

## Japanese Aerospace Literature

### This month: *High Temperature Superconductors*

**A90-29954** Fabrication of thin-film-type Josephson junctions using a Bi-Sr-Ca-Cu-O/Bi-Sr-Cu-O/Bi-Sr-Ca-Cu-O structure. K. MIZUNO, K. HIGASHINO, K. SETSUNE, and K. WASA, *Applied Physics Letters* (ISSN 0003-6951), Vol. 56, April 9, 1990, pp. 1469-1471. 10 Refs.

Thin-film Josephson junctions with normal metal barriers using a Bi-based high T<sub>c</sub> oxide superconductor were successfully fabricated. Bi<sub>2</sub>Sr<sub>2</sub>Ca<sub>1</sub>Cu<sub>2</sub>O(x) films were used for both superconducting electrodes and Bi<sub>2</sub>Sr<sub>2</sub>Cu<sub>1</sub>O(y) for the barrier layer. The junction area of 20 x 40 sq microns was defined by photolithography and Ar-ionmilling. These S/N/S-type junctions clearly exhibited the ac Josephson effect under the irradiation of RF waves of 12 GHz, and more than 20 Shapiro steps were observed.

**A90-27765** Multivalence resonance condensation model for electron pairing and superconductivity in high T<sub>c</sub> superconductors - A possible novel and universal origin of superconductivity. AKIO NAKAMURA, *Japanese Journal of Applied Physics, Part 1* (ISSN 0021-4922), Vol. 28, Dec. 1989, pp. 2468-2478. 56 Refs.

The multivalence resonance-condensation model (MVRC model) is suggested as a possible novel and universal origin of high T<sub>c</sub> superconductivity and successfully applied to various high T<sub>c</sub> oxide superconductors with perovskite-related structure, such as strongly anisotropic layered cuprates and almost isotropic bismuthates. The MVRC state is Bose condensation of the resonance hybrids between two kinds of multivalence states of cations responsible for the superconductivity and is shown from its simple geometrical configuration on the actual crystal lattice planes to provide a unified picture of the superconducting state of all these systems in a consistent manner. Most importantly, the model reveals the inherent deep connection of superconductivity with the fundamental and universal nature of matter, i.e., the chemical bond. Thus, the model is expected to be a guiding chemical and structural principle in both the search for new superconductors and the construction of a new quantitative theoretical model.

**A90-26115** Formation of the high-T<sub>c</sub> phase in rapidly quenched Bi-Pb-Sr-Ca-Cu-O ceramics. TSUNEYUKI KANAI, TOMOICHI KAMO, and SHINPEI MATSUDA, *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 28, Dec. 1989, pp. L2188-L2191. 9 Refs.

Amorphous ceramics with the composition of Bi<sub>2</sub>Pb<sub>0.4</sub>Sr<sub>2</sub>Ca<sub>2</sub>Cu<sub>3</sub>O(y) were prepared by rapid quenching. The change in crystalline structure during annealing and the effect of seeding with the high-T<sub>c</sub> phase were investigated. The volume fraction of the high-T<sub>c</sub> phase increases with annealing time; however, the low-T<sub>c</sub> phase reaches a maximum value of 38 percent for 1-h annealing and decreases on prolonged annealing. The formation rate of the high-T<sub>c</sub> phase changes when the volume of the high-T<sub>c</sub> phase reaches about 30 percent. TEM observation shows that the high-T<sub>c</sub> phase is often located between the low-T<sub>c</sub> phase and the nonsuperconducting phase. The addition of the seed crystals with the high-T<sub>c</sub> phase is effective in forming the high-T<sub>c</sub> phase in shorter annealing times, but a smaller volume fraction of the high-T<sub>c</sub> phase was obtained after annealing for 50 h.

**A90-22049** In situ epitaxial growth of Bi<sub>2</sub>(Sr,Ca) 3Cu<sub>2</sub>O(x) films by ion beam sputtering with an atomic oxygen source. J. FUJITA, T. YOSHITAKE, H. IGARASHI, and T. SATOH, *Applied Physics Letters* (ISSN 0003-6951), Vol. 56, Jan. 15, 1990, pp. 295-297. Research supported by the New Energy and Industrial Technology Development Organization. 8 Refs.

In situ epitaxial growth of Bi<sub>2</sub>(Sr,Ca)3Cu<sub>2</sub>O(x) films was performed by ion beam sputtering in atomic oxygen ambience at the substrate temperature of 640 C. The films showed an epitaxial growth in which the a and b axes were parallel to 100-line MgO, and the superstructure according to the incommensurate modulation along the b axis was also observed. The superconducting properties of the as-grown films seemed to depend on the oxidation treatment during the cooling down process. The zero resistivity temperature T<sub>c</sub> (R = 0) of a 600-A-thick film cooled down in the same atomic oxygen density as the film growth ambience was 60 K, but it increased up to 80 K after a postdeposition annealing at 500 C for 1 h in air. In contrast, as-grown films cooled down in insufficient oxidation ambience showed the T<sub>c</sub> (R = 0) of 76 K without post-deposition annealing.

**A90-23306** Magnetic relaxation of high T<sub>c</sub> superconducting thin films. SHINICHIRO HATTA, HIDEAKI ADACHI, YO ICHIKAWA, SHIGENORI HAYASHI, SHIGEMI KOHIKI et al., *Physical Society of Japan Journal* (ISSN 0031-9015), Vol. 58, Nov. 1989, pp. 4132-4138. 21 Refs.

The magnetic relaxation of high-T<sub>c</sub> superconducting thin films was studied. In an n-type NdCeCuO film, significant relaxation was observed even below 20 K, as compared with other p-type oxide superconducting films. In order to analyze the data, a phenomenological model was presented which used the time-variable pinning-potential barrier for the flux creep, combined with a classical relaxation equation. The activation energy (defined as height of potential barrier at t = infinity) can be calculated to be 0.01 eV, 0.12 eV, and 0.19 eV for NdCeCuO, TlBaCaCuO, and ErBaCuO films, respectively.

**A90-26097** Improvement in critical current density of Bi<sub>2</sub>Sr<sub>2</sub>-Ca<sub>1</sub>Cu<sub>2</sub>O(x) tapes synthesized by doctor-blade casting and melt growth. J. KASE, N. IRISAWA, T. MORIMOTO, K. TOGANO, H. KUMAKURA et al., *Applied Physics Letters* (ISSN 0003-6951), Vol. 56, March 5, 1990, pp. 970-972. 8 Refs.

Bi<sub>2</sub>Sr<sub>2</sub>Ca<sub>1</sub>Cu<sub>2</sub>O(x) superconducting tape with an excellent J<sub>c</sub> at 4.2 K has been synthesized by a modified doctor-blade process. A green tape prepared by doctor-blade casting is laid on a silver foil and heat treated at various temperatures below and above its partial melting temperature. The J<sub>c</sub> of the tape increases dramatically when heat treated in a narrow temperature range just above the melting temperature. A highly oriented layer structure with caxis alignment is obtained by the growth of aligned Bi<sub>2</sub>Sr<sub>2</sub>Ca<sub>1</sub>Cu<sub>2</sub>O(x) grains in the partially melted state. This oriented microstructure produces an exceptional increase in J<sub>c</sub>.

**A90-26116** Superconductivity in Ti-Bi-Ca-Sr-Cu-O and Ti-Bi-Pb-Ca-Sr-Cu-O systems. YASUKO TORII, HIROMI TAKEI, and KOUJI TADA, *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 28, Dec. 1989, pp. L2192-L2195. 9 Refs.

The influence of the substitution of Bi for Ti on the formation of the superconducting phases in Ti-Bi-Ca-Sr-Cu-O and Ti-Bi-Pb-Ca-Sr-Cu-O systems was investigated. The superconducting (Ti, Bi) Ca<sub>2</sub>Sr<sub>2</sub>Cu<sub>3</sub>O<sub>9</sub> phase with critical temperature of 113 K (showing both zero resistivity and diamagnetism) is prepared in a Ti-Bi-Ca-Sr-Cu-O system. The crystal structure of this phase is tetragonally symmetric with lattice constants of a = 3.813(3) Å and c = 15.266(5) Å.

**A90-26112** How to compare J<sub>c</sub> among different sized samples. NOBUHITO IMANAKA, HISAO IMAI, and GINYA ADACHI, *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 28, Dec. 1989, pp. L2158-L2160. 7 Refs.

The J<sub>c</sub> evaluation was examined on the assumption that a Joule heat caused by the current for a resistivity measurement exceeds the sample thermal cooling from the liquid nitrogen refrigerant when current density (J<sub>c</sub>) becomes more than a critical value for BiPbSrCaCuO superconductors or Au-mixed Bi-Pb-Sr-Ca-Cu-O composites. Reexamination revealed that a normalized J<sub>c</sub> value was independent of the sample sizes. The calculation method proposed here allows J<sub>c</sub> of different-sized samples to be directly compared.

**A90-25095** High-T<sub>c</sub> oxide/metal composite superconductors produced by oxidation of unidirectionally solidified Ag-Yb-Ba-Cu alloys. K. TOGANO, H. KUMAKURA, and D. R. DIETDERICH, *Journal of Applied Physics* (ISSN 0021-8979), Vol. 67, Feb. 15, 1990, pp. 2173-2176. 6 Refs.

This communication presents a new method for producing a superconducting high-T<sub>c</sub> oxide/metal matrix composite by unidirectional solidification of metallic precursors and subsequent oxidation. A lamellar eutectic-like structure which is aligned parallel to the solidification direction has been produced in Ag-Yb-Ba-Cu alloys. During oxidation, the superconducting perovskite phase nucleates preferentially within some of the lamellae and at the lamellae boundaries. It is hoped that such preferential nucleation will ultimately improve the continuity of the superconducting phase, and thus the transport current. The highest T<sub>c</sub>, zero resistance, obtained so far is 85 K.

**A90-24446** Effect of oxygen plasma annealing on superconducting properties of Bi<sub>2</sub>(Sr,Ca) 3Cu<sub>2</sub>O (x) and YBa<sub>2</sub>Cu<sub>3</sub>O (7-δ) thin films. T. YOSHITAKE, S. MIURA, J. FUJITA, N. SHOHATA, H. IGARASHI et al., *Applied Physics Letters* (ISSN 0003-6951), Vol. 56, Feb. 5, 1990, pp. 575-577. 10 Refs.

Thin films of the Bi<sub>2</sub>(Sr,Ca) 3Cu<sub>2</sub>O (x) and YBa<sub>2</sub>Cu<sub>3</sub>O (7-δ) system were annealed at 400 C in a high-density oxygen plasma, and its effect on superconducting properties was investigated. After being annealed in the oxygen plasma, their superconducting transition temperatures decreased by about 10 K and 2 K, respectively; the caxis lattice constants of these films were also found to decrease as a result of the annealing in the oxygen plasma. These results suggest that excessive oxygen incorporated into the films by the annealing in the oxygen plasma caused the excessive hole carriers, which deteriorated the superconducting transition temperatures of these films.

**A90-23307** Magnetic properties and superconductivity of the strong coupling Hubbard model. HIROSHI SHIMAHARA, SUSUMU MISAWA, SATOSHI TAKADA, *Physical Society of Japan Journal* (ISSN 0031-9015), Vol. 58, Nov. 1989, pp. 4168-4183. 29 Refs.

The t-J model, which in the case of J much less than t can be derived from the strong coupling Hubbard model, is studied in the improved Hubbard III approximation. It is found that the magnetic properties change from those of localized spin systems to those of itinerant electron systems. In the half-filled limit, the susceptibility is shown to reduce to the Curie-Weiss form in the mean-field approximation to the exchange term of the Hamiltonian. It is also found that the antiferromagnetic transition temperature decreases very rapidly with slight hole-doping of the half-filled case. The superconductivity is also examined within a similar approximation. The relation to the oxide high-T<sub>c</sub> superconductors is discussed.

**A90-23301 Numerical calculation for quantum states of a doped fermion coupled with spins on a frustrated Heisenberg chain.** MASAAKI NOJIMA, ATSUSHI OHTA, TOSHIHIKO SUZUKI, and YUHEI NATSUME, *Physical Society of Japan, Journal* (ISSN 0031-9015), Vol. 58, Nov. 1989, pp. 3886-3889. 35 Refs.

The behavior of a quantum island formed by a doped fermion to the oxygen site on a CuO<sub>2</sub> plane in high-T<sub>c</sub> superconducting oxides is investigated by the numerical calculation of the exact diagonalization for the Heisenberg  $s = 1/2$  chain system of  $2 \times 8$ , with special attention to the effect of the frustration introduced by the second nearest-neighbor antiferromagnetic exchange interaction. Although the island shrinks with increased coupling between the fermion and spins, it spreads significantly due to the essential contribution of the frustration.

**A90-23069 The superconducting properties of YBa<sub>2</sub>Cu<sub>3</sub>O(7-x)-gold composites.** N. IMANAKA, F. SAITO, H. IMAI, G. ADACHI, M. YOSHIKAWA et al., *Journal of Applied Physics* (ISSN 0021-8979), Vol. 67, Jan. 15, 1990, pp. 915-917. 8 Refs.

Gold powder was mixed with YBa<sub>2</sub>Cu<sub>3</sub>O(7-x) superconductors for the purpose of increasing the critical current density (J<sub>c</sub>). The critical transition temperature at zero resistance, T<sub>c</sub>(zero), gradually decreased by the Au addition. However, the depression of T<sub>c</sub>(zero) was as low as 2 K for the YBa<sub>2</sub>Cu<sub>3</sub>O(7-x)-Au composite with Au mixing up to 40 wt pct. A maximum J<sub>c</sub> of 307 A/sq cm was obtained for the Au 5-wt pct mixed composite. The J<sub>c</sub> was about four times as high as that for YBa<sub>2</sub>Cu<sub>3</sub>O(7-x) without Au mixing. In addition to the J<sub>c</sub> enhancement, the weak-link problem was appreciably improved by the Au addition.

**A90-21963 High-resolution transmission electron microscopy of commensurate modulation in Bi<sub>2</sub>Sr<sub>2</sub>CoO(y).** YOSHIO MATSUI, KOHJI KISHIO, YASUhide TOMIOKA, TETSUYA HASEGAWA, and SHOZO IKEDA, *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 28, Nov. 1989, pp. L 1991-L 1994. 14 Refs.

The modulated structure of Bi<sub>2</sub>Sr<sub>2</sub>CoO(y) was directly observed by high-resolution electron microscopy. The modulation periodicity is four times commensurate with the tetragonal subcell, as was pointed out by Tarascon et al., while the average structure is identical to that of compositionally analogous superconductor Bi<sub>2</sub>Sr<sub>2</sub>CuO(y) which has an incommensurate modulation. Some of the weak satellite reflections appearing in the a(asterisk)-b(asterisk) diffraction pattern are, however, incompatible with the body-centered orthorhombic symmetry proposed by Tarascon et al., suggesting that weak additional modifications are induced in the structure.

**A90-21960 Preparation of superconducting (Bi, Pb)-Sr-Ca-Cu oxide tapes with a highly oriented structure by the solidification method.** KUNIO MATSUZAKI, AKIHISA INOUE, and TSUYOSHI MASUMOTO, *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 28, Nov. 1989, pp. L 1967-L 1969. 12 Refs.

Composite tapes consisting of Au and superconducting Bi-Sr-Ca-Cu or Bi-Pb-Sr-Ca-Cu oxide with a pseudotetragonal structure were prepared by annealing the oxide phase which was slowly solidified on the Au tape. The oxide phase has a highly oriented structure, and the c plane lies parallel to the surface of the tape. The tapes were found to exhibit zero resistance at temperatures above 100 K as well as good bending flexibility. The critical current density at 77 K in the absence of applied field is 96 A/sq cm for the BiSrCaCu<sub>2</sub>O(y)-Au tape and 108 A/sq cm for the Pb(0.2) BiSrCaCu(1.5) O(y)-Au tape.

**A90-21958 Contact resistance and V-I characteristics in a Ag-doped Bi-Sr-Ca-Cu-O superconductor.** NORIYUKI SHIMIZU, KAZUO MICHISHITA, YUTAKA HIGASHIDA, HISANORI YOKOYAMA, YUMI HAYAMI et al., *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 28, Nov. 1989, pp. L 1955-L 1958.

Contact resistance and V-I characteristics were investigated in Ag-doped and undoped Bi-Sr-Ca-Cu-O bulk samples prepared by the floating-zone method. In undoped samples, with increasing current pulse width, rapidity of voltage rise in V-I characteristics increases and J(c) decreases. The contact resistance is nonohmic and temperature dependence is semiconductorlike. In an Ag-doped sample, rapidity of voltage rise and J(c) are not influenced by pulse width, and deviation of J(c) among samples is small. The ohmic contact resistance has metallike temperature dependence, and its value is less than 1/500 of that in an undoped sample.

**A90-21957 High pressure oxygen treatment and the substitution of Sr for Ba on (Nd<sub>1/3</sub>Ba<sub>2/3</sub>)(2/3)(Ce<sub>1/3</sub>Nd<sub>2/3</sub>)(2/3)Cu<sub>3</sub>O(y) superconductors.** HITOSHI NOBUMASA, KAZUOHARU SHIMIZU, YUKISHIGE KITANO, MASATAKA TANAKA, and TOMOJI KAWAI, *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 28, Nov. 1989, pp. L 1948-L 1951. 6 Refs.

Substitution of Sr for Ba in the (Nd<sub>1/3</sub>Ba<sub>2/3</sub>)(2/3)(Ce<sub>1/3</sub>Nd<sub>2/3</sub>)(2/3)Cu<sub>3</sub>O(y) superconductor has been performed together with high pressure oxygen treatment, and the relationship among Sr content, lattice parameter, hole concentration and superconducting properties has been clarified. It has been found that there is a strong relationship between superconducting transition temperature (T<sub>c</sub>) and c-axis length. The highest T<sub>c</sub>(onset) and T<sub>c</sub>(zero) of the (Nd<sub>1/3</sub>Ba<sub>3/4</sub>Sr<sub>1/4</sub>)(2/3)(Ce<sub>1/3</sub>Nd<sub>2/3</sub>)(2/3)Cu<sub>3</sub>O(y) treated under 1300 atm oxygen pressure at 600 C for 24 hours are 59.3 K and 41.4 K, respectively. These transition temperatures are about 10 K higher than those of unsubstituted one.

**A90-22050 Creation of strong pinning sites by X-ray irradiation for Gd<sub>1</sub>Ba<sub>2</sub>Cu<sub>3</sub>O(7-x) superconducting thin films.** SHIGEMI KOHIKI, SHIN-ICHIRO HATTA, KENTARO SETSUNE, KIYOTAKA WASA, YASUHIRO HIGASHI et al., *Applied Physics Letters* (ISSN 0003-6951), Vol. 56, Jan. 15, 1990, pp. 298-300. 6 Refs.

A large enhancement of critical current density with the small rate of flux creep was realized by X-ray irradiation before the oxygen annealing for Gd<sub>1</sub>Ba<sub>2</sub>Cu<sub>3</sub>O(7-x) superconducting thin films. The significantly increased magnetization showed both the temperature independence and the small magnetic relaxation. The activation energy estimated by the flux creep model increased from 0.1 to 0.25 eV with the X-ray irradiation treatment.

**A90-21956 High-resolution transmission electron microscopy of defects in YBa<sub>2</sub>Cu<sub>4</sub>O<sub>8</sub>.** KOJI YAMAGUCHI, TAKAYUKI MIYATAKE, TSUTOMU TAKATA, SATOSHI GOTOH, NAOKI KOSHIZUKA et al., *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 28, Nov. 1989, pp. L 1942-L 1944. 8 Refs.

Microscopic structures of the high-T<sub>c</sub> superconductor YBa<sub>2</sub>Cu<sub>4</sub>O<sub>8</sub>(T<sub>c</sub> = 80 K) are examined by high-resolution transmission electron microscopy. Planar defects are observed as white spot lines in the micrograph of the single-phase YBa<sub>2</sub>Cu<sub>4</sub>O<sub>8</sub> and they have a structure with an absence of one Cu-O chain in the double Cu-O chain of YBa<sub>2</sub>Cu<sub>4</sub>O<sub>8</sub>. YBa<sub>2</sub>Cu<sub>3</sub>O<sub>7</sub> and Y<sub>2</sub>Ba<sub>4</sub>Cu<sub>7</sub>O<sub>15</sub>-like local structures exist around the planar defects.

**A90-21955 Effect of 120 MeV O-16 ion irradiation at liquid nitrogen temperature on superconducting properties of Bi-Pb-Sr-Ca-Cu-O.** AKIHIRO IWASE, MITSUO WATANABE, TADAO IWATA, and TAKESHI NIHIRA, *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 28, Nov. 1989, pp. L 1939-L 1941. 6 Refs.

Bi-Pb-Sr-Ca-Cu-O superconductor is irradiated at liquid nitrogen temperature with 120 MeV O-16 ions up to the fluence of  $3.5 \times 10$  to the 14th/sq cm. Transition temperature T(c) and critical current I(c) at 77.3 K decrease with increasing ion fluence. Annealing of the specimen up to 300 K after irradiation causes a slight recovery of T(c) and I(c). However, recovery of the electrical resistance above 100 K is not observed.

**A90-21954 Preparation of a Ag-doped Bi-Sr-Ca-Cu-O bulk sample by the floating-zone method.** YUKIO KUBO, KAZUO MICHISHITA, NORIYUKI SHIMIZU, YUTAKA HIGASHIDA, HISANORI YOKOYAMA et al., *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 28, Nov. 1989, pp. L 1936-L 1938. 7 Refs.

Bulk samples with nominal composition of Bi<sub>2</sub>Sr<sub>2</sub>CaCu<sub>2</sub>O(y) doped with 0, 10 and 20 wt pct Ag were prepared by the floating-zone method at growth rates of 2 mm/h and 5 mm/h. Ag-doping seems to slightly enhance J(c) while annealing is very effective for J(c) enhancement. From preliminary ac susceptibility measurements, the J(c) enhancement by annealing is considered to be due to improvement of the weak link between superconducting grains. The 10 percent Ag-doped sample grown at 2 mm/h possessed J(c) of 5360 A/sq cm at 77 K under zero magnetic field after annealing.

**A90-21953 On the formation of high-T(c) phase in Mo-doped (Bi, Pb)<sub>2</sub>Sr<sub>2</sub>Ca<sub>2</sub>Cu<sub>3</sub>O(y) superconductors.** RYUJI SATO, TAKAYUKI KOMATSU, NOZOMU TAMOTO, KAZUMASA MATSUTA, KAZUHIKO SAWADA et al., *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 28, Nov. 1989, pp. L 1932 - L 1935. 7 Refs.

Superconducting Bi(1.6-x)Pb(0.4)Mo(x)Sr<sub>2</sub>Ca<sub>2</sub>Cu<sub>3</sub>O(y) (x = 0.05 and 0.1) and Bi(1.6)Pb(0.4-x)Mo(x)Sr<sub>2</sub>Ca<sub>2</sub>Cu<sub>3</sub>O(y) (x = 0.1, 0.2, 0.3 and 0.4) ceramics were prepared by the melt-quenching method and the effect of Mo addition on the superconducting properties was examined. It was found that the formation of the high-T(c) phase was largely enhanced by the coexistence of Pb and Mo elements. It was concluded that the lowering of the partial melting temperature at around 870 C caused by the addition of Mo element was very important for the formation of the high-T(c) phase.

**A90-20382 A possible pairing mechanism for high-T<sub>c</sub> superconductivity.** MASAYUKI A. IKEDA, *Physical Society of Japan Journal* (ISSN 0031-9015), Vol. 58, Oct. 1989, pp. 3473-3476. 10 Refs.

A probable pairing mechanism for high-T<sub>c</sub> superconductors is proposed. The strong correlation between intraatomic Cu-d holes, U, is treated exactly. It is assumed that holes introduced by doping occupy O-p(pi) as well as orbits, and p(pi) holes become itinerant. Strong intraatomic correlation between p(pi) and p(sigma) holes, and the Hubbard U can lead to an attractive force between O-p(pi) itinerant holes.

**A90-20369 Structure and superconductivity of sputtered Bi-Sr-Ca-Cu-O films from various targets.** JUN SUGIYAMA, MASAHARU TAKEUCHI, JUNICHI KAWAMOTO, and ISEMI IGARASHI, *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 28, Oct. 1989, pp. L1812-L1815. 12 Refs.

Bi-Sr-Ca-Cu-O films were prepared by use of the single-target sputtering method: deposited on 100-line MgO substrates and then annealed at 860 C. Targets of three types were used: (1) mixed powder, (2) calcined powder, or (3) a sintered disk, all of Bi<sub>2</sub>O<sub>3</sub>, SrCO<sub>3</sub>, CaCO<sub>3</sub> and CuO. Films made from the target (1) almost peeled off from the substrate during the annealing, and small residual films consisted of c-axis-oriented phases of Bi<sub>2</sub>Sr<sub>2</sub>Ca<sub>1</sub>Cu<sub>2</sub>O(x) (2212), Bi<sub>2</sub>Sr<sub>2</sub>Ca<sub>0</sub>Cu<sub>1</sub>O(x) (2201), and a slight amount of Bi<sub>2</sub>Sr<sub>2</sub>Ca<sub>2</sub>Cu<sub>3</sub>O(x) (2223). The films from targets (2) and (3) did not peel off and consisted of randomly oriented 2212 and 2201 phases.

**A90-20370 YBCO dc SQUID of MOCVD thin film bridge.** AKINOBU IRIE, MASANORI ERA, TSUTOMU YAMASHITA, HIDEYUKI KUROSAWA, HISANORI YAMANE et al. *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 28, Oct. 1989, pp. L1816-L1819. 15 Refs.

The fabrication of dc SQUIDs with microbridges by photolithography and the chemical etching technique using  $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$  (YBCO) thin films (0.5-1 micron) prepared by MOCVD is reported. The SQUIDs exhibited a maximum voltage modulation of 80 microvolts at 4.2 K, an inductance of 70 pH, and an intrinsic energy sensitivity of 740 h at 4.2 K. Experimental results suggest a sinusoidal current-phase relationship in a micron-long YBCO bridge.

**A90-20368 Preparation of Bi-Pb-Sr-Ca-Cu-O superconducting fibers by the sol-gel method.** HAOREN ZHUANG, HIROMITSU KOZUKA, and SUMIO SAKKA, *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 28, Oct. 1989, pp. L1805-1808. 13 Refs.

Bi-Sr-Ca-Cu-O superconducting fibers were prepared by the sol-gel method. Gel fibers of 0.01-1mm diameter were directly drawn from a homogeneous viscous sol, which was prepared from an aqueous solution of metal acetates containing acetic acid and tartaric acid. Ceramic fibers with the high  $T_c$  phase as the main phase were obtained by heating gel fibers (derived from a sol of molar composition Bi:Pb:Sr:Ca:Cu = 1.85:0.35:1.9:2.0:3.1) to 835 C at a rate of 0.33 C/min and keeping them there for 40 h. The fiber showed diamagnetism below 110 K and zero electrical resistance at 98 K.

**A90-20366 Comparative studies between Ag-sheathed  $\text{YBa}_2\text{Cu}_3\text{O}(y)$  wires and sintered  $\text{YBa}_2\text{Cu}_3\text{O}(y)$ .** HIDEO ISHII, TSUKUSHI HARA, MASAOKI NAKAMURA, TAKAHIKO YAMAMOTO, and HARUHIKO HOSHINO, *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 28, Oct. 1989, pp. L1793-L1796. 9 Refs.

Comparative studies of certain properties have been performed on Ag-sheathed  $\text{YBa}_2\text{Cu}_3\text{O}(y)$  wire and pressed and sintered  $\text{YBa}_2\text{Cu}_3\text{O}(y)$ . The critical current density of the Ag-sheathed sample is more than five times larger than of the sintered sample, whereas the superconducting volume fraction estimated from magnetic moment measurement is larger for the sintered sample. These results are discussed in relation to the microstructures of the samples observed by SEM images.

**A90-20365 Ferroelasticity in  $\text{La}_2\text{CuO}_4$  single crystals.** AKIKATSU SAWADA, YASUO NISHIHATA, KUNIHICO OKA, and HIROMI UNOKI, *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 28, Oct. 1989, pp. L1787-L1789. 13 Refs.

Domain structures due to a tetragonal-orthorhombic phase transition at  $T(0) = 450$  K have been observed directly using a polarizing microscope. Domain walls are parallel to 100 planes in the tetragonal axial system. Domain walls have been shown to move at room temperature upon application of external compressive stress.

**A90-20364 Modulated structure of the high- $T_c$  superconductor Bi-Pb-Ca-Sr-Cu-O studied by high-resolution electron microscopy and electron diffraction.** YOSHIHIKO HIROTSU, OSAMU TOMIOKA, NAOKI YAMAMOTO, SIGEMARO NAGAKURA, YOSHIO NAKAMURA et al., *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 28, Oct. 1989, pp. L1783-L1786. Research supported by Shinsei Shigen Kyokai. 17 Refs.

A new type of atomic displacive modulation in the incommensurate superconducting oxide Bi-Pb-Ca-Sr-Cu-O (2223 phase) has been studied by high-resolution electron microscopy and electron diffraction. The structure is orthorhombic with cell dimensions  $a = 0.54$ ,  $b = 4.2$ , and  $c = 3.71$  nm. The structural modulation has been analyzed by assuming a commensurate cell with the dimension  $b = 8a$ .

**A90-20361 Superconducting phases with single Ti-O layer structure preparation -  $(\text{Ti}, \text{Pb})\text{Ca}(n-1)\text{Ba}_2\text{Cu}(n)\text{O}(2n+3)$  ( $n = 2, 3, 4, 5, 6$ ).** HIROYUKI KUSUHARA, TOSHIHIRO KOTANI, HIROMI TAKEI, and KOHJI TADA, *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 28, Oct. 1989, pp. L1772-L1774. 6 Refs.

Single Ti-O layer structures with two to six Cu-O layers,  $(\text{Ti}, \text{Pb})\text{Ca}(n-1)\text{Ba}_2\text{Cu}(n)\text{O}(2n+3)$  ( $n = 2, 3, 4, 5, 6$ ), are prepared, and the superconducting properties of their phases are investigated. The c-lattice constants of the observed phases obey the c-axis rule of  $c = 6.38 + 3.19n$  for single Ti-O layer structures. With an increase in Cu-O layers, the superconducting transition temperature, determined from electrical resistivity-temperature dependency and dc susceptibility, rises, reaching a maximum value of 121 K at  $n = 4$ , and then falls with a further increase of the number of Cu-O layers from four to six.