$, and $NdBa_2Cu_3O_{7-\delta}$ films are discussed by C. Schäfer et al. (MPI-Halle). The authors found a strong influence of a-axis orientation on the critical current density J_c and of in-plane rotations on the surface resistance R_S.

Epitaxial $Tl_2Ba_2CaCu_2O_{8+\delta}$ *(Tl-2212)* films about 5500 Å thick have been grown by M. P. Siegal et al. (Sandia-Albuquerque) on $LaAlO_3$ (100) substrates using a new hybrid two-zone/crucible furnace process enabling precise control of thallination. The method combines the best features of both conventional crucible and two-zone processing: superb film properties and reduced handling of hazardous *Tl* oxide powders. Single-phase, highly c-axis-oriented *Tl-2212* films were grown with smooth morphology, Meissner transition at 103 K, and critical current density 1.1×10^7 A/cm^2 at 5 K for twenty consecutive runs without having to change or add to the *Tl* oxide source.

The current-voltage characteristics of superconducting weak links where the coupling medium is the 2D electron gas in *InAs*-based semiconductor quantum wells of width 0.5 μm between *Nb* electrodes have been studied by M. Thomas et al. (UC-Santa Barbara). The devices exhibit Josephson-like current-voltage characteristics but with detailed behavior falling outside the range of established theories. The authors propose that giant shot noise associated with multiple Andreev reflections plays an important role.

Applications

A high-T_c dc SQUID system with single-layer gradiometers intended for clinical use in cardiology has been developed by R. Weidl (Jena) et al. The gradiometer sensors were prepared from laser-deposited *YBCO* films on $SrTiO_3$ substrates using ion-beam etching of the antenna structure. The authors used 10×10 mm^2 bicrystal substrates with 24° grain boundaries, and the baseline of the gradiometers was about 4 mm. The authors discuss problems related to clinical demands and unshielded environments, and they report first results of measurements made in a hospital.

The use of *Si* as a substrate for thin-film devices based on high-temperature superconducting oxides has been studied by P. Seidel et al. (Jena). Additional buffer layers are required to prevent interdiffusion, accommodate lattice mismatch, and relieve internal stress from different thermal expansion coefficients. The authors tested a variety of

materials and found that laser deposition of a double buffer system *YSZ/CeO_2* gives the best results for *Si* substrates on up to two-inch wafers. The resulting *YBCO* films reach zero-resistance transition temperatures T_c near 89 K, and 77 K critical current densities J_c up to 7×10^6 A/cm^2. The authors also found that a nonsuperconducting but crystalline phase with the same stoichiometry *(YBCO*)* can be used as a passivation layer. Using this technology, the authors have realized and investigated step-edge and *Si* bicrystal Josephson junctions, SQUIDs, bolometers using different compensation principles, and a hybrid magnetometer. The magnetometer, based on a simple Hall sensor, was integrated with a superconducting antenna loop on the same chip.

As noted by H. T. Ilhan and P. F. Bagwell (Purdue), control of the Josephson current by varying a gate current has recently been demonstrated in both four-terminal and three-terminal junctions. The authors show theoretically that when the gates are weakly coupled to the Josephson junction, the Josephson current versus gate current (or versus gate voltage) relation is the same for both the four- and three-terminal geometries. At low temperature, the supercurrent switches abruptly as a function of the gate voltage, but only slowly as a function of the gate current.

Quantum interference effects in a macroscopic "superconducting molecule," consisting of two large inductively coupled superconducting rings, each interrupted at the terminals of a common Josephson four-terminal junction, have been analyzed theoretically by R. de Bruyn Ouboter (Leiden) et al. Depending on the values of the magnetic flux through each ring, the system is found to display two groups of states, "orthostates" with both induced currents in the same direction and "parastates" with opposite currents and total induced flux locked to zero value. The system is sensitive to small gradients of the external magnetic field.

Theory

The crossover from weak coupling to strong coupling in an electron gas with a delta-function interaction has been investigated by E. Babaev (Freie Universität Berlin and Ioffe Institute) and H. Kleinert (Freie Universität Berlin) both near zero temperature and near T*, where strong coupling produces a pseudogap in the energy spectrum due to the binding of electron pairs. The authors present curves for the behavior of the superconducting transition temperature, the gap formation temperature, and the gap size as a function of coupling strength and temperature in both two and three dimensions. The authors suggest that the results should be useful for interpreting experimental data in underdoped and optimally doped cuprates.

The possibility of superconductivity in the ground state of the 2D Hubbard model has been investigated by K. Yamaji (ETL and Tsukuba) et al. using the variational Monte Carlo method. The authors examined the energy gain of the d-wave superconducting state, obtained as the difference of the minimum energy with a finite gap and that with zero gap, as a function of U, electron density ρ, and next-nearest-neighbor transfer t', chiefly on a 10×10 lattice. The energy gain was found to be maximized around U/t = 8, where t is the nearest-neighbor transfer.

The phase diagrams and superconducting properties of the extended Hubbard model with pair hopping interaction (Penson-Kolb-Hubbard model) have been studied by S. Robaszkiewicz and B. R. Bulka (Poznan). The authors analyzed the model for d-dimensional hypercubic lattices, including d = 1 and d = ∞, using the (broken symmetry) Hartree-Fock approximations and the slave-boson mean-field method. The authors also compare properties of the pair-hopping model with those of the attractive Hubbard model and point out features of superconducting phases of both models.

The Ginzburg-Landau equations have been derived microscopically by Q. Han and L.-Y. Zhang (Peking) for an anisotropic (d + s)-wave superconductor by assuming a non-Fermi-liquid normal state characterized by a non-vanishing exponent α. The authors studied the transition temperature T_c as a function of α and the parameter g, which measures ab anisotropy. The authors found that the anisotropic effect, which results in the enhancement of T_c and the nonzero bulk value of the s-wave order parameter, is strengthened by the non-Fermi-liquid behavior.

The effect of nonmagnetic impurities on 2D s-wave superconductors has been studied by A. Ghosal et al. (TIFR-Mumbai) beyond the weak disorder regime. The authors find that while there is substantial reduction in the superfluid stiffness and off-diagonal correlations with increasing disorder, amplitude fluctuations by themselves do not destroy the superconductivity.

The use of the Josephson effect as a signature of single-spin superconductivity (SSS), the as-yet-unobserved superconducting state proposed recently as a low-temperature phase of half-metallic antiferromagnets, has been examined by R. E. Rudd and W. E. Pickett (NRL). The authors find that no supercurrent flows between an SSS and an s-wave BCS system because of their orthogonal symmetries.

Using London theory, Z. J. Yang (Argonne) has calculated the interaction between a magnetic dipole (such as on the tip of a magnetic force microscope) and a superconducting sphere of arbitrary radius R relative to the penetration depth $\lambda(T)$. The author suggests how one might apply these results to measure λ as a function of temperature T.

Overviews

An extensive study of the Andreev bound states in $YBa_2Cu_3O_{7-\delta}$ *(YBCO),* $Bi_2Sr_2CaCu_2O_{8+\delta}$ *(Bi-2212),* and $La_{1.85}Sr_{0.15}CuO_4$ *(LSCO)* is reported by L. Alff et al. (Köln). These are revealed in the tunneling spectra of grain-boundary junctions, which show a pronounced zero-bias conductance peak interpretable in terms of zero-energy Andreev bound states at the surface of high-temperature superconductors having d-wave symmetry of the order parameter. Applying a magnetic field results in a nonlinear shift of spectral weight from zero to finite energy. For $Nd_{1.85}Ce_{0.15}CuO_4$, which is most likely an s-wave superconductor, no zero-bias conductance peak is observed (105 refs.).

Mössbauer spectroscopy of some high-temperature superconductors is discussed in a review chapter by A. Nath (Drexel) et al. Among other things, the Mössbauer studies show that the O^{2-} ions in the *Cu-O* chains of $YBa_2Cu_3O_{7-\delta}$ oscillate between two potential wells about 0.015 nm on either side of the chain. The Mössbauer parameters also confirm that $Nd_{2-x}Ce_xCuO_4$ is truly an electron-doped superconductor (70 refs.).

A review of the magnetic field dependence of the electrical and thermal transport properties (electrical resistivity, thermoelectric power, Nernst effect, and magneto-thermal conductivity) in the high-T_c superconductors has been prepared by M. Ausloos (Liège). The author emphasizes the role of anisotropy (66 refs.).

The excess electrical resistivity, excess thermoelectric power, Nernst effect, and excess magneto-thermal conductivity arising when a magnetic field is applied to a superconducting sample are the subject of a brief review by M. Ausloos (Liège) et al. The authors examine several *Bi*-based *2212* and *2223* superconducting ceramics. They also report a linear relationship between the Ginzburg-Landau parameter κ and the vortex viscous drag coefficient η (18 refs.).

A brief review of the theory for the optical excitations in C_{60} and higher fullerenes, including isomers of C_{76}, C_{78}, and C_{84}, has been prepared by K. Harigaya (ETL-Tsukuba). Using a tight-binding model with long-range Coulomb interactions, treated by the Hartree-Fock and configuration-interaction methods, the author finds that the optical excitations in the energy region below about 4 eV have most of their amplitudes at the pentagons (18 refs.).

Ph.D. Thesis

The development of a new calorimetric method to measure ac losses in high-temperature superconductors is the subject of a Ph.D. thesis (in French) by P. Dolez (Sherbrooke) in collaboration with Hydro-Québec. The method exploits the null technique and Fourier analysis to improve the sensitivity. The validity of the results has been confirmed by a comparison with theoretical predictions and *in-situ* electrical measurements. This calorimetric technique can be used to measure the losses in superconducting cables or the ac transport current losses in tapes with superimposed dc or ac magnetic fields or electrical currents (137 refs.).

Contributed by John R. Clem

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High-T_c Update **is available without charge to interested persons. Recipients are expected to participate in this information exchange by sending us preprints, reprints, meeting news, research news, etc. Contributions to defray the cost of newsletter printing and mailing are welcome.**

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.

A partnership between Oak Ridge National Laboratory (ORNL) and Southwire Company of Carrollton, Ga., was announced recently, for development of a 30-m superconducting cable capable of carrying enough energy to power a small city. This work is part of the Superconductivity Partnership Initiative Power Cable Project, other participants of which include Intermagnetics General Corp., Southern Company, Georgia Transmission Corp., Southern California

Edison, Argonne National Laboratory, and Plastronic-EURUS. Joint tasks by ORNL and Southwire include: (1) Measurement of the performance of high-temperature superconducting tapes for the amount of current they can carry, particularly when wound into a cable. This task will be performed by ORNL's Metals and Ceramics Division. (2) Determination and testing of performance of Southwire's Cryoflex dielectric tape at cryogenic temperatures and high pressures. Aging experiments on the tape will also be conducted in ORNL's Life Sciences Division. (3) Testing and measurement of the performance of Southwire's short experimental cables under various conditions to verify design concept. These tests will be conducted by ORNL's Fusion Energy Division. (4) Work to design and specify the cooling system for cable to be installed at Southwire's headquarters. Research will also be performed on new concepts for cooling high-temperature superconducting cables. (5) Research and development of bushings and thermal insulation for the termination (transition between room temperature and high voltage to the superconducting cable), which operates in liquid-nitrogen temperature and high pressure. The termination provides insulation for the cable similar to a thermos bottle. (6) Collaboration to develop a splice to connect two pieces of superconducting cable. This splice does not currently exist. (7) Address the issues of bending and reeling a cable, including a flexible vacuum insulated enclosure for the cable. (8) Work with Southwire and its electric utility partners to determine the electrical characteristics of superconducting cables in their electrical grid network. This work will be performed by ORNL's Energy Division. For further information, contact Fred Strohl, Communications & Public Affairs, Oak Ridge National Laboratory, P.O. Box 2008, Oak Ridge, TN 37831; telephone (423) 574-4165.

The first installed high-temperature superconducting ion-beam switching magnet has completed a successful first year of operation in the particle accelerator run by the Institute for Geological and Nuclear Sciences in Wellington, New Zealand. The accelerator is used in carbon dating and archeological and geophysical studies. The magnet was built and installed by a consortium involving American Superconductor Corporation, Alphatech International (Auckland), ISYS (Palo Alto), and the New Zealand Institute for Industrial Research. Alphatech International has many years experience in the design and manufacture of electromagnets for ion-beam applications. Incorporating high-temperature superconducting wire, the HTS magnet was designed to surpass limitations of the conventional magnet used in the accelerator. Designed as a permanent upgrade, the magnet allows for increased transmission of ion beams in the accelerator without the larger power supply, more cooling capacity, or the heavier iron core required by conventional magnets. The magnet is a critical element of an accelerator system that is used five days a week, and industrial sources report that the magnet and cryocooler have operated for 9600 hours without failure. For information, contact Lana Swan, American Superconductor Corporation, Two Technology Drive, Westborough, MA 01581; telephone (508) 836-4200; telefax (508) 836-4248; e-mail lswan@amsuper.com.

As a manufacturer of high-performance superconductive wireless systems, Conductus, Inc., announced that it has received an order for additional production units of its wireless subsystems from Booz-Allen & Hamilton in its role as a government support contractor. These systems are a modified version of Conductus' commercial ClearSite™ product, which began shipments to wireless operating companies late in 1997. The ClearSite™ product provides good performance in wireless communication systems compared with conventional technology by using a combination of superconducting filters and cryogenically-cooled, low-noise amplifiers, and have successfully completed rigorous field tests and evaluations by commercial service providers and the U.S. Government over the past year. The commercial ClearSite™ product, in industry field trials with multiple wireless operating companies, has demonstrated base station performance enhancements by providing superior coverage, reduced interference, and enhanced voice quality. Company officials are excited about the potential for their products in the government sector that complements their efforts in the commercial sector. For further information, contact Duncan MacMillan, Vice President for Marketing, Conductus, Inc., 969 West Maude Ave., Sunnyvale, CA 94086; telephone (408) 523-9401; telefax (408) 523-9999.

Development of the next generation of the company's Levitator™ product line was announced by Superconductive Components Inc. (SCI), in collaboration with Argonne National Laboratory. The total estimated project cost is $1,518,000 of which $750,000 is to be contributed by the Department of Energy. The company's Levitator™ product line is the enabling component in frictionless bearing systems used in the Flywheel Energy Storage (FES) systems being developed by Commonwealth Edison of Illinois. Officials hope the next generation Levitators™ will exhibit twice the performance of current devices at a significantly lower cost. For more information, contact J. R. Gaines, Jr., Superconductive Components Inc., 1145 Chesapeake Ave., Columbus, Ohio 43212; telephone (614) 486-0261.

Contributed by Sreeparna Mitra

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COMING EVENTS

*(An * indicates a previously listed event.)*

**July 19 - 24, 1998:* Gordon Research Conference on Correlated Electron Systems, Plymouth State College, Plymouth, N.H. Conference will survey significant experimental and theoretical developments in the study of electronic correlations in the cuprates and related materials, heavy-fermion systems, and two-dimensional electron gases. Co-Chairs: Laura H. Greene and Subir Sachdev. Will include formal invited sessions and contributed poster sessions; discussion on posters will be integrated into the formal sessions. Topics are: spin chains and ladders, mesoscopic superconductivity, broken time-reversal symmetry, correlated fermions in adsorbed layers, one-dimensional conductors, heavy fermions, and two-dimensional electron gas. All prospective attendees (including invited speakers) must submit an application. For information, contact Gordon Research Conferences, University of Rhode Island, P.O. Box 984, West Kingston, RI 02892-0984; phone (401) 783-4011; fax (401) 783-7644; e-mail app@grcmail.grc.uri.edu (for application form requests) or grc@grcmail.grc.uri.edu (for general information). Information also available at Web site http://sachdev.physics.yale.edu/grc/index.html.

**Sept. 6 - 11, 1998:* Gordon Research Conference on Superconductivity: Cuprate Superconductors and Related Materials, Queen's College, Oxford, United Kingdom. Colin Gough and Bertram Batlogg, Co-Chairs; M. Brian Maple, Vice-Chair. Sessions are: recent theoretical developments, influence of pairing symmetry on properties, normal-state pseudogap, c-axis conduction, new materials, proximity coupling with CMR and other materials. For information, contact Gordon Research Conferences, University of Rhode Island, P.O. Box 984, West Kingston, RI 02892-0984; phone (401) 783-4011; fax (401) 783-7644; e-mail app@grcmail.grc.uri.edu (for application form requests) or grc@grcmail.grc.uri.edu (for general information).

**Sept. 19 - 20, 1998:* Third Canadian Applied Superconductivity Workshop (CASW '98), University of British Columbia, Vancouver, BC, Canada. Workshop is designed for researchers from industry, universities, and the government working with superconductivity. Emphasis will be on applications that are relevant to Canadian industry, which covers a broad range. Intended as a way to discuss research opportunities for HTS in electronics, microwave, and power applications. Several invited talks are planned to provide a world view of the superconducting industry and, more specifically, to the niche markets targeted by Canadian industry. Areas of interest include: fundamental microwave properties of HTS materials, growth and processing of HTS thin films, SQUID-based applications, fundamentals of active superconducting devices, power applications of HTS, bulk material processing, cryocoolers, and cryogenic packaging. For further information, contact Mike Denhoff, National Research Council of Canada; telephone (613) 993-4042; telefax (613) 952-5711; e-mail denhoff@nrcphy1.phy.nrc.ca; Web site http://hts.ims.nrc.ca/casw.

**Jan. 7 - 13, 1999:* 1999 University of Miami Conference on High Temperature Superconductivity, Miami, Fla. Third in the series. Goal of this conference is to provide a forum for engaging researchers in a focused dialog directed at exploring and distilling the latest experimental and theoretical results in the field likely to have significant influence on the understanding of the normal-state properties and origin of superconductivity in this class of materials. The format will involve a relatively small number (150) of researchers assembled in common sessions. The conference, in addition to addressing physical properties,

microscopic theory, and mechanisms for high-temperature superconductivity, will include other related topics (e.g. ladders, manganites, and nickelates). Partial list of topics for which abstracts are solicited includes: pseudogap, stripes/AF correlations, gap symmetry/tunneling, vortex properties, electronic structure, photoemission, non-Fermi liquids, mechanisms, new materials, other oxides (*Mn, Ni,* etc.), and ladder compounds. **Abstract deadline, October 2, 1998.** Contributed presentations will primarily be in the form of posters, although a small number may be selected for oral presentation. For information contact HTS99@physics.miami.edu. Further details are available on the world-wide web at http://www.miami.edu/physics/hts99.

*July 12 - 16, 1999: Cryogenic

Engineering Conference & International Cryogenic Materials Conference (CEC/ICMC), Hotel Inter-Continental Montreal, Montreal, Quebec, Canada. The CEC focuses on the science and engineering required for cryogenic applications such as liquefied gases for fuels; space applications of cryogenic liquids; cooling and performance of superconducting magnet systems in medical, transportation, power, and basic research applications; as well as the systems, machinery, control technology, and thermodynamics required to produce low temperatures. The ICMC focuses on the development, characterization, fabrication, and optimization of the materials used in cryogenic applications, typically broken into two broad categories: structural materials and superconducting materials. ICMC contributions cover both high- and low-temperature superconducting materials from basic materials research through behavior of composite cables and wires in applications. Cryogenic structural materials cover a broad range, including non-metallic composites, polymeric resins and insulation materials, ferrous alloys, nickel-base alloys, aluminum alloys, and specialized materials for advanced cryocooler applications. **Abstract deadline, December 1998.** For information, contact Centennial Conferences, 4800 Baseline Road, Suite A-112, Boulder, CO 80303; telephone (303) 499-2299; telefax (303) 499-2599; e-mail centennial@orci.com; Web site http://www.cec-icmc.org.

July 29 - Aug. 2, 1999: International

Workshop on Low Temperature Physics in Microgravity Environment (CWS-99), ISSP, Chernogolovka, Moscow Region. Satellite to the LT-22 Conference in Helsinki, Finland (Aug. 4 - 11, 1999). Topics are: studies in low-temperature and fundamental physics in microgravity environment, equilibrium and critical phenomena in quantum fluids and solids, suspended droplets, laser cooling, relativistic effects, and low-temperature techniques for fundamental studies in space. Number of participants limited to 50. **Abstract deadline, March 15, 1999.** For information, contact Leonid Mezhov-Deglin, Institute of Solid State Physics, Russian Academy of Sciences, 142432 Chernogolovka, Moscow Region, Russia; e-mail mezhov@issp.ac.ru.

*Aug. 4 - 11, 1999: 22nd International

Conference on Low Temperature Physics (LT22), Espoo and Helsinki, Finland. Topics will include: quantum gases, fluids and solids; superconductivity; magnetism and lattice properties; quantum electron transport; applications; materials; and techniques. For information, contact Conference Service Bureau, TSG-Congress Ltd., Kaisaniemenkatu 3 B 31, FIN-00100 Helsinki, Finland; telephone +358 9 628044; telefax +358 9 667675; e-mail info@tsgcongress.fi. For technical information, contact the LT22 Office, Low Temperature Laboratory, Helsinki University of Technology, P.O. Box 2200, FIN-02015 HUT; telephone +358 9 451 2962; telefax +358 9 451 2969; e-mail info@LT22.hut.fi.

Aug. 12 - 15, 1999: Electron Transport

in Mesoscopic Systems, Chalmers University of Technology and Göteborg University, Göteborg Sweden. Satellite to the LT-22 Conference in Helsinki, Finland (Aug. 4 - 11, 1999). The five main topics are: single charge tunneling, Andreev reflections and proximity effects in S/N structures, transport in quantum dots and wires, time-dependent transport in mesoscopic structures, and superconducting nano circuits. Format is expected to be two sessions for each main topic with a rapporteur starting the first session (giving an introduction to the topic, the recent progress in the field, and the outstanding problems to be solved with possible projections) and a regular invited speaker starting the other one. Three additional oral contributions and time for extended discussions planned. Attendance limited to about 200 persons. For information, contact Tord Claeson, Conference Chair, Department of Physics, Chalmers University of Technology, S-41296 Göteborg, Sweden; e-mail f4atc@fy.chalmers.se.

Sept. 14 - 17, 1999: Fourth European

Conference on Applied Superconductivity (EUCAS'99), Melia Gran Sitges, Hotel in Sitges, Barcelona, Catalonia, Spain. Aim is to provide a forum for presentation and discussion of the developments in the field of the applications of superconductivity, in both large and small scale, including the most recent advances in the subject. All aspects of applied superconductivity will be covered, from both a scientific point of view (which include contributions from the fields of physics, electronics, material properties, chemistry, and engineering), and also an industrial perspective. Conference will encourage new cooperations on European and wider international levels. For further information, contact Xavier Obradors, Institut de Ciencia de Materials de Barcelona (ICMAB-CSIC), Campus de la UAB, E-08193 Bellaterra (Barcelona), Catalonia, Spain; telephone +34 93 580 18 53; telefax +34 93 580 57 29; e-mail eucas99@icmab.es; Web site http://www.icmab.es/eucas99.

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High-T_c Update is published for the Office of Basic Energy Sciences, U.S. Department of Energy, under Contract W-7405-eng-82 with the Ames Laboratory, Iowa State University. Support is also provided by organizations listed on the masthead and by other donors. Please direct all inquiries to:

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Project Director and Editor: Sreeparna Mitra
Science Editor: John R. Clem
ISSN 1048-1141
Homepage: http://www.iitap.iastate.edu/htcu/htcu.html

High-T_c Update is the high-T_c superconductivity information exchange newsletter. It is available twice-monthly as hard copy and as electronic mail. Please send: 1) preprints, reprints, and other T_c-related reports or publications; 2) descriptions of on-going work; 3) meeting news; and 4) etc. Information in *High-T_c Update* is intended for limited distribution. Readers are expected to respect the rights of authors.