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ARPA

NOTA BENE:

Wishing you happy holidays and best wishes for a bright and prosperous new year! From Sreeparna, John, Charyl, Barb, and Lina—the *High-T_C Update* editors and staff.

Coated Conductors

As reported in a preprint by R. A. Hawsey et al. (Oak Ridge), two new processes have been under development since 1991 that promise a new, cost-effective way to manufacture flexible high-current-density wire made from *$YBa_2Cu_3O_{7-\delta}$ (YBCO).* The key is to prepare a textured substrate or template, on which the *YBCO* may be deposited as a biaxially aligned thick film. Ion-beam-assisted deposition (IBAD) of yttria-stabilized zirconia *(YSZ)* or *MgO* on alloy tapes enables a final superconducting layer with grain-to-grain in-plane alignment to within 3 to 5 degrees. Similar results are achieved on rolling-assisted biaxially textured substrates (RABiTS) using a variety of oxide layers on textured nickel tapes. The performance of research lengths of prototype wires in strong magnetic fields at 65 K already exceeds that of *NbTi* and *Nb_3Sn* in liquid helium. Values of critical current density J_C consistently greater than 1×10^6 A/cm^2 in self-field at 77 K are now obtained on RABiTS, and J_Cs in excess of 2×10^6 A/cm^2 have been obtained on both substrates. A nonmagnetic variation of RABiTS *(Ni-13% Cr)* has also been shown to yield J_C greater than 1.5×10^6 A/cm^2. Six private companies in the U.S. (3M, American Superconductor Corporation, EURUS Technologies, Intermagnetics General Corporation, MicroCoating Technologies, and Oxford Superconducting Technology) are scaling up *YBCO* coated conductors for power and physics applications.

A preprint by D. T. Verebelyi (Oak Ridge) et al. also describes efforts towards the development of second-generation high-temperature-superconducting wires based on buffered metallic tape substrates with nearly single-crystal texture. Previous work had shown that strong alignment of adjacent grains was necessary and that large-angle *YBCO* [001]-tilt boundaries reduce J_C exponentially with increasing misorientation angle θ. In this preprint, the authors pursued the low-θ regime by evaluating single grain boundaries and biaxially aligned polycrystalline films on both RABiTS and IBAD coated-conductor architectures. The authors found that an exponential dependence on J_C is applicable for $\theta \geq 4°$, where the spacing between the periodic disordered regions along the grain boundary becomes smaller than a coherence length. Magnetic-field measurements revealed that single grain boundaries are less sensitive to substantial fields than their adjacent grains, although the overall J_C values are lower.

The electromagnetic connectivity and microstructure of three *YBCO* films grown on biaxially textured substrates have been investigated by C.-Y. Yang (Wisconsin-Madison) et al. using magneto-optical (MO) imaging and scanning electron microscopy (SEM). The films were deposited by pulsed-laser deposition (PLD) on *YSZ*- and *CeO_2*-buffered biaxially textured *Ni* tapes. The transport critical current density (J_C) values of the films were 3, 6, and 7×10^5 A/cm^2 at 77 K and 0 T. MO imaging revealed clearly granular electromagnetic behavior in the samples with the lowest and highest J_C, but considerably better connectivity in the sample with $J_C = 6 \times 10^5$ A/cm^2. High-resolution SEM showed a dense and rather featureless microstructure in the *YBCO* of the most highly electromagnetically connected sample, whereas pores and/or second-phase particles cluttered the *YBCO* layers of the granular samples. Thus, the granular behavior in these samples appears to be caused by pores and second-phase particles that locally obstruct the supercurrent in the *YBCO* layer. Control of these types of defects clearly is important for raising the J_C values.

$RBa_2Cu_3O_{7-\delta}$

Grain-growth kinetics and microstructure evolution in *$YBa_2Cu_3O_{7-\delta}$ (Y-123)* ceramics have been studied by M. F. Imayev et al. (Ufa) during isothermal annealing over

the temperature range 875-975°C. The authors established that grain growth begins near 900°C and that it correlates with the temperature of appearance of a liquid phase at grain boundaries as a result of double (e_1) and/or threefold (e_2) eutectic reactions. Only plate-like grains nucleate and grow, which results in transformation of the initial equiaxed microstructure to a plate-like one.

Microstructural and spectroscopic analyses of a strongly linked (melt-joined) seam between two *Y-123* superconducting pieces are reported by S. M. Mukhopadhyay (Wright State) et al. When a large domain of *Y-123* was cut and mechanically joined, the zero-distance levitation force was reduced to 70% of the original value. On the other hand, when identically cut pieces were joined using a lower-melting-point superconducting powder *(Yb-123)* as solder, 92% of the original value of the zero-distance levitation force was obtained. The authors also investigated the microstructural characteristics of the interface using SEM, energy-dispersive analysis of x-rays (EDAX), and x-ray photoelectron spectroscopy (XPS).

Four papers by H. S. Chauhan and M. Murakami (SRL-ISTEC) report advances in the superconducting properties of melt-textured *Nd-123, (Nd-Y)-123,* and *Gd-123.* In one of these papers, the authors report a new hot-seeding method for growing single-grain *Nd-123* in a controlled-oxygen environment. Using *Nd-123* seed crystals, the authors were able to grow large single-domain c-axis-oriented samples with top surface area larger than 3 cm $\times$ 3 cm. Magnetic measurements showed high T_c and J_c values in specimens selected from these samples.

MeV He-ion channeling has been used by R. P. Sharma (Maryland) et al. to investigate lattice fluctuations in *YBCO*. The authors found that the incoherent lattice fluctuations show significant phase transitions as a function of temperature. The observed transitions are consistent with the electric and magnetic phase evolution as predicted by the stripe-phase model. Transitions are seen at temperatures corresponding to (a) stripe formation, (b) spin-gap and pair formation, and (c) the onset of superconductivity.

Results of x-ray absorption near edge spectra (XANES), neutron powder diffraction, and resonant x-ray diffraction on samples of $PrBa_2Cu_3O_{7-\delta}$ *(Pr-123)* and $Pr_{1-x}Ca_xBa_2Cu_3O_{7-\delta}$ are reported by U. Staub (PSI-Villigen) et al. The data were obtained as a function of the doping levels of *O* and *Ca*. The authors found significant changes in the *Pr* L_3 XANES spectra with changes in *O* or *Ca* concentrations, indicating that the *Pr* electronic properties are affected by doping. The authors used a quantitative model to extract *Pr* valences from the data, although XANES cannot distinguish between models involving charge transfer from those involving hybridization.

Bi Cuprates

A preprint by N. Morozov (Los Alamos) et al. reports measurements of the c-axis resistivity $\rho_c(H)$ in $Bi_2Sr_2Ca-Cu_2O_{8+\delta}$ *(Bi-2212)* in quasistatic magnetic fields up to 60 T. Plots of ρ_c vs H exhibit temperature-dependent peaks. The authors describe this field dependence in terms of tunneling of Cooper pairs and quasiparticles in a d-wave superconductor; the maximum in $\rho_c(H)$ arises from the competition between these two conduction channels below H_{c2}. The low-T saturation of the high-field $\rho_c(T)$ is a consequence of the d-wave character of the superconducting state. The authors find that the quasiparticle conductivity $\sigma_q(H)$ is linear in H and remains small up to 60 T. It becomes gradually weaker and superlinear above T_c, where the quasiparticle tunneling is controlled by the pseudogap.

The normal-state electronic excitations in $Bi_{1.6}Pb_{0.4}Sr_2CuO_6$ *(Bi-2201)* and $Bi_2Sr_2CaCu_2O_{8+\delta}$ *(Bi-2212)* have been studied by J. Mesot (Argonne and Illinois-Chicago) et al. using angle-resolved photoemission spectroscopy (ARPES). The authors' main goal was to establish explicit criteria for determining the Fermi surface from ARPES data on strongly interacting systems where sharply defined quasiparticles do not exist and the dispersion is very weak in parts of the Brillouin zone. Additional complications arise from strong matrix-element variations within the zone. The authors conclude that, despite all the complications, the Fermi surface can be determined unambiguously: it is a single large hole barrel centered about (π,π) in both *Bi-2201* and *Bi-2212.*

Melting relations of *Bi-2212* at oxygen fugacities $f(O_2)$ in the range $(1\text{-}3) \times 10^{-4}$ bar are presented by J. K. Meen et al. (TCSUH). The authors analyze the results to interpret phase relations in the *Bi-Sr-Ca-Cu-O* system.

As noted in a preprint by M. L. Carvalho et al. (TCSUH), a prerequisite to understanding phase equilibria of the quaternary system Bi_2O_3-*SrO-CaO-CuO* is an adequate definition of phase relations in the bounding binary and ternary systems. To this end, the authors studied the melting relations of Bi_2O_3-*CaO-CuO* at 1 atm of O_2, and they report these in their paper.

A lamination process that improves the mechanical properties of *Ag*-clad *Bi-2223* tapes without degrading the transport critical current I_c has been developed by M. Lelovic (Argonne) et al. Tapes were laminated by soldering fully reacted *Bi-2223/Ag* tapes to a thin, hard yellow brass foil (YBH04). When a tensile stress of about 60 MPa was applied to the laminated tape, the I_c was fully retained, but when a stress of about 20 MPa was applied to a tape with no lamination, I_c decreased by about 60%.

Other Cuprates

As reported by E. Bellingeri et al. (Geneva), a new superconducting phase, $Bi_2Sr_2Ca_2Cu_3O_8F_4$, has been obtained by fluorination of standard *Bi-2223* at moderate temperatures (250-300°C) using NH_4HF_2 as the fluorine source. The presence of *F* in this new phase was confirmed by EDAX. Furthermore, x-ray and neutron-diffraction experiments showed that *F* atoms replace *O* atoms in the *BiO* layers in the ratio 2:1. The additional anions form a square-mesh layer between neighboring *BiF* layers. The incorporation of *F* increases the crystallographic c-axis parameter by ~1.8 Å (a = 5.409 Å, b = 5.407 Å, c = 38.792 Å). The CuO_2 layers remain undistorted, but the distance from the *Cu* atom to the apical oxygen atom of the square pyramids is decreased to 2.27 Å from 2.42 Å in *Bi-2223*. A superconducting transition temperature of 75 K was determined from magnetic susceptibility measurements. When applied to *Bi-2212,* the same fluorination process produced the new phase $Bi_2Sr_2CaCu_2O_6F_4$ with similar structural features.

The in-plane penetration depth $\lambda(T)$ has been measured in electron-doped single crystals of $Nd_{1.85}Ce_{0.15}CuO_{4-x}$ *(NCCO)* and $Pr_{1.85}Ce_{0.15}CuO_{4-x}$ *(PCCO)* by R. Prozorov (Illinois-Urbana) et al. using an 11 MHz LC resonator. In *NCCO,* $\lambda(T)$ exhibits a minimum at 3.8 K and a pronounced upturn down to 0.4 K due to the paramagnetic contribution of Nd^{3+} ions. The London penetration depth contribution is linear in T. The paramagnetic contribution is absent in *PCCO,* where $\lambda(T) \sim T^2$ at low temperatures. The results indicate the presence of nodes in the superconducting gap, i.e., non-s-wave symmetry of the order parameter in the electron-doped cuprates.

A paper by A. Mourachkine (Brussels) discusses the Q-integrated inelastic neutron-scattering data and data obtained at the antiferromagnetic vector $\mathbf{Q}_{AF} = (\pi,\pi)$ in $La_{2-x}Sr_xCuO_4$ *(La-214),* $YBa_2Cu_3O_{7-\delta}$ *(Y-123),* and $Bi_2Sr_2CaCu_2O_{8+\delta}$ *(Bi-2212).* The author interprets the results in terms of two order parameters, which have different dependencies upon the hole concentration: Δ_c, the magnitude of the coherent order parameter, and Δ_p, the magnitude of the pairing order parameter.

The effects of different argon or oxygen annealing routes upon the ferromagnetic transition in polycrystalline single-phase $RuSr_2GdCu_2O_8$ *(Ru-1212)* have been studied by R. W. Henn et al. (MPI-Stuttgart). The x-ray patterns and ferromagnetic transition temperatures remained nearly the same in all samples, independent of the annealing procedure used. None of the investigated samples showed any trace of superconductivity down to 2 K. The authors conclude that the absence of superconductivity in these samples cannot be due to a variation of the oxygen content in the *RuO* layers.

The 3D XY model has been used by J. Hofer (Zürich) et al. to scale angular-dependent magnetic torque measurements on single crystals of $HgBa_2CuO_{4+\delta}$ *(Hg-1201),* $La_{2-x}Sr_xCuO_4$ *(La-124),* and $YBa_2Cu_3O_{6.93}$ *(Y-123)* and to determine the scaling function $dG^{\pm}(z)/dz$ describing the universal critical properties near T_c. A systematic shift of the scaling function with increasing effective mass anisotropy $\gamma = (m_c^*/m_{ab}^*)^{1/2}$ was observed, which the authors explain in terms of a 3D-2D crossover. Further evidence for a 3D-2D crossover was found from temperature-dependent torque measurements, carried out in different magnetic fields at different field orientations δ, which show a quasi-2D crossing region in the magnetization vs temperature (M^*,T^*). The crossing temperature T^* was found to be angular-dependent. Torque measurements above T_c revealed that fluctuations are strongly enhanced in the underdoped region where the anisotropy is large, whereas they are less important in the overdoped regime.

Vortices

Neutron-scattering studies of optimally doped single-crystal $YBa_2Cu_3O_{7-\delta}$ *(Y-123)* under an applied magnetic field have been used by D. Vaknin et al. (Ames Lab, Iowa State) to assess the possibility of the existence of antiferromagnetic (AF) correlations in the vortex core. In the superconducting state, a very weak signal at the (1/21/20) reciprocal lattice point was found. The authors argue that this signal can be associated with AF correlations in the vortex cores, and the authors estimate an upper-limit average magnetic moment per vortex in each layer. Above T_c, weak paramagnetic scattering was observed, which the authors hypothesize is due to scattering from nearest-neighbor copper spins that are coupled ferromagnetically by a hole on an oxygen site between them.

The melting line of the pancake-vortex system in a layered superconductor, interpolating between two-dimensional melting (2D) at high fields and the zero-field limit of single-stack evaporation, has been calculated by M.J.W. Dodgson (ETH-Zürich) et al. Long-range interactions between pancake vortices in different layers permit a mean-field approach, the substrate model, where each 2D crystal fluctuates in a substrate potential due to the vortices in the other layers. The authors find the thermal stability limit of the 3D solid, and compare its free energy with that of a 2D liquid to determine the first-order melting transition and its jump in entropy.

Films

A preprint by K. Yamagiwa and I. Hirabayashi (SRL-ISTEC) reports the preparation of $RBa_2Cu_3O_{7-\delta}$ *(RBCO,*

R = Yb, Er, Y, Gd, Sm, Nd, Pr, and *La)* by chemical-solution-deposition (CSD) processing using metal naphthenates under low oxygen partial pressures. The authors investigated process-temperature and ionic-radius dependencies of the preferred orientation axis (c-axis or a-axis growth) of *RBCO* films deposited on $SrTiO_3$, $LaAlO_3$, and *MgO* substrates. *RBCO* films prepared on *MgO* substrates showed c-axis orientation for all *R* elements, but in-plane alignment of these films tended to be obtained for higher temperatures for increasing ionic radius of *R.* For *R = Er, Y, Gd,* and *Sm* on $SrTiO_3$, a/b-axis-oriented films were obtained at low temperatures, whereas only c-axis films were obtained at all temperatures for *R = Yb, Nd, Pr,* and *La* films. On the other hand, *RBCO* films prepared on $LaAlO_3$ were found to have a/b-axis orientation at low temperatures, except for *R = Yb.* The processing-temperature and substrate dependencies of these films grown by solid-phase epitaxy were found to be the same as for films grown by vapor-phase epitaxy. The dependencies on the ionic radius of the *R* atoms could be explained in terms of lattice misfit.

Applications

The magnetic-field dependence of single-layer washer-type high-T_c *YBCO* rf SQUIDs with grain-boundary Josephson junctions, as well as low-T_c *Nb* rf SQUIDs with *Nb-*Al_2O_3*-Nb* tunnel junctions, has been investigated by E. Il'ichev (Jena) et al. The authors found that the suppression of the critical current of the Josephson junction due to the magnetic field leads to a modulation of the amplitude of the SQUID output signal. The role of the unwanted junction in high-T_c rf SQUIDs, which is formed by the grain boundary running through the washer of the SQUIDs on bicrystal substrates, also has been clarified; penetration of the magnetic field into the unwanted junction causes a drop in the SQUID signal. The authors used these results to develop a direct radio-frequency method for the determination of the first critical field H_{c1} in long Josephson junctions.

A transition-edge infrared (IR) detector using a *YBCO* thin film deposited on a chemically etched 7 μm thick sapphire substrate has been fabricated by B. Lakew (NASA/Goddard Space Flight Center) et al. A 30 μm layer of gold black provided IR absorption. The peak optical detectivity obtained was 1.2×10^{10} cm $Hz^{1/2}$ W^{-1} near 4 Hz. The results show that it is possible to obtain high detectivity with thin films on etched sapphire with no processing after the deposition of the *YBCO* film. The authors discuss the etching process and its potential for micromachining sapphire and fabricating two-dimensional detector arrays with suspended sapphire membranes.

An expression for the loss in untwisted, aspected strands (aspect ratio a/b) has been used by M. D. Sumption (Ohio State) et al. to extract the effective transverse matrix resistivity $\rho_\perp$ of *NbTi/Cu* and *Bi*-based multifilamentary strands with low numbers of filaments in coarse arrays. The $\rho_\perp$ values were significantly higher than expected for both strand types by factors of from five to ten. The authors attribute this to filament-array coarseness and geometry, and they predict this effect to be much more noticeable for untwisted than for twisted tapes. The authors also give a loss equation for the special case of twisted tapes with resistive cores. Here the loss is estimated to be about a/b times lower than the uncored case.

Theory

A preprint by Z. Y. Weng et al. (TCSUH) explores quasiparticle properties in an effective theory of the t-J model that includes two important components: spin-charge separation and an unrenormalizable phase shift. The authors show that the phase-shift effect indeed causes the system to be a non-Fermi liquid, as conjectured by Anderson on general grounds. However, this phase shift also drastically changes a conventional perception of quasiparticles in a spin-charge-separation state: an injected hole will remain stable because of spin and holon confinement by the phase-shift field even though the background is a spinon-holon sea. True deconfinement happens only in the zero-doping limit, where a bare hole loses its integrity and decays into holon and spinon elementary excitations.

As shown by M. Calandra and S. Sorella (Trieste), the two-dimensional t-J model with J/t = 0.4 reproduces the main experimental qualitative features of high-T_c cuprate superconductors: d-wave superconducting correlations are strongly enhanced for small doping, and off-diagonal long-range order is found at the optimal doping $\delta \approx 0.15$. On the other hand, antiferromagnetic long-range order, clearly present at zero hole doping, is suppressed at small hole density, with a clear absence of antiferromagnetism at $\delta > 0.1$.

Impurity substitution of *Zn* in *La-214* and *(Y,Ca)-123* high-T_c superconductors suppresses T_c but does not appreciably affect (a) the onset of the pseudogap phase in the underdoped region, (b) the optimal doping level, or (c) the position of the inferred quantum critical point. Using a 1/N expansion of the t-J model, E. Cappelluti and R. Zeyher (MPI-Stuttgart) explain these findings, as well as a similar dependence on magnetic field, in terms of a quantum-critical-point scenario, where a flux phase causes the pseudogap.

Cooper-pair phase fluctuations in cuprate superconductors have been studied by D. Manske (Freie Universität Berlin) et al. assuming a spin-fluctuation pairing interaction.

Using an electronic theory, the authors calculate for underdoped cuprate superconductors the superfluid density $n_S(T)$, the superconducting transition temperature $T_c(x) \propto n_S(0)$, below which phase-coherent Cooper pairs occur, and $T_c^*(x)$, above which phase-incoherent Cooper pairs disappear. The authors also present results for the penetration depth $\lambda(x,T)$ (x = doping) and the weak pseudogap temperature $T^*(x)$, below which a gap structure occurs in the spectral density. A Meissner effect is obtained only for $T < T_c$. The authors also find that fluctuations become increasingly important in the underdoped regime and lead to a reduction in T_c, in good agreement with experiment.

The effects of impurities in time-reversal symmetry (T) breaking superconductors have been studied by Y. Okuno using the Bogoliubov-de Gennes equations. In T-violating superconductors, spontaneous currents are induced around the impurity, and the current patterns around the impurity reflect the structure of the Cooper pairs.

The Keldysh representation of the functional integral for an interacting electron system with disorder has been used by M. V. Feigel'man (Landau Institute) et al. to derive microscopically an effective action for dirty superconductors. This approach reproduces, without the use of the replica trick, the well-known result for the Coulomb-induced renormalization of the electron-electron coupling constant in the Cooper channel. The authors also calculate new results for (a) the subgap Andreev conductance between a superconductor and a 2D dirty normal metal and (b) the Josephson proximity coupling between superconductive islands via a 2D dirty normal metal.

Using a new description of high-temperature superconductors in terms of dynamical symmetries associated with an SU(4) algebra, Y. Sun (Tennessee) et al. obtain multiple energy scales corresponding to multiple energy gaps in the cuprates. The authors show that the dependence of the gaps on hole doping is completely dictated by the symmetry, and this leads to new mechanisms for forming or suppressing superconducting order that are conceptually different from the simple pairing mechanism in conventional BCS theory. The authors compare their predictions with available data and suggest further experiments to identify these gaps.

As noted in a preprint by N. D. Whelan and J. P. Carbotte (McMaster), among high-T_c materials, the *YBCO* compounds are special because they have superconducting chains as well as planes. The authors show that a discontinuity in the density of states as a function of magnetic field may appear at a new energy scale that is characteristic of the chain and distinct from the energy scale set by the d-wave gap. The authors discuss how this new energy scale can be observed in experimental studies of thermodynamic properties such as the specific heat.

The effect of intrinsic doping inhomogeneity and the presence of stripes in high-T_c superconductors on the coupling λ has been analyzed by V. V. Moshchalkov and V. A. Ivanov (Leuven) using a simple analytically solvable model with an angular dependent $\lambda(\phi)$ represented by a square-well form. The authors found that introducing a Coulomb repulsion λ_C, increasing the value of $|\lambda| + |\lambda_C|$, or increasing the depth of the angular modulation of $\lambda(\phi)$ leads to a remarkable enhancement of T_c. This effect can be optimized by combining attractive ($\lambda < 0$) and repulsive ($\lambda > 0$) interactions along stripes and perpendicular to them.

The dynamic critical properties of chiral-glass ordering have been studied by H. Kawamura (Osaka) using Monte Carlo simulations and dynamical scaling analysis. The author emphasizes that the chiral-glass state is a new zero-field phase of superconductors, being made possible by the anisotropic nature of the pairing symmetry of the cuprate superconductors. The author also shows that recent magnetic and transport measurements on *YBCO* high-T_c ceramics are consistent with the chiral-glass picture.

Overviews

Problems in using the low-temperature asymptotics to determine the order-parameter symmetry are discussed in an overview by A. M. Gabovich and A. I. Voitenko (Kiev). The authors show that a model of a conventional s-wave superconductor involving statistical averaging over a spatially dependent gap parameter Δ can mimic the behavior of a d-wave superconductor. However, the power-law low-T asymptotics obtained in this model do not rule out the existence of d-wave superconductivity in the high-T_c oxides (138 refs.).

The growth-related microstructure of melt-grown *$RBa_2Cu_3O_{7-\delta}$ (R-123, R = Y, Nd, Sm, Eu,* and *Gd)* bulk superconductors is reviewed in a preprint by P. Diko (Kosice). The solidification process introduces defects into the *R-123* bulks, thereby influencing the overall superconducting and mechanical properties of fabricated tiles. The most important microstructural features related to the growth process are subgrain boundaries and macroscopic inhomogeneities in the concentration of *R_2BaCuO_5 (R-211)* particles (58 refs.).

Experimental evidence, based on the ac and dc magnetic response, for a generic phase diagram for weakly pinned superconducting systems is presented in an overview by S. S. Banerjee (TIFR-Mumbai) et al. The phase diagram comprises quasiglassy phases (the Bragg glass, a vortex glass, and a reentrant glass) and completely amorphous pinned and unpinned phases. The characteristic metastability and thermomagnetic history-dependent features seen in the various glassy phases suggest close connections between

vortex matter and other disordered condensed matter systems such as spin glasses, supercooled liquids, and structural glasses (55 refs.).

A history of the creation of the microscopic theories of superfluidity (1947) and superconductivity (1957) has been prepared by P. N. Bogolubov and P. S. Isaev (JINR-Dubna). The work commemorates the 90th anniversary of the birth of N. N. Bogoliubov (in Russian, no refs.).

Contributed by John R. Clem

Contents:

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TECHNOLOGY NEWS

(Also see Applications section of Nota Bene.)

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

As part of a major South Korean fusion reactor project, Intermagnetics General Corporation (IGC) has been awarded a $1 million contract to supply additional superconducting material for powerful magnets. Delivery of the *Nb_3Sn* material is scheduled to begin in spring 2000. The purchase by Samsung Advanced Institute of Technology, which is a key participant in the Korean National Fusion Project and oversees its Korean Superconducting Tokamak Advanced Research project, is the second major order placed with Intermagnetics' IGC-Advanced Superconductors Division.

In other news from the company, the largest power-utility-size fault current controller recently completed a testing cycle at a Southern California Edison (SCE) substation in Norwalk, Calif. The innovative FCL device, which is expected to benefit the nation's utility industry, incorporates three record-size high-temperature superconducting coils manufactured by IGC. The company participated on a team led by General Atomics, which designed and built a pre-commercial 15 kV-class superconducting current controller under the auspices of a U.S. Department of Energy (DOE) Superconductivity Partnership Initiative (SPI) program. The fault current controller is one of several potential applications of HTS technology which IGC is seeking to commercialize. Others include transformers and power transmission cables.

For further information, contact Glenn H. Epstein or Cathy Yudzevich, Intermagnetics General Corporation, telephone (518) 782-1122.

Recently, Pirelli Cables and Systems announced a new agreement by which it will provide up to $13.8 million in additional funding to American Superconductor for the development of HTS wires for use in power cables. HTS power cables are expected to carry up to five times the amount of power as copper cables of the same size. The companies also announced the signing of an agreement to exploit HTS wire for use in fault current limiters. The new HTS wire-development program focuses on further improvements in American Superconductor's currently available commercial HTS wire as well as on the development of a next-generation wire technology. Pirelli has designed and commissioned a dedicated HTS cable manufacturing line, and has also demonstrated key components of HTS cable systems for power transmission and distribution networks. For information, contact Kevin Coates, American Superconductor Corporation, Two Technology Drive, Westborough, MA 01581; phone (202) 434-8308; e-mail kcoates@amsuper.com.

Contributed by Sreeparna Mitra

PREPRINTS

To obtain a particular preprint, contact the first author at the address given at the end of the citation. Help us expand this list by sending us your complete preprint. **Please specify where and when your paper was submitted.** An * next to an entry indicates it is a correction or revision of a previous entry. PACS codes and/or key words are given at the end of the citation.

P. Badica and G. Aldica, "Phase Formation During Non-Isothermal Decomposition of the Freeze Dried *Bi:Pb:Sr:Ba:Ca:Cu*=1.8:0.4:1.8:0.2:1.2:2.0 Complex Nitrate Powder." To be published in J. Supercond. National Institute of Materials Physics, P.O. Box MG-7, Bucharest-Magurele, R-76900 ROMANIA; telefax +40 1 4930 267; e-mail badpet@alpha1.infim.ro. Key words: non-isothermal decomposition, freeze-dried powder, *Bi(Pb)-Sr(Ba)-Ca-Cu-O* system, x-ray diffraction.

P. Badica, G. Aldica, M.-C. Bunescu, and A. V. Nemyrovsky, "Studies Concerning Secondary Synthesis Processes in $[Bi(Pb)]_2[Sr(Ba)]_2Ca_2Cu_3O_y$ Freeze Dried Superconducting Ceramic." To be published in J. Mater. Sci. Lett. National Institute of Materials Physics, P.O. Box MG-7, Bucharest-Magurele, R-76900 ROMANIA; telefax +40 1 4930 267; e-mail badpet@alpha1.infim.ro.

Satyajit Sukumar Banerjee, Srinivasan Ramakrishnan, Dilip Pal, Shampa Sarkar, Arun Kumar Grover, Gurazada Ravikumar, Prasant Kumar Mishra, Turumella Venkata Chandrasekhar Rao, Vinod Chandra Sahni, Chakkalakal Varduuny Tomy, Mark Joseph Higgins, and Shobo Bhattacharya, "Magnetic Phase Diagram of Weakly Pinned Type-II Superconductors." Preprint #TIFR/CM/99/601(I); to be published in J. Phys. Soc. Jpn.: Proc. of the Frontiers in Magnetism Workshop, Kyoto, Japan, Oct. 4-7, 1999. Department of Condensed Matter Physics and Material Science, Tata Institute of Fundamental Research, Homi Bhabha Road, Colaba, Mumbai 400005, INDIA; e-mail sb@tifr.res.in; preprint also available at http://xxx.lanl.gov/abs/cond-mat/9911324. Key words: magnetic phase diagram, type-II superconductors, peak-effect phenomenon, ordered and disordered phases, history effects.

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K. Yoshida, H. Sasakura, S. Tsukui, R. Oshima, and Y. Mizokawa, "Superconductivity in *Bi-2212* Thin Films of $Bi_2Ln_{0.3}Ca_{2.7}Cu_2O_z$ *(Ln=Pr, Nd, Sm, Eu* and *Gd)* Prepared by Laser Ablation Method." To be published in Physica C (in press). Department of Physics, Hamamatsu University School of Medicine, Handa-cho, Hamamatsu, Shizuoka 431-3192, JAPAN; telephone +81 53 435 2345; telefax +81 53 435 2315; e-mail kyoshida@hama-med.ac.jp. Key words: superconductivity, *Bi-2212,* metastable, $Bi_2Ln_{0.3}Ca_{2.7}Cu_2O_z$, thin film, laser ablation. 74.76.-w; 74.72.-h.

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.)*

**Feb. 10 - 11, 2000:*

The 2000 Wire Development Workshop of the DOE Superconductivity Program, Hilton St. Petersburg, St. Petersburg, Fla. Recent progress in first- and second-generation wire technology will be presented by national laboratories, wire manufacturers, and other program partners. Workshop brings together the leading U.S. scientists and engineers involved in the research and development of high-temperature superconducting (HTS) wire. Will focus on the development of commercially useful coated conductors. Most current agenda available at Web site. Contact Audrey Lamanna, Energetics, telephone (202) 479-2748, e-mail alamanna@energeticsinc.com; Web site http://www.eren.doe.gov/superconductivity/calendar.html.

**March 31 - April 10, 2000:*

Conference on Major Trends in Superconductivity in the New Millennium (MTSC 2000) and Symposium on Itinerant and Localized States in HTSC (SILS), Klosters, Kanton Graubünden, Switzerland. Scope of MTSC 2000 is on recent developments and trends in new superconducting systems with emphasis on experiments and theories which are relevant to the pairing mechanism. Besides the superconducting cuprates, conventional superconductors, organic systems, borocarbides, ruthenates, nanostructures, and fullerenes will be addressed. In order to raise the awareness for novel ideas and results in this rapidly growing field, the physics and chemistry of related materials will be included. Special emphasis on phenomena related to nanoscale phase separation and charge modulation. Symposium on Itinerant and Localized States in HTSC (SILS) will focus on large and small polaron and bipolaron effects in high-T_c materials with special emphasis on their preparative properties. MTSC 2000 is organized in close analogy to the Gordon conferences. Limited number of slots for posters. Total number of participants limited to 130 persons. Proceedings will be published in a special issue of *Journal of Superconductivity.* For more information, contact Annette Bussmann-Holder, Max-Planck-Institut für Festkörperforschung, Heisenbergstr. 1, D-70569 Stuttgart, Germany; telephone +49 711 689 1679; telefax +49 711 689 1091. Or contact Vladimir Z. Kresin, Lawrence Berkeley Laboratory, University of California, 1 Cyclotron Road, Berkeley CA 94720; telephone (510) 486-6951; telefax

(510) 486-5401. Information also available at Web site http://www.mpi-stuttgart.mpg.de/CONF/mtsc2000.html.

June 18 - 23, 2000:* European Conference on Energy Dispersive X-Ray Spectrometry (EDXRS 2000), Kraków, Poland. Aim of the conference is to bring together scientists working either in basic research in x-ray spectrometry, detectors and sources, or involved in applications of x-ray spectrometry or some of the related experimental techniques. Main topics: interaction of photons and particles with matter and modeling; new developments in instrumentation (instruments utilizing polarized radiation, synchrotron radiation and other x-ray sources, grazing angle spectrometers, portable instruments); energy dispersive x-ray detectors (cryo-detectors, low-Z detectors, Peltier-cooled detectors, dedicated pulse processing); data handling (sample preparation, quality control and quality assurance, simulation, modeling, software); x-ray optics (capillaries, mirrors, multilayers, TXRF, imaging); microanalysis and elemental mapping (micro-XRF, micro-PIXE, EPMA); and x-ray spectrometry applications in life and environmental sciences, earth sciences, art and cultural heritage, material sciences, and industry. **Abstract deadline, March 1, 2000. The official language of the Conference is English. For information, contact EDXRS-2000 Secretariat, Faculty of Physics and Nuclear Techniques, University of Mining and Metallurgy, Al. Mickiewicza 30, 30-059 Kraków, Poland; telefax +48 12 6340010; Web site http://www.ftj.agh.edu.pl/wfitj/conf/edxrs/.

June 19 - 22, 2000:* International Workshop on Superconductivity, Kunibiki Messe, Matsue, Shimane Prefecture, Japan. Workshop will focus on fundamental properties of high-temperature superconducting materials for actual applications. Theme of the workshop is "Structure and Property Relationships for Applications of High-Temperature Superconducting Materials." No parallel sessions; significant amount of time to be allotted for the discussion of each paper. Topics of interest (including, but not restricted to): interfaces, grain boundaries, surfaces, thin films, bulks, wires and tapes, etc. Invited presentations, contributed papers, and contributed posters. **One-page summary deadline, January 15, 2000. Contact Tetsuji Kobayashi, Director, International Affairs Department, ISTEC Eishin Kaihatsu Bldg., 6F, 34-3 Shimbashi 5-chome, Minato-ku, Tokyo 105-0004, Japan; telephone +81 3 3431 4002; telefax +81 3 3431 4044; e-mail t-kobayashi@istec.or.jp; Web page http://www.istec.or.jp/ISTEC_homepage/WORK/e-workshop.html.

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

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: Applications are invited for a postdoctoral position at the Chalmers University of Technology for development of highly textured HTS films on flexible substrates. Research will address induced epitaxial film growth both for multilayer superconducting electronics (e.g., pick-up loops and transformers based on *YBCO* on flexible substrates for SQUID applications), and the need for producing high-current-density, high-critical-field cable for future power applications. Prefer candidates with recent (less than about 2 years) Ph.D. degree in physics, and a strong background in thin film deposition and characterization of high-temperature superconductors. A newly built deposition system will be used for the project. For further information, please contact Dr. Dag Winkler or Prof. Tord Claeson, IMEGO, Institute of Microelectronics in Gothenburg, Byggnad 11, Aschebergsgatan 46, SE-411 33 Goteborg, SWEDEN; telephone +46 31 750-1808 or -1800; telefax +46 31 750-1801; e-mail dag.winkler@imego.com.

Position Open: A two-year postdoctoral position is available in the research group on solid-state chemistry and ceramic superconductors. Topic: mechanochemistry and reactive spray drying. Scientific responsibilities will encompass application of spray drying to reactive inorganic systems in aqueous and non-aqueous media and the evaluation of its repercussions on physical and chemical aspects of the granular materials obtained. In addition, the applicant is expected to organize meetings with industrial and academic partners in order to develop a task force for the introduction and follow up of a four-year European research program. Salary: 1375 ECU/month. Applicants are requested to send their CV by Jan. 15, 2000,

to Prof. Serge Hoste, Department of Inorganic and Physical Chemistry, University of Ghent, Krijgslaan 281, 9000 Ghent, Belgium; telephone +32 9 264 44 41; telefax +32 9 264 49 83; e-mail serge.hoste@rug.ac.be.

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