HIGH T UPDATE

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$RBa_2Cu_3O_{7-\delta}$

Papers by M. Muralidhar (SRL-ISTEC) et al. and by M. Muralidhar and M. Murakami (SRL-ISTEC) report on the superconducting properties of oxygen-controlled-melt-growth (OCMG) *(Nd,Eu,Gd)$Ba_2Cu_3O_y$ (NEG-123)* samples containing additions of *(Nd,Eu,Gd)$_2BaCuO_5$ (NEG-211), Pt,* and *CeO_2*. For an *NEG* sample with 40 mol% *NEG-211* additions, resulting in very fine (~0.1 μm) mostly *Gd-211* particles, the authors observed a critical current density J_c of 6×10^4 A/cm^2 at 77 K in a magnetic field of 3 T applied parallel to the c-axis. Similar zero-field and peak J_c values were obtained in samples containing 30 and 40 mol% of *NEG-211*. While *Pt* appears to assist in refining the size of the *NEG-211* particles and enhancing J_c, *CeO_2* was found to be less effective.

Using transmission electron microscopy, F. Sandiumenge (Barcelona) et al. have found a three-dimensional dislocation substructure in an as-grown directionally solidified sample of *$NdBa_2Cu_3O_{7-\delta}$*. Dislocations with a near or perfect [001] orientation and with Burgers vectors lying on the basal plane were found to glide on (010) and {110}. This results in the natural occurrence of dislocation lines perpendicular to the basal planes acting as linear pinning centers normal to the weakly coupled *CuO_2* layers. The authors propose a model in which cubic-like glide is achieved through the formation of a track of *Nd→Ba* antisites along the path swept by the dislocations. This finding can be correlated with enhanced flux pinning under **H**||[001] observed in these materials.

Using thermal neutrons to irradiate two ceramic samples of *$GdBa_2Cu_3O_{7-\delta}$*, one with *^{155}Gd* (σ = 61,000 b) and the other with *^{160}Gd* (σ = 0.77 b), G. Brandstätter et al. (Atominstitut-Wien) have learned that the overall contribution of point defects to flux pinning in *123* superconductors is small.

The effects of the heating rate (100°C/h - 6,000°C/h) to a peritectic temperature (T_p = 1,015°C) on conversion of *Y_2O_3-$BaCuO_2$-CuO* and *Y_2BaCuO_5-$BaCuO_2$-CuO* precursor powders into *$YBa_2Cu_3O_{7-\delta}$ (Y-123)* have been studied by C.-J. Kim et al. (KAERI). The authors found that both precursor powders were rapidly converted into the *Y-123* phase.

Two preprints by D. K. Aswal et al. (Shizuoka) report *in-situ* measurements of the growth rate of *$YBa_2Cu_3O_{7-\delta}$* single crystals along the [100]/[010] directions using high-temperature optical microscopy. The authors found that the growth rate of the *$YBa_2Cu_3O_{7-\delta}$* crystals is intimately related to the dissolution of *Y_2BaCuO_5* particles in the liquid.

Using ultrafast time-resolved optical spectroscopy, V. V. Kabanov et al. (Ljubljana) have experimentally and theoretically investigated photoexcited quasiparticle relaxation dynamics in superconducting *$YBa_2Cu_3O_{7-\delta}$* as a function of doping δ and temperature T. The observed photoinduced transmission $|\Delta T/T|$, reflection $|\Delta R/R|$, and quasiparticle relaxation time τ were found to agree quantitatively over a wide range of doping ($0.1 < \delta < 0.48$) with a temperature-dependent BCS-like isotropic gap near optimum doping ($\delta < 0.1$) and a temperature-independent isotropic gap in underdoped *$YBa_2Cu_3O_{7-\delta}$* ($0.15 < \delta < 0.48$). A pure d-wave gap was found to be inconsistent with the data.

Bi Cuprates

A preprint by G. Villard et al. (Caen) reports magnetization measurements of the penetration depth $\lambda_{ab}(0)$ and

second peak H_{sp} in $Bi_2Sr_2CaCu_2O_{8+\delta}$ *(Bi-2212)* single crystals with doping levels ranging from the underdoped to the overdoped regime. The authors observed a boomerang shape for the T_c vs. $1/\lambda_{ab}^2(0)$ curve in the region $0.8 \leq T_c/T_c^{max} \leq 1$. On the overdoped side of the boomerang, $1/\lambda_{ab}^2(0)$ decreases as the doping level increases, while the second-peak field H_{sp} increases monotonically.

A near-net-shape process for *Ag*-clad *Bi-2212* superconductors has been developed by M. T. Lanagan (Argonne) et al. The authors note that this alternative to the powder-in-tube process offers the advantages of nearly continuous processing, minimization of processing steps, reasonable ability to control the *Bi-2212/Ag* ratio, and early development of favorable texture of the *Bi-2212* grains.

The primary phase field (the compositional region one can use for crystal growth and melt processing) of the 110 K high-T_c superconductor $(Bi,Pb)_2Sr_2Ca_2Cu_3O_{10+\delta}$ *[Bi(Pb)-2223]* under the condition of 7.5% O_2 has been determined by W. Wong-Ng (NIST-Gaithersburg) et al. The presence of liquid has been known to be critical during the processing of *Bi(Pb)-2223.* The authors provide information concerning the set of 29 five-phase equilibrium volumes that contain the *2223* phase, and they give the initial liquid composition of these volumes.

A significant reduction of ac losses in twisted *Bi-2223* multifilamentary tapes with *Ag* sheaths has been achieved by Y. B. Huang (Genève) et al. using oxide $(BaZrO_3$ and $SrZrO_3)$ barriers between filaments. These barriers have two important effects: they increase the transverse resistivity, which suppresses induced coupling currents, and they reduce filament bridging, which in pure *Ag*-sheathed tapes largely cancels the beneficial effect of filament twisting. The decoupling can be gauged by the frequency f_m at which the losses show a maximum in a low-amplitude field applied perpendicular to the tape. To date, f_m has been enhanced from 5 Hz (untwisted) to 82 Hz (11 mm in twist pitch length). The authors discuss different ways to introduce oxide barriers in tapes with 19 to 95 filaments.

Comparisons of three methods of measuring the ac losses in 1-1.5 m segments of a *Bi-2223* cable conductor fabricated by Pirelli in a longer length are reported by G. Coletta (Pirelli) et al. The authors discuss the main features of two calorimetric methods, one based on temperature-profile determinations, the other based on the liquid-nitrogen boil-off rate, and an electrical method, based on voltage measurements using a lock-in amplifier. The authors analyze and discuss the advantages and limits of each approach.

Measurements of the ac losses in individual *Bi-2223* tapes and in a 1 kA transmission line model are reported by L. M. Fisher (Moscow) et al. A 5 m long model transmission line was fabricated from 120 tapes for the forward line and 120 tapes for the return line. The ac losses in the current core were found to be substantially greater than those seen in the individual tapes.

Measurements of the critical current and magnetic field performance of long-length *Bi-2223/Ag* composite superconducting tapes fabricated by a consortium involving Metal Manufactures, Ltd. (MM Cables), the University of Wollongong, and CSIRO are reported in a paper by N. Savvides (CSIRO) et al. The authors also report self-field transport ac losses and strain performance.

The room-temperature elastic constants of a dense, bulk $(Bi,Pb)_2Sr_2Ca_2Cu_3O_{10+\delta}$ bar, fabricated by sinter forging, have been measured by K. C. Goretta (Argonne) et al. The bar exhibited excellent phase purity and strong texturing, with the c-axes aligned parallel to the forging direction. One elastic constant also was measured to 760°C. The authors report that *Bi-2223* is 25-30% stiffer than $Bi_2Sr_2CaCu_2O_{8+\delta}$.

A nondestructive, noncontact, continuous quality test for the uniformity of *Bi-2223* tape is proposed in a preprint by R. Weinstein (TCSUH) et al. The method, based on Hall-probe measurements of the trapped field of a field-cooled tape, should be capable of revealing ~4% variations of critical current along the length of the tape.

Other Cuprates

Measurements of the low-temperature specific heat (LTSH) of $La_{2-x}Sr_xCuO_4$ (x = 0.10, 0.16, and 0.22) as a function of applied magnetic field have been carried out by S. J. Chen (National Sun Yat-Sen University) et al. Such measurements probe the influence of lines of nodes in the superconducting order parameter. The authors found that in all doping regimes, the increase in the linear-T coefficient γ is proportional to $H^{1/2}$, consistent with d-wave superconductivity. The data also show evidence for an αT^2 term at zero magnetic field in the LTSH of $La_{1.78}Sr_{0.22}CuO_4$.

The far-infrared sphere resonance in T*-phase $SmLa_{0.8}Sr_{0.2}CuO_{4-\delta}$ powder samples has been measured by H. Shibata and T. Yamada (NTT) down to 7 cm^{-1}. Below T_c, the authors observed two peaks, one at 11 cm^{-1} and the other at 30 cm^{-1} for $\delta = 0.05$. Comparing with the ...S/I/S/I'/S/I/S/I'/S... (...superconductor/insulator1/superconductor/insulator2/superconductor...) Josephson junction array model discussed by van der Marel and Tsvetkov, the authors attribute the two peaks to the different Josephson plasma resonances of the intrinsic Josephson junctions at the fluorite-type Sm_2O_2 block layer and the rocksalt-type $(La,Sr)_2O_{2-\delta}$ block layer. Both peaks shift to lower frequencies as the doping decreases. The authors suggest that other cuprates with two intracell couplings,such as $(Eu,Ce)_2(Ba,Eu)_2Cu_3O_{10-\delta}$,

(Pb,Cu)(Eu,Ce)$_2$(Sr,Eu)$_2$Cu$_2$O$_9$, Bi$_2$Sr$_2$(Gd,Ce)$_2$Cu$_2$O$_{10}$, and *(Tl,Pb)(CO$_3$)Sr$_4$Cu$_2$O$_7$,* also should show double Josephson plasma resonances.

Single crystals of optimally doped and moderately and strongly overdoped *Tl$_2$Ba$_2$CuO$_{6+\delta}$ (Tl-2201)* with T_c = 80, 56, and 30 K, respectively, have been investigated by L. V. Gasparov (Aachen and Chernogolovka) et al. using polarized Raman scattering. Taking the peak position of the B_{1g} component of the electronic Raman scattering as $2\Delta_0$, the authors found that the reduced gap value ($2\Delta_0/k_BT_c$) strongly decreases with increasing doping. The behavior of the low-frequency scattering for the B_{1g} and B_{2g} scattering is similar for optimally doped and overdoped crystals and can be described by ω^3 and ω laws, respectively, behavior consistent with d-wave symmetry of the order parameter.

Measurements by K. Fujinami (Tokyo Tech) et al. of the irreversibility field H_{irr} vs. reduced temperature T/T_c in *HgBa$_2$Ca$_2$Cu$_3$O$_{8+\delta}$ (Hg-1223)* show that the H_{irr} vs. T/T_c characteristics improve with increasing oxygen excess δ. The authors conclude that overdoped *Hg-1223* is a good candidate for a superconducting material with T_c > 100 K in high magnetic field applications.

Vortices

The c-axis resistivity in irradiated and pristine *Bi$_2$Sr$_2$CaCu$_2$O$_{8+\delta}$ (Bi-2212)* crystals has been measured by N. Morozov (Los Alamos) et al. as a function of the in-plane magnetic field component at fixed out-of-plane component B_c in the vortex-liquid phase at T = 67 K. From this data the authors extracted the phase-difference correlation function and the correlation length of the pancake density correlation function along the c axis as a function of the filling factor f = B_c/B_ϕ. The authors found that the correlation length reaches a maximum of about 15 interlayer distances near f ≈ 0.35.

A theoretical paper by D. Ertas (Exxon Research & Engineering) reports calculations of the thermal depinning of a single vortex from a single nonuniform columnar defect.

Taking into account only the magnetic interactions between pancake vortices in highly anisotropic layered superconductors, A. Buzdin (Bordeaux) finds that vortices will be trapped by tilted columnar defects even when the external magnetic field is oriented along the c axis. For such tilted trapped vortices, the interaction at long distance becomes attractive in some directions, which should lead to the formation of vortex chains with an intervortex distance of the order of the London penetration depth.

The well-known reversal of the magnetic field pattern of a vortex line not parallel to a symmetry axis of an anisotropic superconductor, and the corresponding attraction between two parallel vortex lines are discussed in a preprint by P. Muzikar (Purdue). The author uses perturbation theory to identify the supercurrents responsible for the magnetic field pattern and to determine the relevant screening lengths involved.

Using large-scale Monte Carlo simulations on a uniformly frustrated 3D-XY model, S.-K. Chin et al. (Trondheim) have found a first-order vortex crystal melting transition in clean, isotropic, extreme type-II ($\kappa\rightarrow\infty$) superconductors. The authors stress that this clarifies an important issue: that the unpinned vortex liquid is always incoherent with no phase coherence in any direction for all anisotropies, and that previous findings of a disentangled vortex liquid (line liquid) based on simulations for isotropic superconductors were due to finite-size effects.

A paper by A. K. Kienappel and M. A. Moore (Manchester) reports on simulations of layered superconductors using the Lawrence-Doniach model in the framework of the lowest-Landau-level approximation. The authors find a first-order phase transition with a B(T) dependence that agrees well with what has been identified as the experimental melting line in *YBa$_2$Cu$_3$O$_{7-\delta}$*. However, the authors assert that this transition is not associated with vortex-lattice melting but instead separates two vortex-liquid states characterized by different degrees of short-range crystalline order and different length scales of correlations between vortices in different layers. The transition line ends at a critical end-point at low fields. The authors find the magnetization discontinuity and the location of the lower critical magnetic field to be in good agreement with experiments in *YBa$_2$Cu$_3$O$_{7-\delta}$*. They also find that the first-order phase transition persists in the presence of weak random point disorder but can be suppressed entirely by strong disorder. No vortex-glass or Bragg-glass state is found in the presence of disorder.

The depinning of a massive elastic manifold with d internal dimensions, embedded in a (d+n)-dimensional space, and subject to an isotropic pinning potential $V(\mathbf{u}) = V(|\mathbf{u}|)$ has been investigated by D. A. Gorokhov and G. Blatter (ETH-Zürich). The authors also discuss the application of their results to the problem of depinning of vortices in high-T_c superconductors.

A preprint by I. Vekhter (Guelph) et al. shows that the density of states and the thermodynamic properties of a 2D d-wave superconductor in an applied in-plane magnetic field **H** depend on the angle between **H** and the order-parameter nodes. Within a semiclassical treatment of the extended quasiparticle states, the authors obtain fourfold oscillations of the specific heat, whose measurement should provide a simple probe of gap symmetry. The frequency dependence of the density of states and the temperature dependence of the thermodynamic properties obey different power laws for fields in the nodal and antinodal directions. The fourfold

pattern is changed to a twofold pattern in orthorhombic materials.

A microscopic evaluation of the electrodynamic response for the vortex-lattice state of a model ultraclean s-wave superconductor is reported by W. A. Atkinson and A. H. MacDonald (Indiana). The calculation accounts self-consistently for both quasiparticle and collective order parameter response. In the absence of disorder and extrinsic pinning, the authors find a single dominant absorption peak at a frequency close to the cyclotron frequency. The authors then discuss the effects of homogeneous and inhomogeneous pinning on the optical conductivity and the penetration depth, and comment on the relationship between macroscopic and local penetration depths.

As noted by M. N. Kunchur (South Carolina) et al., the time-dependent Ginzburg-Landau approach qualitatively justifies the decomposition of the Hall angle in the mixed state into two terms, one proportional to field (as in a normal metal) and the other weakly dependent on field. The authors compare the theory with experimental data and find rough quantitative agreement.

The relaxation of a nonequilibrium normal domain in a superconductor has been studied by M. Ghinovker et al. (Bar-Ilan). The authors found both analytically and numerically that relaxation leads to nucleation of vortices and antivortices, which become pinned when pinning is strong.

The appearance of large-amplitude radio-frequency oscillations in high-sheet-resistance indium/indium-oxide films carrying nonuniform currents below the zero-field superconducting transition is reported by S. E. Hebboul et al. (Ohio State). The samples consisted of rectangular films, into which lines perpendicular to the current flow were cut, thereby producing highly nonuniform current flow around the tips of the lines. As the dc current increased above a threshold, several peaks were found to appear in the spectrum of the rf voltage vs. frequency, and these peaks grew and shifted to higher frequencies with increasing current. The authors attribute this effect to wave excitations in the density of current-depaired vortices and antivortices near the line tip.

Numerical studies supporting the idea that during nonuniform current flow in a two-dimensional superconductor, current-depaired vortices and antivortices can form a stable nonequilibrium vortex-density-wave state are presented in a preprint by S. E. Hebboul (Ohio State). The author found that a necessary condition for generating vortex density waves is a dc current distribution displaying a pronounced symmetrical dip along the direction of equipotential lines. Above a crossover current, the stationary densities of vortices and antivortices evolve into two coupled density waves, which travel in opposite directions.

The interaction of vortices in a quasi-one-dimensional array of Josephson junctions with small capacitance has been considered in a preprint by C. Bruder (Karlsruhe) et al. If the charging energy of a junction is of the order of the Josephson energy, the fluctuations of the superconducting order parameter in the system are considerable, and the vortices behave as quantum particles. The authors find that the interplay between the quantum nature of a vortex and the long-range interaction between vortices leads to the existence of a commensurate-incommensurate transition in a one-dimensional vortex lattice.

Films

The use of metal organic decomposition (MOD) to produce thick films of *YBCO* on *$SrTiO_3$ (STO)* and *$LaAlO_3$ (LAO)* single-crystal substrates is reported by S. Sathyamurthy and K. Salama (TCSUH). Films of thickness 0.5 μm were found to have critical current densities J_c in excess of 5×10^5 A/cm^2 at 77 K in zero field.

Direct peritectic growth (DPG) is a process in which textured *YBCO* thick films are deposited directly onto an unoriented silver alloy, with no buffer layer between the *YBCO* and the substrate. X. Wen (Cincinnati) et al. have used this method to produce thick *YBCO* films with transport $J_c = 8 \times 10^4$ A/cm^2 at 77 K in zero magnetic field. The authors assert that the DPG method is capable of producing highly textured *YBCO* thick films, which are scalable to long lengths at low cost.

The microwave power-handling capabilities of *YBCO* thin superconducting films, up to 150 W of input power, have been investigated by J. Wosik et al. (TCSUH) using a 14 GHz shielded dielectric cavity. For all films, the authors found that the heating of weak links switched to the normal state is one of the major limitations for rf power handling.

Applications

A cylindrical *YBCO* single-domain superconducting cavity resonator for microwave applications has been made by D. Qu et al. (Cincinnati) using a net-shape melt-processing method. The authors report measurements of the quality factor (unloaded Q) as a function of annealing temperature and oxygen annealing history.

Levitation results are reported by Y. Postrekhin et al. (TCSUH) for high-temperature superconducting (HTS) trapped-field magnets made of disks of melt-textured *$YBa_2Cu_3O_{7-\delta}$* prepared by the seeded directional solidification method. The authors found that the force between the magnet and the HTS trapped-field magnet depends on the polarity of the frozen magnetic field and can be positive or negative. The authors compared the levitation force between

a magnet and a trapped-field magnet with that between the magnet and a zero-field-cooled high-temperature superconductor without trapped flux. The authors also investigated the stability of a levitation system based on trapped-field magnets by studying the amplitude-frequency characteristics of a system where a permanent magnet is attached to a soft cantilever beam and placed above the trapped-field magnet.

Theory

The feasibility of a perturbation expansion for Green's functions of the t-J model directly in terms of X-operators has been demonstrated by R. Zeyher and A. Greco (MPI-Stuttgart) using the Baym-Kadanoff functional method. As an application, the authors derive explicit expressions for the kernel Θ of the linearized equation for the superconducting order parameter in leading order of a 1/N expansion. The authors solve the linearized equation numerically on a square lattice taking instantaneous and retarded contributions into account.

Fixed-node Green's function Monte Carlo calculations have been performed by A. C. Cosentini (INFM and Roma) et al. for large (16×16) 2D Hubbard lattices, large interaction strengths (U = 10, 20, and 40), and many (15-20) densities between empty and half-filling. The authors show that for such large lattice sizes, the evaluation of the energy does not suffer from finite-size, shell, or boundary-condition effects, which are relevant for small systems. The energies do suffer, however, from a fixed-node bias.

A paper by Z. Y. Weng et al. (TCSUH) relates magnetic incommensurability to the intrinsic properties of the doped Mott insulator, described by the t-J model. The authors show that such incommensurability is a direct manifestation of the phase-string effect introduced by doped holes in both one- and two-dimensional cases. The magnetic incommensurate peaks in the dynamic spin susceptibility in momentum space are in agreement with neutron-scattering results in cuprate superconductors in both position and doping dependence. In particular, this incommensurate structure can naturally reconcile neutron-scattering and NMR experiments in the cuprates.

A mean-field treatment of the phase-string effect in the t-J model is presented in a preprint by Z. Y. Weng et al. (TCSUH). Such a theory is able to unite the antiferromagnetic (AF) phase at half-filling and the metallic phase at finite doping within a single theoretical framework. The low-temperature occurrence of AF long-range ordering at half-filling and superconducting condensation in the metallic phase are due to Bose condensations of spinons and holons, respectively, on top of a spin background described by bosonic resonating-valence-bond (RVB) pairing. The fact that both spinons and holons are bosons, as a result of the phase-string effect, represents a crucial difference from the conventional slave-boson and slave-fermion approaches.

An extended Hubbard model with nearest-neighbor correlated hopping and next-nearest-neighbor hopping t' is found by L. Arrachea (Rio) and A. A. Aligia (Bariloche) to be an effective model for the cuprate superconductors. Using a generalized Hartree-Fock BCS approximation, the authors find that for high enough t' and doping, antiferromagnetism is destroyed and the system exhibits d-wave superconductivity. The calculated superconducting critical temperature as a function of doping is in good agreement with experiment.

A preprint by O. Tchernyshyov (Columbia) points out an error in a 20-year-old paper by Sadovskii, who reported an exact solution of a model exhibiting a pseudogap in the electron energy spectrum of a one-dimensional conductor. The author also shows that antiferromagnetic fluctuations alone cannot explain the presence of a strong pseudogap in cuprate superconductors seen by local probes of the density of states, such as tunneling spectroscopy and NMR. Pairing fluctuations seem to be a necessary ingredient to explain the pseudogap at low frequencies.

The effect of order-parameter phase fluctuations on the single-particle properties of fermions in the underdoped cuprate superconductors has been studied by H.-J. Kwon and A. T. Dorsey (Florida) using a phenomenological low-energy theory. The authors identify the fermion - phase-field coupling as the Doppler shift of the quasiparticle spectrum induced by the fluctuating superfluid velocity, and they calculate the effect of these fluctuations on the fermion self-energy. Vortex-pair unbinding near the superconducting transition causes a significant broadening in the fermion spectral function, producing a pseudogap-like feature. The authors also discuss the specific heat and show that the phase-fluctuation effect is visible because of the short coherence length.

A simple model for the doped compound $Nd_{2-x}Ce_xCuO_4$ is presented by R. E. Lagos (Rio Claro) et al. Using Hartree-Fock, the authors start from an impurity Anderson-like model and consider the magnetic splitting of the *Nd* 4f ground-state Kramers doublet due to exchange interactions with the ordered *Cu* moments. The results are in good agreement with the experimental data, yielding a Schottky anomaly peak for the specific heat that reduces in amplitude, broadens, and shifts to lower temperatures upon *Ce* doping.

Some applications of higher symmetry groups to condensed matter systems are discussed in a preprint by R. S. Markiewicz and M. T. Vaughn (Northeastern). The authors give special attention to the groups SO(n) (n = 4, 5, 6, and 8) in the two-dimensional Hubbard model and its generalizations, which model the high-T_c cuprate superconductors.

The attenuation of longitudinal ultrasonic waves in a clean two-dimensional d-wave superconductor has been considered by I. Vekhter (Guelph) et al. The authors show that the attenuation coefficient is linear in temperature at low temperatures for all in-plane directions of the propagation of the ultrasound, and that the coefficient of the linear term can be used to determine the parameters crucial for the low-temperature transport in these compounds.

The real-axis Eliashberg equations for the retarded electron-boson interaction have been solved by G. A. Ummarino and R. S. Gonnelli (Torino) for the case of d-wave symmetry for the pair wave function. The numerical simulations provide a good fit to the gap, critical temperature, and the density of states obtained recently in break-junction tunneling experiments.

A paper by A. H. Romero et al. (UC-San Diego) applies weak-coupling perturbation theory to the Holstein molecular crystal model in order to compute an electron-phonon correlation function characterizing the shape and size of the polaron lattice distortion in one, two, and three dimensions. The authors find that the width of the polaron thus determined disagrees in every dimension with some well-known characterizations of polarons, signaling in particular the breakdown of the adiabatic approximation and the characterizations of self-trapping associated with it.

Other Activities

The transport critical current J_c in a polycrystalline superconductor is known to be a hysteretic function of the applied magnetic field because of intragranular flux trapping. This effect has been observed by several groups, and attempts have been made to calculate the intergranular field H_i as a function of the applied field H_0 in terms of an effective geometrical demagnetization factor D. In general, a first-principles calculation of D is very difficult, and moreover D is not constant but rather a hysteretic function of H_0. A paper by M. N. Kunchur (South Carolina) and T. R. Askew (Kalamazoo and Argonne) describes a self-consistent scheme to extract D and H_i directly from the $J_c(H_0)$ data. The authors apply this model to analyze data on sintered $YBa_2Cu_3O_{7-\delta}$ rods.

Measurements of the ac susceptibility of a ceramic high-temperature superconductor as a function of temperature, frequency, and ac-field amplitude are reported by S. Çelibi (Karadeniz Technical University) et al. The sample was a rectangular bar-shaped sample of $Bi_{1.84}Pb_{0.34}Sr_{1.91}Ca_{2.03}Cu_{3.06}O_{10}$ prepared by the liquid ammonium nitrate method. The authors observed that as the frequency increased, the intra- and intergranular ac loss peaks moved to higher temperature, while as the ac-field amplitude increased, the peaks moved to lower temperature, indicating that the ac losses were due to both hysteretic bulk pinning losses and viscous (flux-flow) losses.

Overviews

A review chapter by G. Hilscher and H. Michor (Wien) summarizes the superconducting and normal properties of the borocarbide superconductors YNi_2B_2C and $LuNi_2B_2C$. The authors then review the magnetic properties of the RNi_2B_2C borocarbides with magnetic *R* ions, emphasizing the interplay between superconductivity and magnetism in these compounds (157 refs.).

A handbook chapter by W. Wong-Ng (NIST-Gaithersburg) illustrates representative examples of phase diagrams of the high-temperature superconductors, emphasizing the $BaO\text{-}Y_2O_3\text{-}CuO$, $BaO\text{-}R_2O_3\text{-}CuO$, and $Bi_2O_3\text{-}PbO\text{-}SrO\text{-}CaO\text{-}CuO$ systems. The author also discusses the basic definitions of some frequently encountered terms, and describes experimental procedures for constructing phase diagrams (100 refs.).

An overview by J. Mannhart and H. Hilgenkamp (Augsburg) notes that the physics of interfaces involving complex superconductors is considerably richer and much less explored than the physics of interfaces and surfaces of conventional superconductors. The authors summarize a variety of unusual interface properties that arise from basic properties of unconventional superconductors, such as their pairing symmetry, small carrier densities, small coherence lengths, and band bending (87 refs.).

A review chapter by H. Schmidt and H. F. Braun (Bayreuth) summarizes a variety of investigations of borocarbide compounds relating their physical properties, such as superconductivity, magnetism, and their interplay, to their material parameters, such as chemical composition, lattice constants, long-range order, and transition-metal doping (81 refs.).

Contributed by John R. Clem

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COMING EVENTS

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

Oct. 23 - 25, 1998:

Joint Midwest Solid State Conference and Solid State Theory Conference, Scheman Building, Ames, Iowa. Two traditional Midwest solid state conferences will be held: the Midwest Solid State Conference, which in the past has included mainly experimental work, and the Midwest Solid State Theory Conference. Selection of invited speakers covers a wide range of topics both in theory and experiment. **Abstract deadline, Oct. 15, 1998; registration deadline, Oct. 16, 1998.** For information, contact Konnie Willie-Kennicker, Conference Secretary, A109 Physics, Department of Physics and Astronomy, Iowa State University, Ames, IA 50011-3020; phone (515) 294-3481; fax (515) 294-0689; e-mail kkennick@ameslab.gov; Web site http://cmpweb109.ameslab.gov/conference.

April 8 - 9, 1999:

Workshop on ac Losses (WACL 99), EPRI, Palo Alto, Calif. Two-day workshop will cover theoretical and experimental research on power-line-frequency (50-60 Hz) ac losses in high-temperature superconductors, and the influence such losses have on the design of HTS devices for electric power applications. As in previous EPRI-sponsored workshops held in 1995 and 1997, the program will consist of talks, posters, and workshop discussions. No registration fee, but attendance limited to 65 participants. For further information, contact Kathleen Lyons, Conference Coordinator, EPRI, 3412 Hillview Ave., Palo Alto, CA 94304; telephone (650) 855-2656; telefax (650) 855-8997; e-mail klyons@epri.com.

June 14 - 18, 1999:

Specialized Colloque AMPERE: EPR, NMR, NQR in Solid State Physics – Recent Trends, Dipartimento di Fisica, Pisa, Italy. Meeting will deal with recent magnetic-resonance studies in strongly correlated systems (such as charge-doped transition metals oxides, heavy fermions, and high-temperature superconductors) at phase transitions in incommensurate and/or disordered systems and glassy materials, and in fullerenes and fullerites. Also included will be particular aspects in strong magnetic fields and nonlinear effects, as well as studies in new branches of magnetism such as quantum magnetism in planar antiferromagnets, spin ladders, and chains or magnetic clusters. Recent experimental developments (including high-field/high-frequency EPR spectroscopy and magnetic resonance microscopy) and their applications to the study of new magnetic materials will be discussed.

Intention is to cast these topics in a unified frame based on the common experimental approaches with resonance and relaxation techniques, with an effort towards unifying aspects and methodology at an advanced level. For further information, contact Conference Secretariat, IFAM-CNR, Via del Giardino, 7, I-56127 Pisa, Italy; telefax +39 50 3139035; e-mail ampere@ifam.pi.cnr.it; Web site http://www.ifam.pi.cnr.it/ampere.html.

June 28 - July 3, 1999: World Electrotechnical Congress and Exhibition (WELC-99), Moscow, Russia. Plenary sessions and fourteen technical sessions to be organized at various locations in Moscow. Subsection on Electrical Engineering Equipment for Transmission and Distribution of Electric Energy will include session on HTSC applications in power engineering. For information, contact WELC-99, Section 2 Organizing Committee, 12 Krasnokazarmennay Street, VEI, 111250 Moscow, Russia; telefax +7 095-362 5617 or -362 5503; e-mail agilim@vei.ru or finareva@vei.ru.

RESOURCES

Information

Books: *The Physics of Composite Superconductors,* by A. V. Gurevich, R. G. Mints, and A. L. Rakhmanov. Composite superconductors offer a solution to a wide range of problems, including thermomagnetic instability, instability of the superconducting state with respect to strong pulsed perturbations, heat release under varying external conditions, and inadequate strength and plasticity. The macroscopic properties of composite superconductors, and the processes that occur in them, are studied in the rapidly developing subject of the physics of composite superconductors. This monograph presents a unified account of the subject and covers all important aspects of composite superconductors such as structure and physical characteristics, losses, stability of the critical state, superconducting-to-normal transition, and high-temperature superconductivity. Publ. 1997; 348 pp.; price $112.50; ISBN 1-57600-066-5. Contact Begell House Publishers, 79 Madison Avenue, New York, NY 10016; phone (212) 725-1999; fax (212) 213-8368; e-mail begellhouse@worldnet.att.net; Web site www.begellhouse.com.

New Book: *The Superconducting State in Magnetic Fields – Special Topics and New Trends,* edited by Carlos A. R. Sà de Melo. This volume is a collection of short review articles written by leading international experts on the superconducting state in magnetic fields, a rapidly developing area. The philosophy of the book is to emphasize the importance of having experimental and theoretical works side by side. Every effort has been made to match each experimental article with a corresponding theoretical article. The selection of materials includes special topics, new effects, and new trends concerning superconductors in low and high magnetic fields. Special topics and new trends include quantum and classical melting of the vortex lattice, new vortex lattice symmetries, vortex core states, nonlinear Meissner effect, symmetry of the order parameter in high-temperature superconductors, and superconductors in high magnetic fields. Targeted at a broad audience, including graduate students, postdocs, and other researchers active or interested in this field. Publ. 1998; 340 pp.; price US$78/£54, US$38/£26 (pbk); ISBN 981-02-3374-4 or ISBN 981-02-3566-6 (pbk). Contact World Scientific Publishing Co., Inc., 1060 Main Street, River Edge, NJ 07661; telephone (800) 227-7562 or (201) 487-9655; telefax (201) 487-9656; e-mail wspc@wspc.com; Web site http://www.wspc.com/.

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Position available: Postdoctoral fellowship at the CSIRO Telecommunications and Industrial Physics in Sydney, NSW, Australia. Applicant to undertake basic research on critical current limitations and flux dynamics of high-temperature superconductors to improve the current-carrying capability in strong magnetic fields. Ph.D. in condensed matter or other related areas of physics, electrical engineering, or materials science required. Three-year term. Salary: 44 K to 50 K (Australian dollars) + superannuation. **Application deadline, December 4, 1998.** For a copy of selection criteria and duty statement, contact Geoff Hall, telephone +61 2 9413 7450, telefax +61 2 9413 7631, e-mail geoff.hall@tip.csiro.au. Applicants should quote reference number AS98/13, include relevant personal particulars, including qualifications and experience, and send applications to Human Resources Department, CSIRO Telecommunications & Industrial Physics, P.O. Box 218, Lindfield NSW 2070, Australia.

The World Laboratory announces a scholarship named in honor of E. R. Caianiello to be awarded annually to a young physicist. The scholarship will be tenable at the International Institute for Advanced Scientific Studies “E. R. Caianiello” in Vietri sul Mare, Salerno, Italy, and at the Department of Physical Sciences “E. R. Caianiello” of the Salerno University. Open to candidates from developing countries working in condensed-matter physics and quantum-field theory. Date of availability: Sept. 1999 (negotiable); duration: 12 months; amount of the scholarship: approximately 1300 Swiss francs per month. **Application deadline, Dec. 31, 1998.** Prospective candidates are invited to send their CV, list of publications, and two letters of recommendation to Prof. F. Mancini, Dipartimento di Scienze Fisiche “E. R. Caianiello”, Universita’ degli Studi di Salerno, Via S. Allende, I-84081 Baronissi (SA), Italy; phone +39 89 965322; fax +39 89 965275; e-mail mancini@vaxsa.csied.unisa.it.

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