

Photoemission Study of Electronic Structure of (Cu, Tl)-1223

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A discovery of a significant rise of superconducting transition temperature T_C of (Cu, Tl)Ba₂Ca₂Cu₃O_{9±z} [(Cu, Tl)-1223], one of the families of the Cu-system superconductors, from ~95 K in the as-grown specimen to above 130 K in the oxygen-depleted one by post-annealing, has revealed an importance of this material for practical applications above 77 K, though complex variations of their properties with the reduction are also observed. Therefore, elucidation of mechanism of this change of electronic structure which finally leads the optimized state for superconductivity is important to achieve higher performance, especially higher T_C , in the Cu-system. We have recently performed *in-situ* X-ray photoemission spectroscopy of this compound as a function of the annealing temperature and have found out the presence of charge-redistribution dominating this change.

For preparing clean surfaces to be investigated, a fracturing in ultra high vacuum was adopted to the samples grown by high pressure sintering. This treatment yielded clear Fermi edges in their valence band spectra. This is the first observation of photoelectron Fermi level of this system and proves these surfaces should be intrinsic. The edge-height of the fracture-only sample with T_C of 94.7 K was 20~50 % higher than those of optimally doped superconducting cuprates. It indicates the as-grown specimens should be in over-doped states. The surfaces were, then, annealed in vacuum and subsequent measurement was performed. The treatment temperature T_{ann} was elevated by 100 °C every anneal-measurement cycle. Figure 1 shows a T_{ann} dependence of Tl 4f signal. Binding energy (BE) of the Tl 4f_{7/2} peak of the fracture-only sample was 117.4 eV which coincided with Tl₂O₃. The signal monotonously shifts towards higher BE with a rise of T_{ann} . BE of the peak of the 550 °C sample with T_C above 130 K exceeded the central value of those of Tl³⁺ and Tl¹⁺. This amount of shift of 0.6 eV was much larger than that of chemical-potential about 0.15 eV observed in valence band spectra. These results indicate that the Tl ions in the high T_C phase developed by the high temperature annealing should have a mixed valence. Figure 2 shows a change of Cu 2p_{3/2} signal with T_{ann} . For the fracture-only sample, the wide peak for 2p⁵3d¹⁰L̄ final states (L̄: ligand hole) and intense satellite-peak indicate heavily hole-doped states. By the annealing up to 350 °C, BE of the 2p⁵3d¹⁰L̄ peak decreased with a rise of T_{ann} . On the other hand, a higher temperature treatment resulted in a recovery of it. These changes mean that the hole content of the Cu-O clusters once decreased and the further annealing led the re-increase of it. In oxygen-depleted YBa₂Cu₃O_y, electron-movement from CuO₂ planes to CuO chain takes place, which originated in a fall of Madelung potential for electron of the latter sites due to a decrease of oxygen coordination number. A T_{ann} dependence of Ba core signal of the (Cu, Tl)-1223 also indicated a selective oxygen-deple-

tion from the Tl-O layers. Analogously, it seems reasonable that this should originate the valence-reduction of the Tl ions in the charge reservoir, which should, consequently, pull electrons out from the CuO₂ planes. In the samples reduced above 400 °C, Madelung potential of their Tl sites would be sufficiently lowered to compensate a rise of total ionization energies necessary to this charge-redistribution.

The present study reveals that the reduction annealing above 400°C of the high pressure synthesized (Cu, Tl)-1223 results in the electron movement from the CuO₂ planes to Tl-O ones, which causes the re-increase of hole-concentration of the CuO₂ planes. It suggests that, started with the over-doped states, optimization of electronic structure such as hole-content and -distribution, as well as enhancements of superconducting properties, especially T_C , would be performed by utilizing the charge redistribution mechanism.

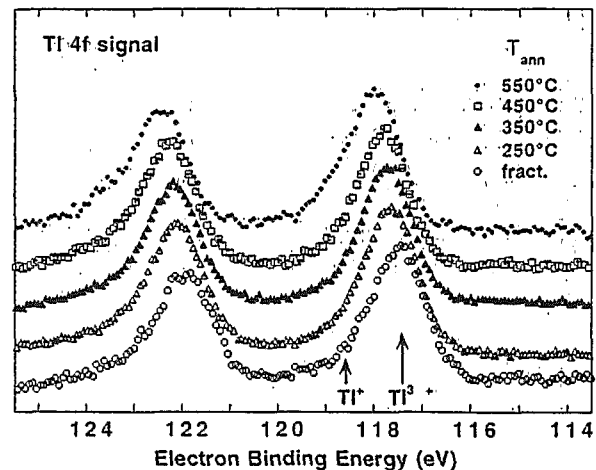


Fig.1 A change of the Tl 4f signal of the high pressure synthesized (Cu, Tl)-1223 with the annealing temperature T_{ann} . Positions of Tl 4f_{7/2} peak of Tl³⁺ and Tl¹⁺ compounds are indexed with arrows.

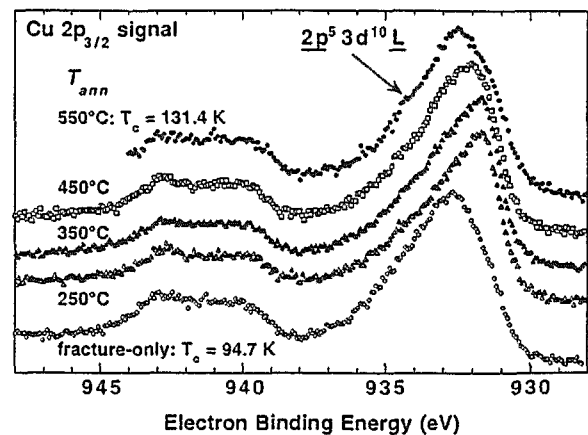


Fig.2 A change of the Cu 2p_{3/2} signals of the high pressure synthesized (Cu, Tl)-1223 and Tl-1223 with the annealing temperature T_{ann} . The fracture-only states of both compounds are represented as "fract".

(1) Publications

- 1) H. Ihara, Y. Sekita, H. Tateai, N.A.Khan, K. Ishida, E. Harashima, T. Kojima, H. Yamamoto, K. Tanaka, Y. Tanaka, N. Terada, H. Obara, Superconducting Properties of $\text{Cu}_{1-x}\text{Tl}_x\text{-1223}[\text{Cu}_{1-x}\text{Tl}_x(\text{Ba,Sr})_2\text{Ca}_2\text{Cu}_3\text{O}_{10-y}]$ Thin Films, IEEE Trans. Appl. Superconductivity 9(1999) 1551
- 2) 徳永陽、石田憲二、北岡良雄、伊原英雄 : Cu 系多層型高温超伝導体における二つの超伝導転移温度 日本物理学会誌 54(1999) 730
- 3) Y. Tokunaga, H. Kotegawa, K. Ishida, G. -q. Zheng, Y. Kitaoka, K. Tokiwa, A. Iyo, H. Ihara, Carrier distribution and superconductivity in multilayer high-Tc cuprates proved by ^{63}Cu NMR, J. of Low Temp. Phys. 117(1999) 473
- 4) T. Watanabe, H. Kashiwagi, S. Miyashita, N. Ichioka, K. Tokiwa, A. Iyo, Y. Tanaka, S.K. Agarwal, H. Ihara Synthesis and Physical Properties of $(\text{Cu,M})\text{Ba}_2\text{Ca}_3\text{Cu}_4\text{O}_x$ ($\text{M}=\text{C,Mg,Ni,Al,Zn,Tl}$), J. of Low Temp. Phys. 117(1999) 753
- 5) K. Tokiwa, C. Kunugi, H. Kashiwagi, T. Nibe, H. Aota, N. Ichioka, T. Watanabe, A. Iyo, Y. Tanaka, S.K. Agarwal, H. Ihara Pressure Effects on Resistive Transition in $(\text{Cu,M})\text{Ba}_2\text{Ca}_3\text{Cu}_4\text{O}_y$ ($\text{M}=\text{C,Al,Tl,Mg,Zn}$) Superconductors J. of Low Temp. Phys. 117(1999) 903
- 6) Y. Tokunaga, K. Ishida, Y. Kitaoka, K. Asayama, K. Tokiwa, A. Iyo, H. Ihara Effect of carrier distribution on superconducting characteristics of multilayered high-Tc cuprate $(\text{Cu}_{0.6}\text{C}_{0.4})\text{Ba}_2\text{Ca}_3\text{Cu}_4\text{O}_{12+y}$: ^{63}Cu -NMR study, Phys.Rev. B 61 (2000) 9707
- 7) 伊原英雄 Cu-1234 系による最高性能超伝導材料の可能性 固体物理 35 (2000) 301
- 8) K. Tokiwa, H. Aota, C. Kunugi, K. Tanaka, Y. Tanaka, A. Iyo, H. Ihara, T. Watanabe, Pressure effect on T_c in $(\text{Cu, Tl})\text{Ba}_2\text{Ca}_2\text{Cu}_3\text{O}_y$ superconductor, Physica B 284-288 (2000) 1077
- 9) K. Tanaka, A. Iyo, Y. Tanaka, K. Tokiwa, M. Tokumoto, M. Ariyama, T. Tsukamoto, T. Watanabe, H. Ihara Low superconducting anisotropy ($\gamma = 5 \sim 11$) in $(\text{Cu,Tl})\text{-1223}$ superconductors, Physica B 284-288 (2000) 1081
- 10) K. Tanaka, A. Iyo, Y. Tanaka, K. Tokiwa, N. Terada, M. Tokumoto, M. Ariyama, T. Tsukamoto, S. Miyashita, T. Watanabe, H. Ihara, T_c beyond 130K on a high-pressure synthesized $(\text{Cu,Tl})\text{-1223}$ superconductor Physica B 284-288 (2000) 1079
- 11) A. Iyo, Y. Tanaka, N. Terada, M. Tokumoto, H. Ihara Annealing effect on the irreversibility line in $(\text{Cu, C})\text{Ba}_2\text{Ca}_2\text{Cu}_3\text{O}_y$, Physica B 284-288 (2000) 867
- 12) T. Watanabe, S. Miyashita, N. Ichioka, K. Tokiwa, K. Tanaka, A. Iyo, Y. Tanaka, H. Ihara Carrier doping and superconducting properties in Cu-1234 and CuTl-1223 superconductors, Physica B 284-288 (2000) 1075
- 13) H. Ihara, A. Iyo, Y. Tanaka, N. Terada, K. Tokiwa, T. Watanabe, Y. Tokunaga, K. Ishida, Y. Kitaoka, N. Hamada Selective-over-doping in Cu-1234 $(\text{CuBa}_2\text{Ca}_3\text{Cu}_4\text{O}_{12-y})$ system with high $T_c > 116\text{K}$ and low superconducting anisotropy 1.6 Physica B (2000) in press
- 14) H. Ihara, K. Tanaka, Y. Tanaka, A. Iyo, N. Terada, M. Tokumoto, F. Tateai, M. Kawamura, K. Ishida, S. Miyashita, T. Watanabe, Selective reduction for hole-doping in $\text{Cu}_{1-x}\text{Tl}_x\text{-1223}$ $(\text{Cu}_{1-x}\text{Tl}_x\text{Ba}_2\text{Ca}_2\text{Cu}_3\text{O}_{10-y})$ system with $T_c > 132\text{K}$ Physica B 284-288 (2000) 1085
- 15) N. Hamada, H. Ihara, Electronic band structure of $\text{CuBa}_2\text{Ca}_3\text{Cu}_4\text{O}_{10+x}$ ($x=0,1$), Physica B 284-288 (2000) 1073
- 16) N. Terada, K. Tanaka, Y. Tanaka, A. Iyo, K. Tokiwa, T. Watanabe, H. Ihara, Photoemission study of chemical bond nature of $(\text{Cu,Tl})\text{-1223}$ with T_c above 130K, Physica B 284-288 (2000) 1083
- 17) H. Ihara, K. Tanaka, Y. Tanaka, A. Iyo, N. Terada, M. Tokumoto, M. Ariyama, K. Ishida, I. Hase, N. Hamada, S. Miyashita, K. Tokiwa, T. Watanabe, Mechanism of T_c Enhancement in $\text{Cu}_{1-x}\text{Tl}_x\text{-1234}$ and -1223 System, Physica C (2000) in press
- 18) S. Ohshima, Y. Takano, M. Mukaida, M. Kusunoki, K. Ehata, T. Chiba, K. Suzuki, M. Inadomaru Fabrication of low YBCO films and its application to patch antenna, Physica C (2000) in press
- 19) H. Kamimura, T. Hamada, M. Nishimura, H. Ushio, Microscopic Origin of the Pseudogap, Physica C (2000) in press
- 20) J. C. Nie, Y. Sekita, A. Sundaresan, K. Hayashi, Y. Ishiura and H. Ihara, Stoichiometry and distribution of BaCuO_2 and

- CaCuO₂ thin films by off-axis RF sputtering, submitted to Journal of Applied Physics(2000)
- 21) H. Ihara, Possibility of the Best Performance High-T_c Superconductor based on Cu-1234 System, Proceedings of the APCC2000(2000) in press
- 22) N. Terada, A. Iyo, Y. Tanaka, K. Obara and H. Ihara, Photoemission Study of (Cu, Tl)-1223 and Tl-1223 with T_c above 130K, submitted to IEEE Transactions on Applied Superconductivity(2000)
- 23) N. Terada, S. Ikegawa, Y. Motoi, K. Obara and H. Ihara, Photoemission Study of Chemical bond nature of Pb-3212 Epitaxial Films, submitted to IEEE Transactions on Applied Superconductivity(2000)
- 24) A. Sundaresan, M. Hirai, J.C.Nie, K. Hayashi, Y. Ishiura and H. Ihara, Preparation of (Cu_{1-x}Tl_x)Ba₂Ca₃Cu₄O_y superlattice by Self Assembling Epitaxy (SAE) method, submitted to Physica C(2000)
- 25) A. Iyo, Y. Aizawa, Y. Tanaka, M. Tokumoto and H. Ihara, High-Pressure Synthesis of TlBa₂Ca_{n-1}Cu_nO_y (n=3 and 4) with T_c=133.5K (n=3) and 127K (n=4), submitted to Physica C(2000)
- 26) HIJIRI KITO, AKIRA IYO, MADOKA TOKUMOTO, SATORU OKAYASU and HIDEO IHARA, Effect of the Neutron Irradiation of the High Temperature superconductor (Cu,C)Ba₂Ca_{n-1}Ca_nO_{2n+4-δ} (n=3, 4 and 5) submitted to Physica C(2000)
- 27) I. Hase, N. Hamada, A. Iyo, N. Terada, Y. Tanaka and H. Ihara, Carrier Reentrance by selective reduction in Tl1223-system, submitted to Physica C(2000)
- 28) Y. Tanaka, A. Iyo, N. Shirakawa, M. Ariyama, M. Tokumoto, S. I. Ikeda and H. Ihara, Specific Heat Study on Cu_xBa₂Ca_{n-1}Cu_nO_y, submitted to Physica C(2000)
- 29) N. Hamada and H. Ihara, Electronic Band Structure of CuBa₂Ca_{n-1}Cu_nO_{2n+2+x} (n=3-5), submitted to Physica C(2000)
- 30) J.C.Nie, A.Sundaresan, K. Hayashi, Y. Ishiura, Y. Tanaka and H. Ihara, (CaCuO₂)_m/(Sr_xCa_{1-x}CuO₂)_n superlattice growth by reactive sputtering, submitted to Physica C(2000)
- 31) Tl-valence change and T_c enhancement (>130K) in (Cu,Tl)Ba₂Ca₂Cu₃O_y due to nitrogen annealing K. Tanaka, A. Iyo, N. Terada, K. Tokiwa, S. Miyashita, Y. Tanaka, T. Tsukamoto, S.K.Agarwal, T. Watanabe and H. Ihara, submitted to Physical Review B(2000)
- 32) Yasumoto Tanaka, Akira Iyo, Naoki Shirakawa, Minoru Ariyama, Madoka Tokumoto, Shin-Ichi Ikeda and Hideo Ihara, Specific Heat Study on Cu_xBa₂Ca₃Cu₄O_y, submitted to Journal of Physical Society of Japan(2000)
- 33) 伊豫彰、田中康資、徳本圓、伊原英雄 T_cが130Kを越える TlBa₂Ca₂Cu₃O_yの合成 submitted to Forum of Superconductivity Science and Technology(FSST) NEWS(2000)
- 34) Hg系に匹敵する超伝導転移温度(T_c>130K)を示す Tl系銅酸化物超伝導体の開発 伊豫彰、田中康資、徳本圓、伊原英雄 submitted to ETL NEWS(2000)
- 35) Akira Iyo, Yasumoto Tanaka, Madoka Tokumoto and Hideo Ihara, Synthesis of TlBa₂Ca₂Cu₃O_y superconductors having a comparable T_c (>130 K) with HgBa₂Ca₂Cu₃O_y, submitted to Physical Review B(2000)
- 36) Shigetoshi OHSHIMA, Katsufumi EHATA, Md. Idris ALI and Katsuaki SATO, FABRICATING AND CHARACTERIZATION OF HTS ANTENNAS FOR SATELLITE COMMUNICATION AND SECURITY SYSTEM, submitted to Proceedings of the (APMC2000) 2000 Asia-Pacific microwave CONFERENCE(2000)

(2) Presentations

- 1) 田中浩介、渡辺恒夫 (東京理科大学)、伊豫彰、伊原英雄 (電総研) 「(Cu_{1-x}Tl_x)-1234 の選択ドーピング」 応用物理学会 (東京理科大学) 99.3.31
- 2) 柏木博史、常盤和靖、渡辺恒夫 (東京理科大)、伊豫彰、伊原英雄 (電総研) 「Cu_xCy-および Cu_xMzCy-1234(M=Al,Ni)の合成と物性評価」 応用物理学会 (東京理科大学) 99.3.31
- 3) 青田秀晃、常盤和靖、渡辺恒夫(東京理科大)、伊豫彰、伊原英雄(電総研)「Cu系超伝導体のT_cの圧力依存症」同上

4) 浜田典昭 (東京理科大学)、伊原英雄 (電総研)

「CuBa₂Ca₃Cu₄O_{10+x}(Cu₁₂₃₄)のバンド計算」 日本物理学会 (広島大学) 99.3.28

5) 小手川恒、徳永陽、石田憲二、北岡良雄 (大阪大学)、常盤和靖 (東京理科大)、伊豫彰、伊原英雄 (電総研)

「CuTlBa₂Ca₂Cu₃O_y(Cu-1223)のNMR」 日本物理学会 (広島大学) 99.3.31

6) 伊豫彰、田中康資、寺田教男、徳本圓、伊原英雄 (電総研)

「(Cu,C) Ba₂Ca₂Cu₃O_y における不可逆磁界の熱処理効果」 日本物理学会 (広島大学) 99.3.28

7) K. Tokiwa(SUT, CREST), H. Aota(SUT), C.Kunugi(SUT), K. Tanaka(SUT), Y. Tanaka(ETL, CREST), A. Iyo(ETL, CREST), H. Ihara(ETL, CREST), T. Watanabe(SUT, CREST) Pressure effect on T_c in (Cu, Tl)Ba₂Ca₂Cu₃O_y superconductor XXII International Conference On Low Temperature Physics, Espoo and Helsinki, Finland August 6, 1999

8) K. Tanaka(SUT, ETL), A. Iyo(ETL, CREST), Y. Tanaka(ETL, CREST), K. Tokiwa(SUT, CREST), M. Tokumoto(ETL, CREST), M. Ariyama(SUT, ETL), T. Tsukamoto(SUT), T. Watanabe(SUT, CREST), H. Ihara(ETL, CREST) Low superconducting anisotropy ($\gamma=5\sim 11$) in (Cu, Tl)-1223 superconductors, XXII International Conference On Low Temperature Physics, Espoo and Helsinki, Finland August 6, 1999

9) K. Tanaka(SUT, ETL), A. Iyo(ETL, CREST), Y. Tanaka(ETL, CREST), K. Tokiwa(SUT, CREST), N. Terada(ETL, CREST), M. Tokumoto(ETL, CREST), M. Ariyama(SUT, ETL), T. Tsunemoto(SUT), S. Miyashita(SUT), T. Watanabe(SUT, CREST), H. Ihara(ETL, CREST) T_c beyond 130K on a high-pressure synthesized (Cu, Tl)-1223 superconductor XXII International Conference On Low Temperature Physics, Espoo and Helsinki, Finland August 6, 1999

10) A. Iyo(ETL, CREST), Y. Tanaka(ETL, CREST), N. Terada(ETL, CREST), M. Tokumoto(ETL, CREST), H. Ihara(ETL, CREST) Annealing effect on the irreversibility line in (Cu, C)Ba₂Ca₂Cu₃O_y, XXII International Conference On Low Temperature Physics, Espoo and Helsinki, Finland August 9, 1999

11) T. Watanabe(SUT, CREST), S. Miyashita(SUT), N. Ichioka(SUT), K. Tokiwa(SUT, CREST), K. Tanaka(SUT), A. Iyo(ETL, CREST), Y. Tanaka(ETL, CREST), H. Ihara(ETL, CREST), Carrier doping and superconducting properties in Cu-1234 and CuTl-1223 superconductors, XXII International Conference On Low Temperature Physics, Espoo and Helsinki, Finland, August 6, 1999

12) H. Ihara(ETL, CREST), A. Iyo(ETL, CREST), Y. Tanaka(ETL, CREST), N. Terada(ETL, CREST), K. Tokiwa(SUT, CREST), T. Watanabe(SUT, CREST), Y. Tokunaga(Osaka-uni., CREST), K. Ishida(Osaka-uni., CREST), Y. Kitaoka(Osaka-uni., CREST), N. Hamada(SUT, CREST), Selective-over-doping in Cu-1234 (CuBa₂Ca₃Cu₄O_{12-y}) system with high T_c>116K and low superconducting anisotropy 1.6 XXII International Conference On Low Temperature Physics, Espoo and Helsinki, Finland, August 6, 1999

13) H. Ihara(ETL, CREST), K. Tanaka(SUT), Y. Tanaka(ETL, CREST), A. Iyo(ETL, CREST), N. Terada(ETL, CREST), M. Tokumoto(ETL, CREST), F. Tateai(SUT, CREST), M. Kawamura(SUT, CREST), K. Ishida(ETL, CREST), S. Miyashita(SUT), T. Watanabe(SUT, CREST), Selective reduction for hole-doping in Cu_{1-x}Tl_x-1223 (Cu_{1-x}Tl_xBa₂Ca₂Cu₃O_{10-y}) system with T_c>132K, XXII International Conference On Low Temperature Physics, Espoo and Helsinki, Finland, August 6, 1999

14) N. Hamada(SUT, CREST), H. Ihara(ETL, CREST) Electronic band structure of CuBa₂Ca₃Cu₄O_{10+x} (x=0,1), XXII International Conference On Low Temperature Physics, Espoo and Helsinki, Finland, August 6, 1999

15) H. Ihara(ETL, CREST), K. Tanaka(SUT), Y. Tanaka(ETL, CREST), A. Iyo(ETL, CREST), N. Terada(ETL, CREST), M. Tokumoto(ETL, CREST), M. Ariyama(SUT, ETL), F. Tateai(SUT, ETL), M. Kawamura(SUT, ETL), K. Ishida(ETL, CREST), S. Miyashita(SUT), K. Tokiwa(SUT, CREST), T. Watanabe(SUT, CREST), Selective Reduction Method for T_c Enhancement over 130K in Cu_{1-x}Tl_x-1223 System International Conference on Physics and Chemistry of Molecular and Oxide Superconductors(MOS99) Kungliga Tekniska Hogskolan, Stockholm, Sweden July 30, 1999

16) K. Tokiwa(SUT, CREST), C. Kunugi(SUT), H. Kashiwagi(SUT), T. Nibe(SUT), H. Aota(SUT), N. Ichioka(SUT), T. Watanabe(SUT, CREST), A. Iyo(ETL, CREST), Y. Tanaka(ETL, CREST), S.K. Agarwal(ETL), H. Ihara(ETL, CREST), Pressure Effects on Resistive Transition in (Cu,M)Ba₂Ca₃Cu₄O_y (M=C,Al,Tl,Mg,Zn), Superconductors International Conference on Physics and Chemistry of Molecular and Oxide Superconductors(MOS99) Kungliga Tekniska Hogskolan,

Stockholm, Sweden July 30, 1999

17) T. Watanabe (SUT, CREST), H. Kashiwagi (SUT), S. Miyashita (SUT), N. Ichioka (SUT), K. Tokiwa (SUT, CREST), A. Iyo (ETL, CREST), Y. Tanaka (ETL, CREST), S.K. Agarwal (ETL), H. Ihara (ETL, CREST), Synthesis and Physical Properties of $(\text{Cu}, \text{M})\text{Ba}_2\text{Ca}_3\text{Cu}_4\text{O}_x$ ($\text{M}=\text{C}, \text{Mg}, \text{Ni}, \text{Al}, \text{Zn}, \text{Tl}$) International Conference on Physics and Chemistry of Molecular and Oxide Superconductors (MOS99) Kungliga Tekniska Hogskolan, Stockholm, Sweden July 29, 1999

18) Y. Tokunaga (Osaka-Uni., CREST), H. Kotegawa (Osaka-Uni.), K. Ishida (Osaka-Uni., CREST), G.-q. Zheng (Osaka-Uni.) Y. Kitaoka (Osaka-Uni., CREST), K. Tokiwa (SUT, CREST), A. Iyo (ETL, CREST), H. Ihara (ETL, CREST) Carrier distribution and superconductivity in multilayer high- T_c cuprates proved by ^{63}Cu NMR International Conference on Physics and Chemistry of Molecular and Oxide Superconductors (MOS99) Kungliga Tekniska Hogskolan, Stockholm, Sweden July 31, 1999

19) 田中浩介 (東理大)、伊豫彰 (電総研、CREST)、田中康資 (電総研、CREST)、常盤和靖 (東理大、CREST)、塚本恒世 (東理大)、渡辺恒夫 (東理大、CREST)、伊原英雄 (電総研、CREST) $(\text{Cu}_{1-x}\text{Tl}_x)\text{-1223}$ の超伝導異方性のトルクによる評価 平成 11 年秋季第 60 回応用物理学学会学術講演会 神戸市 甲南大学 1999 年 9 月 2 日

20) N.A.Khan (電総研)、河村政宏 (東理大、CREST)、館合文子 (東理大、CREST)、関田吉泰 (電総研、CREST)、石田克英 (電総研、CREST)、石浦由美子 (CREST)、寺田教男 (電総研、CREST)、渡辺恒夫 (東理大、CREST)、伊原英雄 (電総研、CREST) $(\text{Cu}_{1-x}\text{Tl}_x)\text{-1234}[(\text{Cu}_{1-x}\text{Tl}_x)\text{Ba}_2\text{Ca}_3\text{Cu}_4\text{O}_y]$ 薄膜の作製と超伝導特性、同上

21) 伊豫彰 (電総研、CREST)、田中康資 (電総研、CREST)、寺田教男 (電総研、CREST)、徳本圓 (電総研、CREST)、伊原英雄 (電総研、CREST)、常盤和靖 (東理大、CREST)、渡辺恒夫 (東理大、CREST)、 $(\text{Cu}, \text{Tl})\text{Ba}_2\text{Ca}_2\text{Cu}_3\text{O}_y$ ($T_c > 130\text{K}$) の高圧合成と物性評価 日本物理学会 1999 年秋の分科会 岩手大学 1999.9.27

22) H. Ihara (ETL, CREST) Creation the Best Performance Superconductor based on $\text{Cu-1234}(\text{CuBa}_2\text{Ca}_3\text{Cu}_4\text{O}_{12-y})$ System Materials Research Society Fall meeting 99 Hines Convention Center and Boston Marriott Copley Place, Boston, Massachusetts Nov 29, 1999

23) N. Terada (ETL, CREST), K. Tanaka (SUT), Y. Tanaka (ETL, CREST), A. Iyo (ETL, CREST), K. Tokiwa (SUT, CREST), T. Watanabe (SUT, CREST), H. Ihara (ETL, CREST) Photoemission study of chemical bond nature of $(\text{Cu}, \text{Tl})\text{-1223}$ with T_c above 130K XXII International Conference On Low Temperature Physics, Espoo and Helsinki, Finland August 6, 1999

24) H. Ihara (ETL, CREST), K. Tanaka (SUT), Y. Tanaka (ETL, CREST), A. Iyo (ETL, CREST), N. Terada (ETL, CREST), M. Tokumoto (ETL, CREST), M. Ariyama (SUT, ETL), K. Ishida (ETL, CREST), I. Hase (ETL), N. Hamada (SUT, CREST), S. Miyashita (SUT), K. Tokiwa (SUT, CREST), T. Watanabe (SUT, CREST), Mechanism of T_c Enhancement in $\text{Cu}_{1-x}\text{Tl}_x\text{-1234}$ and -1223 System, 6th International Conference Materials and Mechanisms of Superconductivity and High Temperature Superconductors, George R. Brown Convention Center and Hyatt Regency Hotel-Downtown, Houston, Feb. 21, 2000

25) S. Ohshima (Yamagata Uni., CREST), Y. Takano (Yamagata Uni.), M. Mukaida (Yamagata Uni.), M. Kusunoki (Yamagata Uni., CREST), K. Ehata (Yamagata Uni.), T. Chiba (Yamagata Uni.), K. Suzuki (Yamagata Uni.), M. Inadomaru (Yamagata Uni.) Fabrication of low YBCO films and its application to patch antenna, 6th International Conference Materials and Mechanisms of Superconductivity and High Temperature Superconductors George R. Brown Convention Center and Hyatt Regency Hotel-Downtown, Houston, Texas February 24, 2000

26) H. Kamimura (SUT, CREST), T. Hamada (SUT, CREST), M. Nishimura (SUT), H. Ushio, Microscopic Origin of the Pseudogap 6th International Conference Materials and Mechanisms of Superconductivity and High Temperature Superconductors George R. Brown Convention Center and Hyatt Regency Hotel-Downtown, Houston, Feb. 21, 2000

27) 伊豫彰 (電総研、CREST)、田中康資 (電総研、CREST)、寺田教男 (鹿児島大、電総研、CREST)、石浦由美子 (CREST)、常盤和靖 (東理大、CREST)、渡辺恒夫 (東理大、CREST)、有山稔 (東理大、電総研)、徳本圓 (電総研、CREST)、伊原英雄 (電総研、CREST) $\text{TlBa}_2\text{Ca}_2\text{Cu}_3\text{O}_y$ ($T_c > 130\text{K}$) の高圧合成と物性評価 日本物理学会 2000 年春の分科会 大阪府吹田市 関西大学 2000 年 3 月 23 日

28) 有山稔 (東理大、電総研)、伊豫彰 (電総研、CREST)、田中康資 (電総研、CREST)、寺田教男 (鹿児島大、電総研、CREST)、常盤和靖 (東理大、CREST)、渡辺恒夫 (東理大、CREST)、徳本圓 (電総研、CREST)、伊

- 原英雄 (電総研、CREST) $TiBa_2Ca_2Cu_3O_y$ の T_c と超伝導体積分率のアニール効果、同上
- 29)長谷泉 (電総研)、浜田典昭 (東理大、CREST)、田中康資 (電総研、CREST)、伊原英雄 (電総研、CREST) $TiBa_2Ca_2Cu_3O_y$ のバンド構造とドーブ効果 応用物理学会 2000 年春季講演会 青山学院大学 2000 年 3 月 31 日
- 30)S.K.Agarwal (電総研)、有山稔 (東理大、電総研)、河村政宏 (東理大、CREST)、伊豫彰 (電総研、CREST)、寺田教男 (鹿児島大、電総研、CREST)、徳本圓 (電総研、CREST)、宮下至幸 (東理大)、常盤和靖 (東理大)、渡辺恒夫 (東理大、CREST)、伊原英雄 (電総研、CREST)、 $(Cu_{1-x}Ti_x)-1234[(Cu_{1-x}Ti_x)Ba_2Ca_3Cu_4O_y]$ 系の Cs 置換効果 応用物理学会 2000 年春の講演会 渋谷区 青山学院大学 2000 年 3 月 31 日
- 31)S.K.Agarwal(電総研)、有山稔(東理大、電総研)、河村政宏(東理大、CREST)、伊豫彰(電総研、CREST)、寺田教男(鹿児島大、電総研、CREST)、徳本圓(電総研、CREST)、宮下至幸(東理大)、常盤和靖(東理大)、渡辺恒夫(東理大、CREST)、伊原英雄 (電総研、CREST)、 $(Cu_{1-x}Ti_x)-1234[(Cu_{1-x}Ti_x)Ba_2Ca_3Cu_4O_y]$ 系の Cs 置換効果 同上
- 32)A. Sundaresan, K. Hayashi, Y. Sekita, Y. Ishiura, H. Ihara, On the building blocks, $Ba(Cu,Tl)O_{3-y}$ and $CaCuO_2$ for the preparation of $(Cu,Tl)Ba_2Ca_3Cu_4O_y$ superconductor thin film 同上
- 33)石浦由美子 (CREST)、田中康資 (電総研、CREST)、A. Sundaresan (CREST)、関田吉泰 (電総研、CREST)、河村政宏 (東理大、CREST)、館合文子 (東理大、CREST)、伊豫彰 (電総研、CREST)、伊原英雄 (電総研、CREST) $(Cu,Tl)BaCa_nCu_{n+1}O_y$ 関連物質中の簡便な CO_3 測定法、 同上
- 34)伊豫彰 (電総研、CREST)、田中康資 (電総研、CREST)、寺田教男 (電総研、鹿児島大、CREST)、石浦由美子 (CREST)、常盤和靖 (東理大、CREST)、渡辺恒夫 (東理大、CREST)、有山稔 (電総研、東理大)、徳本圓 (電総研、東理大、CREST)、伊原英雄 (電総研、東理大、CREST) 130K 以上の T_c を示す $TiBa_2Ca_2Cu_3O_y$ 系超伝導体の合成 2000 年春季低温工学・超伝導学会 つくば市 工業技術院筑波研究センター共用講堂 2000.5.30
- 35)H. Ihara(ETL, CREST) Possibility of the Best Performance High- T_c Superconductor based on Cu-1234 System The 8th Asia Pacific Physics Conference(APPC2000), Institute of Physics, Academia Sinica, Taipei Aug. 8, 2000
- 36)A. Sundaresan(ETL, CREST), M. Hirai(ETL, CREST), K. Hayashi(ETL, CREST), Y. Ishiura(ETL, CREST), H. Ihara(ETL, CREST), Preparation of $(Cu_{1-x}Ti_x)Ba_2Ca_3Cu_4O_y$ superrattice thin film by Self Assembling Epitaxy(SAE) method 2000 年秋季 第 61 回応用物理学会学術講演会 札幌市 北海道工業大学 2000 年 9 月
- 37)J.C.Nie(ETL, CREST), A. Sundaresan(ETL, CREST), Y. Tanaka, K. Hayashi(ETL, CREST), Y. Ishiura(ETL, CREST), H. Ihara(ETL, CREST), Preparation of $(SrCuO_2)_m/(CaCuO_2)_n$ multilayer thin film 同上
- 38)田中康資 (電総研、CREST)、伊豫彰 (電総研、CREST)、白川直樹 (電総研)、徳本圓 (電総研、CREST)、有山稔 (東理大)、池田伸一 (電総研)、伊原英雄 (電総研、CREST) $(Cu_{0.6}Co_{0.4})Ba_2Ca_3Cu_4O_y$ の比熱 同上
- 39)伊豫彰 (電総研、CREST)、田中康資 (電総研、CREST)、寺田教男 (電総研、鹿児島大、CREST)、石浦由美子 (CREST)、常盤和靖 (東理大、CREST)、渡辺恒夫 (東理大、CREST)、徳本圓 (電総研、CREST)、伊原英雄 (電総研、CREST) $TiBa_2Ca_2Cu_3O_y(T_c \geq 130K)$ の高圧合成 同上
- 40)石浦由美子 (CREST)、平井学 (電総研、東理大)、田中康資 (電総研、CREST)、伊豫彰 (電総研、CREST)、A.Sundaresan (CREST)、伊原英雄 (電総研、CREST) $(Cu_{1-x}Ti_x)-1234$ の常圧合成における炭酸放出効果 同上
- 41)河村政宏 (東理大、電総研)、藤原真吾 (東理大、電総研)、石浦由美子 (CREST)、平井学 (東理大、電総研)、田中康資 (電総研、CREST)、伊原英雄 (電総研、CREST) $(Cu_{1-x}Ti_x)Ba_2Ca_3Cu_4O_y, (Cu_{1-x}Ti_x)Ba_2Ca_2Cu_3O_y$ 薄膜作製の低温化 同上
- 42)平井学 (電総研、東理大)、A.Crisan (電総研、NIMP-Bucharest, Romania)、伊豫彰 (電総研、CREST)、田中康資 (電総研、CREST)、徳本圓 (電総研)、新井重一郎 (東理大)、伊原英雄 (電総研、CREST) $CuBa_2Ca_3Cu_4O_y$ の臨界電流密度、pinning ポテンシャル、不可逆磁場の AC 帯磁率による評価 同上
- 43)終田大司 (鹿児島大)、木上善貴 (鹿児島大)、林拓郎 (鹿児島大)、永瀬英樹 (鹿児島大)、中津隆行 (鹿児島大)、伊豫彰 (電総研、CREST)、田中康資 (電総研、CREST)、小原幸三 (鹿児島大)、伊原英雄 (電総研、CREST)、寺田教男 (鹿児島大、電総研、CREST) 光電子分光による $(Cu,C)-1223$ の電子状態・化学的結合状態の評価 同上
- 44)木上善貴 (鹿児島大)、終田大司 (鹿児島大)、永瀬英樹 (鹿児島大)、中津隆行 (鹿児島大)、林拓郎 (鹿児島大)、伊豫彰 (電総研、CREST)、田中康資 (電総研、CREST)、小原幸三 (鹿児島大)、伊原英雄 (電総研、CREST)、

- 寺田教男（鹿児島大、電総研、CREST） 常圧合成 Tl-1223 の表面処理・評価 同上
- 45) 橋本義宏（東理大）、小関隆夫（東理大）、藤原真吾（東理大）、北脇仁史（東理大）、佐川裕祐（東理大）、常盤和靖（東理大、CREST）、伊豫彰（電総研、CREST）、田中康資（電総研、CREST）、伊原英雄（電総研、CREST）、渡辺恒夫（東理大、CREST） (Cu,C)1201 薄膜の作製及びアニール効果 同上
- 46) 上村洸（東理大、CREST）、濱田剛（東理大、CREST）、潮秀樹（東京高専、CREST）
擬ギャップのマイクロな起源 日本物理学会第 55 回年次大会 新潟市 新潟大学 2000 年 9 月 24 日
- 47) N. Terada(Kagoshima Univ., ETL, CREST), A. Iyo(ETL, CREST), Y. Tanaka(ETL, CREST), K. Obara(Kagoshima Univ.) and H. Ihara(ETL, CREST), Photoemission Study of (Cu, Tl)-1223 and Tl-1223 with T_c above 130K
Applied Superconductivity Conference 2000(ASC2000), Virginia Beach, VA, USA, Sep. 18, 2000
- 48) N. Terada(Kagoshima Univ., ETL, CREST), S. Ikegawa(Toshiba Corp.), Y. Motoi(Toshiba Corp.), K. Obara(Kagoshima Univ.) and H. Ihara(ETL, CREST), Photoemission Study of Chemical bond nature of Pb-3212 Epitaxial Films
Applied Superconductivity Conference 2000(ASC2000), Virginia Beach, VA, USA, Sep. 19, 2000
- 49) 田中康資（電総研、CREST）、伊豫彰（電総研、CREST）、白川直樹（電総研）、徳本圓（電総研、CREST）、有山稔（東理大）、池田伸一（電総研）、伊原英雄（電総研、CREST） $Cu_xBa_2Ca_3Cu_4O_y$ の比熱
日本物理学会第 55 回年次大会 新潟市 新潟大学 2000 年 9 月
- 50) 鬼頭聖、伊豫彰、徳本圓、岡安悟、伊原英雄 多層型高温超伝導体(Cu, C)1245 系の中性子線照射効果 同上
- 51) A. Iyo(ETL, CREST), Y. Aizawa(ETL, CREST), Y. Tanaka(ETL, CREST), M. Tokumoto(ETL, CREST) and H. Ihara(ETL, CREST), High-Pressure Synthesis of $TlBa_2Ca_{n-1}Cu_nO_y$ ($n=3$ and 4) with $T_c=133.5K$ ($n=3$) and $127K$ ($n=4$), 13th INTERNATIONAL SYMPOSIUM ON SUPERCONDUCTIVITY, Toshi Center Hotel Tokyo, Tokyo, Oct. 16, 2000
- 52) N. Hamada(SUT, CREST) and H. Ihara(ETL, CREST), Electronic Band Structure of $CuBa_2Ca_{n-1}Cu_nO_{2n+2+x}$ ($n=3-5$), 13th INTERNATIONAL SYMPOSIUM ON SUPERCONDUCTIVITY, Toshi Center Hotel Tokyo, Tokyo, Oct. 16, 2000
- 53) Shigetoshi OHSHIMA(Yamagata Univ.), Katsufumi EHATA(Yamagata Univ.), Md. Idris ALI(Yamagata Univ.) and Katsuaki SATO(Yamagata Univ.), FABRICATING AND CHARACTERIZATION OF HTS ANTENNAS FOR SATELLITE COMMUNICATION AND SECURITY SYSTEM, 2000 Asia-Pacific microwave CONFERENCE(APMC2000), Sydney, Australia, Dec. 6, 2000
- (3) Patent applications 3files