HIGH T_C UPDATE

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NOTA BENE:

Dear Readers: **Several of you have e-mailed us expressing relief to see our Jan. 1, 2000, issue and assuming our financial crisis is over. Unfortunately, our situation has not changed. We are presently using reserve funds to produce our last few newsletters. Here at the office, our two secretaries have secured employment elsewhere and are only working part-time for *High-T_C Update*. So please bear with us if we take a little longer to mail your newsletters or answer your queries. In the next issue, we will direct you toward a few alternate resources you may find helpful in our absence.**

Coated Conductors

The microstructural development of *$YBa_2Cu_3O_{7-\delta}$ (Y-123)* coated conductors based on ion-beam-assisted deposition (IBAD) of yttria-stabilized zirconia *(YSZ)* to produce a biaxially textured template has been studied by T. G. Holesinger (Los Alamos) et al. The architecture of the conductors was *Y-123* / *CeO_2* / IBAD *YSZ* / Inconel 625. The authors found that a continuous and passivating *Cr_2O_3* layer forms between the *YSZ* layer and the Inconel substrate. *CeO_2* and *Y-123* are closely lattice-matched, and misfit strain is accommodated at the *YSZ/CeO_2* interface. Localized reactions between the *Y-123* film and the *CeO_2* buffer layer result in the formation of *$BaCeO_3$, $YCuO_2$,* and *CuO*. The positive volume change that occurs from the interfacial reaction may act as a kinetic barrier that limits the extent of the reaction. Excess copper and yttrium generated by the interfacial reaction appear to diffuse along grain boundaries and intercalate into *Y-123* grains as single layers of the *Y-247, Y-248,* and *Y-224* phases. The interfacial reactions do not preclude the attainment of high I_C and J_C in these films nor do they affect to any appreciable extent the nucleation and alignment of the *Y-123* film.

In the fabrication of multilayer coated conductors, it is essential to avoid film cracking. By observing crack formation of the films, Y. Yamada et al. (SRL-ISTEC) have evaluated the effective thermal expansion coefficient of c-axis-oriented twinned *$YBa_2Cu_3O_{7-\delta}$ (YBCO)* films deposited by liquid-phase epitaxy (LPE) on *$SrTiO_3$ (STO)* substrates. The critical thickness of a *YBCO* film grown on *STO* at 920°C is about 1.35 μm; for thicker films, cracks result from the tensile stress in the *YBCO* films. A simple fracture model accounting for the mechanical properties of the materials yields an effective thermal expansion coefficient for *YBCO* films of about 1.40×10^{-5}/K as an engineering value for prediction of crack formation on various substrates. Using this estimate, the authors predict the critical film thickness on various substrates widely used in oxide superconductor research. The authors also found that control of the oxygenation conditions can be used to avoid maximum stress caused by the thermal expansion difference between the substrate and the film.

As reported by K. Matsumoto (SRL-ISTEC) et al., *YBCO* films with high critical current density J_C have been successfully fabricated on nickel tapes buffered with epitaxial *NiO*. The *NiO* was formed on the textured nickel tape by the surface-oxidation epitaxy (SOE) method. The authors previously reported values of T_C = 87 K and J_C = 4-6 $\times 10^4$ A/cm^2 (77 K, 0 T) for *YBCO* films on *NiO/Ni* tapes. To enhance the superconducting properties of the *YBCO* films on SOE-grown *NiO,* the authors deposited thin oxide cap layers such as *YSZ, CeO_2,* and *MgO* on *NiO*. These oxide cap layers, grown epitaxially on *NiO,* provided the template for epitaxial growth of *YBCO* films. Using an *MgO* cap layer of thickness 50 nm, the authors obtained substantially improved results: T_C = 88 K, $J_C = 3 \times 10^5$ A/cm^2 (77 K, 0T) and 1×10^4 A/cm^2 (77 K, 4 T, **H** || c). The authors suggest that the method described in this paper provides a simple way to produce long *YBCO* tape conductors with high J_C values.

$RBa_2Cu_3O_{7-\delta}$

The influence of magnetic (S = 1) and nonmagnetic (S = 0) impurities upon the spin dynamics of an optimally

doped high-temperature superconductor, $YBa_2Cu_3O_7$, has been compared by Y. Sidis (Saclay) et al. in two samples with almost identical superconducting transition temperatures: $YBa_2(Cu_{0.97}Ni_{0.03})_3O_7$ (T_c = 80 K) and $YBa_2(Cu_{0.99}Zn_{0.01})_3O_7$ (T_c = 78 K). In the *Ni*-substituted system, the magnetic resonance peak (observed at $E_r \approx$ 40 meV in the pure system) shifts to a lower energy with a preserved E_r/T_c ratio, while the shift is much smaller upon *Zn* substitution. By contrast, *Zn,* but not *Ni,* restores significant spin fluctuations around 40 meV in the normal state. The authors discuss these observations in the light of models proposed for the magnetic resonance peak.

A paper by W. A. MacFarlane (Orsay) et al. presents a comprehensive study of the spin dynamics of local magnetic defects induced by nonmagnetic substitutions (here *Li*) of plane-site *Cu* atoms in the normal state of $YBa_2Cu_3O_{6+x}$. The fluctuations of the *Cu* moments in the vicinity of *Li* are probed by both near-neighbor ^{89}Y and ^{7}Li NMR spin-lattice relaxation. From the isolated-impurity behavior for *Li* concentrations ≤ 1%, the authors extracted the T dependence of the correlation time τ of the local magnetic moment. They found this to be proportional to the local static susceptibility from the underdoped to the overdoped regime. The authors note that this correlation is remarkably reminiscent of Kondo impurities in conventional metals.

Results of reflectivity measurements with **E** || c and **E** ⊥ c on $NdBa_2Cu_3O_{7-\delta}$ *(Nd-123)* single crystals close to full oxygen doping are reported by R. Hauff et al. (Karlsruhe). Along the c axis, the optical conductivity σ_1^c shows a well developed absorption band around 450 cm^{-1} at all temperatures. The in-plane optical properties are dominated by crystal-field excitations at low energies, a prominent step at 400 cm^{-1}, and a weaker feature in the range 500-550 cm^{-1}.

Single crystals of $NdBa_2Cu_3O_{6+x}$ and $LaBa_2Cu_3O_{6+x}$ at oxygen concentrations $x \approx 0.4$, 0.5, and 0.76 have been investigated by T. Frello (Risø) et al. using hard x-ray diffraction. The authors found intricate oxygen superstructures in nonsuperconducting $NdBa_2Cu_3O_{6.5}$ crystals. By numerical calculations, the authors demonstrate that three unique coexisting configurations are required to obtain the observed diffraction pattern. The oxygen configurations found are unlikely to give rise to hole doping of the CuO_2 planes, explaining why a higher oxygen doping is necessary in $NdBa_2Cu_3O_{6+x}$ than in $YBa_2Cu_3O_{6+x}$ to make the compound superconducting.

The properties of melt-processed $(Nd_{0.33}Eu_{0.33}Gd_{0.33})$-$Ba_2Cu_3O_{7-\delta}$ *(NEG-123)* bulk superconductors have been investigated by M. Muralidhar et al. (SRL-ISTEC) and by A. K. Pradhan et al. (SRL-ISTEC). The first preprint reports on the enhancement of J_c by the addition of $(Nd_{0.33}Eu_{0.33}$-$Gd_{0.33})_2BaCuO_5$ *(NEG-211)* particles, while the second preprint reports the current-voltage characteristics.

Bi Cuprates

The topology of the normal-state Fermi surface of $Bi_2Sr_2CaCu_2O_{8+\delta}$ *(Bi-2212)* is reported in preprints by M. S. Golden (Dresden) et al. and S. V. Borisenko (Dresden) et al. The authors used angle-resolved photoemission with unpolarized radiation, high (E,**k**) resolution, and an extremely dense sampling of **k** space. They found that the Fermi surface is hole-like, with the form of rounded tubes centered on the corners of the Brillouin zone. The authors also observed two additional features: shadow Fermi surfaces and diffraction replicas of the main Fermi surface caused by passage of the photoelectrons through the modulated *BiO* planes.

The peak effect in heavily *Pb*-doped $Bi_2Sr_2CaCu_2O_{8+\delta}$ *(Bi-2212)* single crystals has been studied by X. L. Wang et al. (Wollongong) via magnetization hysteresis. In contrast to the weak peak effect found in pure single crystals, the *Pb*-doped crystals showed a very strong peak effect over a wide temperature range, from 20 K up to T_c.

The mixed-state resistivity of polycrystalline $(Bi,Pb)_2$-$Sr_2Ca_2Cu_3O_{10+\delta}$ *[(Bi,Pb)-2223]* has been analyzed by M. Pekala (Warsaw) et al. to locate the percolation line in the phase diagram. The authors also calculated the magnetic-field and temperature variations of the vortex liquid viscosity and determined the activation energies.

Using a micro-XRD (x-ray diffraction) system, Y. B. Huang et al. (BICC General Superconductors) have analyzed the phase content and grain alignment within each individual filament of *Bi-2223* multifilamentary tapes. The filaments could be divided into three groups, depending upon the degree of *2223* phase formation and texture. The filaments near the center of the tape were found to have higher *2223* phase content and better texture, while those near the edges were poorer. The authors suggest that the strong variation in filament shape and density could affect *2223* phase conversion and texture quality. The authors discuss methods to increase the filament uniformity.

As reported by M. Ishizuka (Sumitomo) et al., *Bi-2223/Ag-Cu* alloy sheathed tapes have been fabricated by the powder-in-tube technique using *Ag*-10 at% *Cu* alloy sheath doped with *Ti* or *Hf* of less than 0.1 at%. The authors found that *Hf* doping led to enhancements of J_c while causing no substantial change in T_c.

Other Cuprates

The optical absorption spectrum from 0.1 to 0.5 eV photon energy has been measured by D. S. Kleinberg et al. (MIT) for extremely lightly oxygen-doped crystals of

La_2CuO_4. The authors found that crystals grown by two different methods have different low-temperature spectra and different temperature dependencies. However, the spectra at room temperature are nearly identical, suggesting that they result from the optical absorption of free isolated holes in the two-dimensional antiferromagnetic CuO_2 square lattice.

Low-temperature fluorination of $Sr_{2-x}Ba_xCuO_3$ (x = 0.0 - 0.6) has been carried out by S. Adachi et al. (SRL-ISTEC). Pristine samples were heat-treated with NH_4F at 210°C in flowing nitrogen gas. The fluorinated samples exhibited weak Meissner signals, and a maximum superconducting transition temperature of 68 K was detected in the fluorinated sample with x = 0.2. The authors present evidence the superconductivity is associated with the K_2NiF_4 phase.

ac Losses

Measurements of the ac losses of a novel multi-filamentary *(Bi,Pb)-2223* superconducting wire with round cross section are reported by D. M. Spiller et al. (BICC General Superconductors). The losses were found to be less than those of a traditional elliptical tape. The authors also measured the critical current I_c as a function of the angle of an applied magnetic field and found less than a 5% variation of I_c.

The self-field losses of *Bi-2223* tapes and round wires with twisted filaments have been studied by C. M. Friend et al. (BICC General Superconductors). The round wires were made by parallel stacking of monocore tapes inside a tube and twisting with a pitch of 6 mm. Their losses were purely hysteretic and did not change with twisting. The tapes had 37 filaments twisted with a pitch of 3.3-13 mm. The losses of tapes with pitch greater than 4 mm contained sizable nonhysteretic loss components. Explanation of these results will require understanding the effect of the longitudinal field imposed by the helical path of the transport current.

The Meissner shielding in arrays of parallel diamagnetic strips has been studied by P. Fabbricatore (Genova) et al. when the field is applied normal to the wide face of the strips. Numerical solutions of the Laplace equation were found using a commercially available finite element code for electrical and magnetic analysis. After testing the method on simpler geometries, the authors examined typical filament configurations of two real *Bi-2223* multi-filamentary tapes and calculated the susceptibilities in the Meissner state. The authors found that the regularity in the filament distribution can dramatically influence the magnetic properties and hence the magnetic ac losses in the tape.

Vortices

A preprint by J. Kierfeld and V. Vinokur (Argonne) reports the development of a theory for dislocation-mediated structural transitions in the vortex lattice which allows for a unified description of phase transitions among the three phases (the elastic vortex glass, the amorphous vortex glass, and the vortex liquid) in terms of a free-energy functional for the dislocation density. The authors also explain the origin of the experimentally observed critical endpoint of the melting line at high magnetic fields.

The dynamics of pinning of an elastic string in the transient subthreshold region have been studied by G. K. Leaf (Argonne) et al. The authors found three distinct transient regimes: (a) a fast initial relaxation, (b) an intermediate exponential decay of the activity resulting from residual motion in the exponentially rare regions free of defects, and (c) a novel avalanche-like terminal relaxation to the pinned state, $A_r \sim (t_p - t)^{\Psi}$, resulting from finite-size effects.

A paper by C. M. Palmer (George Washington) and T. P. Devereaux (Waterloo) presents the results of three-dimensional molecular dynamics simulations of vortices which indicate that, for $B > B_\phi$, the enhanced pinning effectiveness of splayed columnar defects relative to parallel columnar defects can be explained in terms of the existence or absence of channels through which the vortices can flow without encountering defects.

Simulations of the gauge-glass model in three dimensions have been carried out by T. Olson and A. P. Young (UC-Santa Cruz) using exchange Monte Carlo. The authors find clear evidence for the vortex-glass ordered phase at finite temperature. Using finite-size scaling, the authors obtain estimates for the correlation-length exponent $\nu = 1.39 \pm 0.20$, the correlation-function exponent $\eta = -0.47 \pm 0.07$, the dynamic exponent $z = 4.2 \pm 0.6$, and the resistivity exponent $s = 4.5 \pm 1.1$. The authors also provide a plausible lower bound on the zero-temperature stiffness exponent $\theta \geq 0.18$.

The behavior of the thermal conductivity $\kappa(H)$ in the vortex state of a quasi-two-dimensional d-wave superconductor when both the heat current and the applied magnetic field are in the basal plane has been analyzed by I. Vekhter (Guelph) and P. J. Hirschfeld (Florida). The authors find that at low temperature, $\kappa(H)$ exhibits twofold oscillations as a function of the angle between the field and the heat current, in agreement with experiment.

A microscopic calculation of the longitudinal thermal conductivity of quasiparticles κ_{xx} in a 2D d-wave superconductor in the vortex state has been carried out by I. Vekhter (Guelph) and A. Houghton (Brown). The authors include both impurity scattering and a contribution to the thermal transport lifetime due to the scattering of quasiparticles by vortices. The

authors briefly compare their results with experimental measurements in high-T_c cuprates and organic superconductors.

The magnetic-field dependence of the Josephson plasma resonance (JPR) frequency in the vortex-crystal state has been analyzed by A. E. Koshelev (Argonne) and L. N. Bulaevskii (Los Alamos). The authors found that in the single-vortex regime at low magnetic fields, the JPR provides a direct probe for meandering of individual lines. A theory of pancake fluctuations gives a good description of the plasma frequency up to the melting field.

Josephson-plasma and vortex modes in layered superconductors have been studied theoretically by E. B. Sonin (Hebrew University of Jerusalem) for low magnetic fields parallel and perpendicular to the layers. The author stresses that the two modes belong to the same lowest-frequency branch of the collective-mode spectrum localized near vortices. The author interprets the recently observed jump of the magnetoabsorption resonance frequency at the vortex phase transition line as a transition from the Josephson-plasma mode to the vortex mode.

Numerical investigations of the critical current of two-dimensional fully frustrated arrays of resistively shunted Josephson junctions at zero temperature have been carried out by B. J. Kim and P. Minnhagen (Umeå). The authors find that a domino-type mechanism is responsible for the existence of a critical current lower than the one predicted from the translationally invariant flux lattice. The authors suggest that the domino-type vortex motion can be observed in experiments as voltage pulses propagating from the contacts through the array.

Theory

As pointed out by M. R. Norman (Argonne) et al., if high-temperature cuprate superconductivity is due to electronic correlations, then the energy difference between the normal and superconducting states can be expressed in terms of the occupied part of the single-particle spectral function. The authors note that the latter can, in principle, be determined from angle-resolved photoemission (ARPES) data. As a consequence, the energy gain driving the development of the superconducting state is intimately related to the dramatic changes in the photoemission lineshape when going below T_c.

The relation between the incommensurability observed in neutron-scattering experiments in bilayer cuprate superconductors and the electronic structure has been investigated by M. R. Norman (Argonne). The author finds that the observed incommensurability pattern, as well as its dependence on energy, can be well reproduced by electronic dispersions motivated by angle-resolved photoemission data. The author also discusses the commensurate resonance and its contribution to the superconducting condensation energy.

To test the recently proposed connection between the neutron resonance and the specific-heat anomaly in the cuprates, B. Jankó (Argonne) has used the experimental specific-heat data on $YBa_2Cu_3O_{6.93}$ and a theoretical estimate of the single-particle fermionic contribution to the specific heat to provide an upper bound for the intensity of the neutron peak. The deduced peak intensity is similar in magnitude and temperature dependence to that observed in neutron-scattering experiments, and it is constrained to decrease strongly under the influence of moderate magnetic fields oriented along the c axis of the crystal. The author proposes an explanation for the predicted suppression based on the observation that the resonance intensity is very sensitive to superconducting phase correlations.

A preprint by C. Kusko and R. S. Markiewicz (Northeastern) notes that recent experiments have introduced a new concept for analyzing the photoemission spectra of correlated electrons: the remnant Fermi surface (rFs), which can be measured even in systems that lack a conventional Fermi surface. The authors analyze the rFs in a number of interacting-electron models, and they find that the results fall into two classes. For systems with particle-particle (pairing) instabilities, the rFs is an accurate replica of the true Fermi surface. In the presence of particle-hole (nesting) instabilities, the rFs is a map of the resulting superlattice Brillouin zone. The results suggest that the gap in $Ca_2CuO_2Cl_2$ is of particle-hole origin.

A phase-separation model for the stripe phase of the cuprates, which allows the doping dependence of the photoemission spectra to be calculated, has been developed by R. S. Markiewicz (Northeastern). The author analyzes the idealized limit of a well-ordered array of magnetic and charge stripes, including effects of long-range Coulomb repulsion. Remarkably, down to the limit of two-cell-wide stripes, the dispersion can be interpreted as essentially a superposition of the two end-phase dispersions, with superposed minigaps associated with the lattice periodicity. The author uses the model to show that the systematic progression from $Sr_2CuO_2Cl_2$ to $La_{2-x}Sr_xCuO_4$ to $Bi_2Sr_2CaCu_2O_{8+\delta}$ can be understood theoretically in terms of increasing fluctuations, and that the incommensurate magnetic order also can be understood within the same model.

From calculations of the high-temperature series for the free energy of the two-dimensional t-J model, W. O. Putikka (ETH-Zürich and Ohio State) and M. U. Luchini (Imperial) have constructed series for ratios of the free energy per hole. The ratios can be extrapolated very accurately to low temperatures and used to investigate phase separation.

The results confirm that phase separation occurs only for $J/t \geq 1.2$. The phase transition into the phase-separated state has $T_C \approx 0.25\ J$ for large J/t.

The effect of disorder on the ratio of the stripe spin correlation length ξ_S to the charge correlation length ξ_C has been analyzed by O. Zachar (Trieste). The author finds that if the stripe correlations are disordered primarily by nontopological elastic deformations (i.e., a Bragg-glass type of disorder), then $\xi_S/\xi_C \geq 2.5$ is expected. On the other hand, if stripe disorder is controlled by topological defects (e.g., dislocations), then $\xi_S/\xi_C \leq 1$ is expected. The author concludes that the observation of $\xi_S/\xi_C > 2.5$ in $(LaNd)_{7/8}Sr_{1/8}CuO_2$ implies that the stripes are in a Bragg-glass type state, and that topological defects are much less relevant than commonly assumed.

A dynamical theory of the stripe phase arising in a two-dimensional electron liquid near half-integral fillings of high Landau levels has been proposed by M. M. Fogler (Princeton) and V. M. Vinokur (Argonne). The theory is expected to apply at relatively high temperatures and in the clean limit. The authors found that the collective-mode properties of the system exhibit nontrivial power-law scaling, which can be verified by microwave and surface acoustic wave measurements.

Using high-temperature series, W. O. Putikka (UC-Santa Barbara, ETH-Zürich, and Ohio State) et al. have calculated temperature derivatives of the spin-spin and density-density correlation functions to investigate the low-energy spin and charge excitations of the two-dimensional t-J model. The authors find that the temperature derivatives indicate different momentum dependencies for the low-energy spin and charge excitations. By comparing short-distance density-density correlation functions with those of spinless fermions and hard-core bosons, the authors find that the t-J model results are intermediate between the two cases, being closer to those of hard-core bosons.

A BCS - Bose-Einstein crossover scenario for $0 \leq T \leq T_C$ and its implications for the superfluid density and specific heat has been investigated by Q. Chen et al. (Chicago). The authors find that the low-lying excitations consist of both nodal (fermionic) quasiparticles and excited (bosonic) pair states. A semi-quantitative comparison with cuprate data looks reasonable, with no compelling indications for Landau-parameter effects.

As noted in a preprint by A. Perali (Roma) et al., various properties of underdoped superconducting cuprates, including the momentum-dependent pseudogap opening, indicate a mixed BCS vs Bose-Einstein behavior, which the authors describe in terms of a two-gap model. This model assumes an anisotropic pairing interaction among two kinds of fermions with small and large Fermi velocities representing the quasiparticles near the M and nodal points of the Fermi surface, respectively. By evaluating the superconducting fluctuation propagator, the authors find that the gap near the M points experiences strong short-wavelength fluctuations below the mean-field pairing temperature until phase coherence is established by coupling to the stiffness of the pairing near the nodal points. By tuning the momentum-dependent interaction, the authors obtain a continuous evolution from a pure BCS pairing (in the overdoped and optimally doped regime) to a mixed boson-fermion picture (in the strongly underdoped regime).

A mechanism that explains the peak structure in the doping dependence of T_C in the cuprates is proposed by H. Shimahara (Hiroshima) et al. The authors find that the pseudogap due to antiferromagnetic fluctuations suppresses T_C in the underdoped region and eventually destroys superconductivity at a finite doping. The pseudogap effects are less pronounced near optimum doping where T_C has its maximum. The density of states is large, since the Fermi energy is at the shoulder of the Van Hove singularity, thus leading to high T_C. The authors propose that the decrease of T_C in the overdoped region is connected with the decrease in the density of states, since the Fermi energy moves away from the location of the Van Hove singularity.

Using an improved SU(2) slave-boson approach to the t-J Hamiltonian, S.-S. Lee (POSTECH) and S.-H. S. Salk (POSTECH and KIAS) derive a phase diagram of high-T_C cuprates that displays both the superconducting and pseudogap phases in the temperature vs hole-doping plane. The authors find that inclusion of phase fluctuations in the order parameters yields results in closer agreement with the observed curve of T_C vs hole doping.

An analytic expression for the finite-temperature sublattice magnetization in two-dimensional antiferromagnets, valid for the whole range of temperatures between 0 and T_N is proposed in a preprint by E. C. Marino and M. B. Silva Neto (Rio de Janeiro). The authors' expression, which has no adjustable parameters, is able to reproduce both the qualitative behavior of the phase diagram M(T) vs T and the experimental values of the Néel temperature T_N for both doped $YBa_2Cu_3O_{6.15}$ and stoichiometric La_2CuO_4 compounds.

Qualitative differences in the spectrum of a superconductor near magnetic-impurity pairs with moments aligned parallel and antiparallel have been derived by M. E. Flatté and D. E. Reynolds (Iowa). The authors propose a new, nonmagnetic scanning tunneling microscopy of magnetic impurity interactions based on these differences. Near parallel impurity pairs, the mid-gap localized spin-polarized states associated with each impurity hybridize and form bonding and anti-bonding molecular states with different energies. For antiparallel moments, the states do not hybridize; they are degenerate.

A preprint by K.S.D. Beach (Queen's) et al. critiques a Padé analytic continuation method whereby a rational polynomial function is fit to a set of input points by means of a single matrix inversion. Using a novel symbolic computation algorithm, the authors have developed a new Padé method with extremely high accuracy. The authors demonstrate the use of this method by determining the spectral function of a single-particle thermal Green's function known only at a finite number of Matsubara frequencies for two example self-energies drawn from the T-matrix theory of the Hubbard model. The authors present a systematic error analysis and they propose procedures for quantitatively testing the reliability of the resulting continuation.

The dynamic critical exponent z has been determined by L. M. Jensen et al. (Umeå) from numerical simulations for the three-dimensional XY model subject to two types of dynamics, i.e., relaxational dynamics and resistively-shunted-junction (RSJ) dynamics, as well as for two different treatments of the boundary, i.e., periodic boundary conditions (PBC) and fluctuating twist boundary conditions (FTBC). For relaxational dynamics, finite-size scaling at the critical temperature gives $z \approx 2$ for PBC and 1.5 for FTBC, while for RSJ dynamics, $z \approx 1.5$ is obtained in both cases. The authors discuss their results in the context of superfluids, superconductors, and vortex dynamics, and they compare their results with those obtained using other models.

According to a preprint by K. Yang and D. F. Agterberg (Florida State), because of the difference in the momenta of the superconducting order parameters, the Josephson current in a Josephson junction between a Fulde-Ferrell-Larkin-Ovchinnikov (FFLO) superconductor and a conventional BCS superconductor is suppressed. The authors show that the Josephson current may be recovered by applying a magnetic field in the junction. The field strength and direction at which the supercurrent recovery occurs depend upon the momentum and structure of the order parameter in the FFLO state. Thus the Josephson effect provides an unambiguous way to detect the existence of an FFLO state and to measure the momentum of the order parameter.

Overviews

As noted by A. S. Alexandrov (Loughborough) and P. P. Edwards (Birmingham), identifying and understanding the microscopic origin of high-temperature superconductivity stands as one of the greatest theoretical challenges as we enter this century. In their review, the authors develop their view that high-temperature superconductivity in the layered cuprates originates from the Bose-Einstein condensation of bipolarons - tightly bound pairs of small polarons. The authors also interpret a number of experimental observations in terms of this scenario (97 refs.).

A review by M Muralidhar et al. (SRL-ISTEC) reports on the properties of melt-processed *(Nd,Eu,Gd)-Ba-Cu-O [(Nd,Eu,Gd)-123]* superconductors, as investigated by differential thermal analysis (DTA), electron-probe microanalysis (EPMA), and magneto-optical studies. The authors also report the results of microstructural characterization by scanning and transmission electron microscopy. Finally, the authors summarize the relationship between the observed critical currents and microstructure, and they draw some conclusions about the flux-pinning mechanisms based on scaling of the volume pinning forces (69 refs.).

Thesis

The Ph.D. thesis of G. Koster (Twente) reports on the fabrication of artificially layered oxides by pulsed-laser deposition (PLD). To overcome the problem of electron scattering in a relatively high background gas pressure, the author developed a high-pressure RHEED (reflection high-energy electron diffraction) system to monitor film growth. In the course of studying the properties of $SrTiO_3$ surfaces and the homoepitaxy of $SrTiO_3$, the author developed a method called interval deposition, which imposes a layer-by-layer growth mode despite unfavorable conditions for this mode. The author used the interval deposition method to fabricate artificial layered structures in the $(Ba,Sr,Ca)CuO_2$ system. Unit-cell layers of $BaCuO_2$, $SrCuO_2$, and $CaCuO_2$ were sequentially deposited using a fully automated process (291 refs.)

Contributed by John R. Clem

Contents:

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S. Adachi, T. Tatsuki, T. Sugano, A. Tokiwa-Yamamoto, and K. Tanabe, "Low Temperature Fluorination of $(Sr,Ba)_2CuO_3$ Using NH_4F." To be published in Physica C (in press). Superconductivity Research Laboratory, International Superconductivity Technology Center (ISTEC), 10-13 Shinonome 1-chome, Koto-ku, Tokyo 135, JAPAN; telephone +81 3 3536 5709; telefax +81 3 3536 5717; e-mail adachi@istec.or.jp. Key words: Sr_2CuO_3, fluorination, NH_4F, Meissner, structural property, aging. 74.62.Bf; 74.62.Dh; 74.72.Jt; 81.40.Gh.

Ali Riza Akcay, "A 'New Formula' to Provide the Compatibility Between the Special Theory of Relativity (STR), Black Holes and Strings." TUBITAK/UEKAE, P.O. 21, 41470 Gebze, Kocaeli, TURKEY; telephone +90 262 648 1356; telefax +90 262 648 1100; e-mail aakcay@yunus.mam.gov.tr; preprint also available at http://xxx.lanl.gov/abs/physics/9912025. Key words: 'New Formula', Einstein's Famous Formula (EFF), black holes, superconductivity, superconducting strings, space-time singularities.

A. S. Alexandrov and P. P. Edwards, "High-T_c Cuprates: A New Electronic State of Matter?" To be published in Physica C. Department of Physics, Loughborough University, Loughborough Leicestershire LE11 3TU, UNITED KINGDOM; telephone +44 1509 223303; telefax +44 1509 223985.

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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.)*

April 16 - 19, 2000: 6th Twente Workshop on Superconducting Electronics, Congress Center "Drienerburght," University of Twente, Enschede, The Netherlands. Aim of this meeting is an international exchange of latest results and new ideas on the electronic applications of superconductors focusing on the following areas of research: using fundamental aspects for new device concepts (e.g. π junctions, qubits); relation between materials properties and transport; advanced circuitry; spin-dependent transport; and novel applications. Morning sessions devoted to invited talks with discussion breaks; afternoon sessions devoted to contributed papers. **Abstract deadline, March 15, 2000.** For information, contact Ingrid Oomen or Alexander Brinkman, Department of Applied Physics (TN/LT), University of Twente, P.O. Box 217, 7500 AE Enschede, The Netherlands; telephone +31 53 489 2806; telefax +31 53 489 1099; e-mail i.oomen@tn.utwente.nl or a.brinkman@tn.utwente.nl.

May 15 - June 9, 2000: Spring College on Electronic Structure Approaches to the Physics of Materials, Miramare, Trieste, Italy. Goal of this College is to educate younger condensed-matter physicists on various first-principles electronic structure calculation approaches to the understanding and prediction of real material properties. Emphasis will be on physics, as opposed to methodology development. Lectures intend to offer a broad and comprehensive perspective of the field and cover the basic aspects of modern electronic structure theories and to highlight their application to the structural (ground state, dynamical, thermodynamical, etc.) and electronic (spectroscopic, dielectric, magnetic, transport, etc.) properties of real materials. Program will also include formal and informal seminars on a variety of research topics by lecturers, participants, and visiting experts. College open to young research workers from all countries that are members of the United Nations, UNESCO or IAEA. Some funds are available for subsistence allowance to a limited number of participants from developing countries. No registration fee. **Deadline for participation request, January 31, 2000.** Request for participation obtainable via e-mail from smr1223@ictp.trieste.it. Contact Spring College on Electronic Structure Approaches to the Physics of Materials, International Centre for Theoretical Physics, P.O. Box 586, I-34100 Trieste, Italy; telephone +39 040 2240111; telefax +39 040 224163; e-mail SMR1223@ictp.trieste.it, Web site http://www.ictp.trieste.it/cgi-bin/ICTPsmr/mkhtml/smr2html.pl?smr1223/Bulletin.

May 24 - 27, 2000: Sixth Symposium on High Temperature Superconductors in High Frequency Fields (HTS-HF 2000), The Island of Capri, Naples, Italy. Organized by I.N.F.M. and Dipartimento Scienze Fisiche, and the University Federico. Aim of this biannual symposium is to bring together distinguished researchers involved in the study of the properties of high-temperature superconductors in rf and microwave fields, with emphasis on fundamental properties and material aspects, experimental methods, and market-emerging targets. Three areas have been identified as the main topics of the 2000 symposium: (1) Science and technology of HTS at microwave frequencies – new ideas and novel materials; correlation between microwave properties and material structure, morphology, defects, and impact on devices; nonlinear effects, harmonic generation and intermodulation distortion in devices, and understanding and standardization of measurements. (2) Microwave applications of HTS – recent advances in telecommunication systems; tunable devices and totally agile superconducting systems; NMR and MRI applications; spatial probing; and cryopackaging issues. (3) Space applications of HTS – state of art of the North American and European programs. Scientific program will include keynote lectures supplemented by poster sessions, and ample time will be given to discussions and socialization. Participation is by invitation only and is presently limited to about 80 attendants. **Abstract deadline, March 15, 2000.** For information, contact Annamaria Mazzarella, Conference Secretariat; telephone +39 081-8534123 or -8661381; telefax +39 081-5267654; e-mail cib@secyann.cib.na.cnr.it.

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-T_c 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. **Abstract deadline, March 15, 2000. 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/.

Aug. 1 - 4, 2000: Minisymposium on Correlation in Mesoscopic Systems, Miramare, Trieste, Italy. Objective is to bring together leading researchers actively working in the field of normal-metal mesoscopic systems and 2D metal-insulator transitions, in order to discuss the most recent developments and research directions. Topics are interaction in mesoscopic systems, 2D delocalization transition, and non-equilibrium mesoscopics. Scientists and physicists from all countries that are members of the UN, UNESCO or IAEA can attend the Minisymposium. Some funds are available for subsistence allowance to a limited number of participants from developing countries. No registration fee. **Deadline for participation request, March 31, 2000.** Request for participation obtainable via e-mail from smr1234@ictp.trieste.it. Contact Ms. E. Brancaccio, Minisymposium on Correlation in Mesoscopic Systems, International Centre for Theoretical Physics, Strada Costiera 11, I-34014 Trieste, Italy; telephone +39 040 2240284; telefax +39 040 2245163; e-mail SMR1234@ictp.trieste.it; Web site http://www.ictp.trieste.it/cgi-bin/ICTPsmr/mkhtml/smr2html.pl?smr1234/Bulletin.

Sept. 17 - 22, 2000:* The Applied Superconductivity Conference (ASC 2000), Pavilion Convention Center, Virginia Beach, Virginia. Premier conference on applied superconductivity held every two years. The meeting will highlight the latest developments and will feature invited presentations that offer an exciting look into the future. Papers solicited in three general areas of superconductivity: large scale, materials, and electronics. **Abstract deadline, February 11, 2000. All abstracts must be submitted electronically. Further information available at the Web site http://www.ascinc.org.

FYI

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

Position open: Nordic Superconductor Technologies seeks engineers/scientists for development and process optimization of heat treatment of powder-in-tube (PIT) *Bi-2223* tapes. Candidates should have a Ph.D. in ceramic engineering, chemical engineering, or materials science and 1-3 years industrial or research experience in advanced ceramic materials processing. Experience with *Bi*-superconductors and industrial manufacturing is preferred. Work will involve R&D on optimizing the heat treatment process of *Bi-2223* in PIT tapes, cooperation with commercial suppliers of *Bi-2223* precursors to adapt their precursors to the company thermal process, and vice versa. Start date will be as soon as possible. Please send your written application marked “R&D Engineer PIT-HT” including a C.V., relevant publication list, and names and contact information for two references to Per Vase, Vice President Engineering, Nordic Superconductor Technologies A/S, Priorparken 685, 2605 Brøndby, Denmark; telephone +45 43483592; telefax +45 43482501; e-mail p.vase@nst.com.

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