Versatile Applications of Metal/Mixed Metal Oxides as Superconductors

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ABSTRACT:

The metal oxides / mixed metal oxides have various applications as catalyst, photocatalyst, sensors, superconductors, adsorbent, ceramics, fuels, antifungal agents and have large number of applications in medicines. These metal / mixed metal oxides play a very important role in day to day human life. Today metal oxides are attracting special attention of scientists due to their easy mode of formation and multifunctional behavior. In this article an attempt has been made to focus on their applications as Superconductors in various chemical reactions.

Keywords: Metal oxides, Mixed metal oxides, chemical reactions, Superconductors

INTRODUCTION:

The metal oxides are attracting special attention of scientists due to their easy mode of formation and multifunctional behavior. Besides these they are excellent photoactive materials and work as photosensitizer. Mixed metal oxide (MMO) electrodes are devices with useful properties for chemical electrolysis. The term refers to electrodes in which the surface contains two kinds of metal oxides- one kind usually RuO_2 and IrO_2 desired reaction such as production of chlorine gas. The other metal oxides is typically titanium dioxide which does not conduct or catalyze the reaction, but is cheaper and prevents corrosion of the interior. The interior of the electrode is typically made of titanium. The amount of precious metal (that is other than titanium) can be around 10 to 12 grams per square meter.

Applications include electrolytic cells for producing free chlorine from salt water in swimming pools and cathodic protection of buried submerged structures. The first requirement of any novel study of nanoparticulated oxides is the synthesis of the material. The development of systematic studies for the synthesis of oxide nanoparticles is a current challenge and, essentially, the corresponding preparation methods may be grouped in two main streams based upon the liquid-solid [1] and gas solid [2] nature of the transformations. Liquid-solid transformations are possibly the most broadly used in order to control morphological characteristics with certain "chemical" versatility and usually follow a "bottom-up" approach.

Superconductors:

Metal / Mixed metal oxides have wide application as Superconductors some of them are described here.Masahide Takahama *et al.*[3] synthesized filamentary Y123 superconductors by solution spinning and partial – melt process. The fiber axis of the filament is normal to the c-axis of the orthorhombic phase. For the direction to the fiber diameter, the J_C value of the sample with random orientation was higher than that the sample with c-axis orientation texture. The sample with random orientation has J of 104A/cm^2 at 77K and O T. Although the J_C value (103/Acm^2 at 4 T) of the sample slightly decreased with the applied field, the J_c value of than 102/A cm^2 was maintained at 10T. P. Manasiev *et al.* [4] used chemical methods of synthesis of materials play a crucial role in the design and discovery of new material's, and also provide better and less cumbersome methods for preparing known materials. The reaction mechanisms of transition metal salts and their mixtures in molten nitrates are given. Then, the preparation of dispersed simple oxides, multicomponent system, layered intercalation hosts and supported catalysts are described. Several examples of this molten salt synthesis approach are given with the described. Several examples of this molten salt synthesis approach are given with the objective of optimizing textural properties for catalytic applications. Management of the reaction can be obtained by modifications of the molten bath by using some dopant such as a nitrite or a carbonate. Josef Novak *et al.* [5] followed this method is based on the oxidation of a known amount of iron (II) ions with oxide superconductors YBaCuO and BiSrCaCuO in a 2-5 mol^{-1} solution of hydrobromic acid. This procedure allows the dissolution of samples even at elevated temperature. The reliability interval is 5%. R. Retoux *et al.* [6] prepared a new bismuth iron oxide, isostructural with the 2233 superconductor. The electron diffraction study showed the existence of satellites, similar to those observed in the superconducting bismuth curates. A preliminary Mossbauer study was performed.Hideo Hosono et al. [7] discovered two new classes of superconductors in the course of materials exploration for electronic active oxides. One is 12CaO. 7Al2O3 crystal in which electrons accordance in the crystallographic sub-nanometer sized cavities. The other is iron oxypnictides with a layered structure. The high Tc is emerged by doping carriers to the metallic parent phases which undergo crystallographic transition (tetra to ortho) and Pauli para to antiferromagnetic transition at 150K. C. De. Boeck et al. [8] discovered that oxygen deficiency in the iron based – HTSC GdFeAsO seems to create a parallelogram shaped Fe2+ ion/oxygen deficiency pattern in the Fe2O2 plane in c- direction. The doping distance in direction of the super-current shows a strong correlation to the transition temperature. Nohara et al. [9] developed an overview of the crystal structures and physical properties of the recently discovered iron-platinum – arsenide superconductors Ca10(PtnAs8)(Fe 2-x Pt xAs2)5 (n=3 and 4), which have a superconducting transition temperature up to 38 K, is provided. The upper critical field Hc2, hydrostatic pressure dependence of superconducting transition temperature Tc and normal-state magnetic susceptibility are reported. Masahito Yoshizawa et al. [10] investigated the elastic properties of the iron – based superconductor Ba(Fe 1-xCo x)2As2 with various Co concentrations. The elastic constant shows remarkable anomalies associated with the structural phase transition and the superconducting transition. These results shows the strong electron – lattice coupling in this system, and support the prevailing scenario on the relevant role of structural fluctuation coupling to orbital's to understand a whole picture of iron- based superconductor. Shein et al. [11] found that the atomic models of nanotubes for layered FeSe, LiFeAs, SrFe2As2, and LnFeAsO- the parent phases of so – called 11, 111, 122 and 1111 groups of newly discovered family of iron-based high temperature superconductors are proposed. Shirage et al. [12] reported we have utilized a high-pressure (HP) technique to synthesize a series of newly – discovered iron (nickel) – based superconductors. For the LnFeAsO-based superconductors (Ln=lanthanide), we show that the introduction of oxygen (O)- deficiency in the LnO layers, which is achievable only through HP process, The effect of O-deficiency, variation of Ln ions, and the external pressure on T are examine. Upper critical field measurement on single crystalline sample of PrFeAsO 1-y shows the superconducting antistrophe of 5, which is smaller than cuprates.Gomez et al. [13] examined the substitution of a small fraction of Cu atoms by Fe atoms in the copper oxide superconductors has proven to be useful in sensing, with Mossbauer spectroscopy the local surroundings of the Cu sites of their structures. In this work we report the results of such substitution in the Nd 1.85Co 0.15Cu2O 4-s system. Whangbo et al.[14] reviews examination of superconducting temperature Tc and the in plane Cu-O bond lengths of the TI-and Bi – based copper – oxide superconductors reveals the Tc vs. characteristics similar to those found for La 2-xSrxCuO4. The tc vs. correlations are grouped into three major classes according to the size of the cations occupying the 9-coordination sites. The observations and their implications are examined in terms of the overlap populations of the in-plane Cu-O bonds calculated as a function of the number of electrons in the x2-y2 bands of the CuO2 layers.Ihara et al. [15] worked empirical rules on high-Tc superconductors with cubic lattice structure . High entropy state of lattice, high degeneracy of energy levels and high possibility of electronic and lattice instability are key factors for cubic superconductors with high Tc. The basis of the rules, some cubic-structured copper-oxides with inversion symmetry were proposed as high Tc superconductors. Bushida et al.[16] produced the new cubic Cu6O8MX compounds (M= In, Sc, Cu, Y and Pb, and X=NO3 and CI) for High-Tc superconductors. They have high structure symmetry (Fm3m) and CuO4 clusters as structural units which play an important role to the mechanisms of superconductivity. Ohta and coworkers [17] utilized a clear correlation between superconducting transition temperature, Tc, and the energy level of apical oxygen relative to that of the CuO2 plane, VA, is found to exist throughout all the known hole-doped superconductors. Pressure dependence of Tc is explained in terms of this Tc-VA correlation. Crabtree et al. [18] characterized resistive and magnetic measurements of the superconducting transition in good quality single crystals of YBa2Cu3O7-s and La2-xSrxCuO4 and in good polycrystalline samples of Ba1-xKxBiO3 used to derive the temperature dependence and anisotropy of the upper critical field. The definition of Tc from resistance curves and the origin of the upward curvature in the upper critical field are discussed.Manthiram et al. [19] evaluated thallium curates chemically characterized by adopting simple wet-chemical procedures for the determination of Tl and oxygen contents. The oxidation of the CuO2 sheets in the Tl2-yBa2Can-1CunO2n+4-x family is primarily due to (i) an overlap of the Tl-6s band with the conduction bond of the CuO2 sheets for smaller y=0.0 and (ii) Tl vacancies for larger y=0.5. Thallium cup rates have an oxygen deficiency in the Tl2O2 layers unlike the analogous bismuth curates, which have excess oxygen in the Bi2O2+x layer. The origin of the orthorhombicity, which appears after low-temperature. Marashima and coworkers [20] checked the effect of Zn substitution in La-Sr-Cu-O and Y-Ba-Cu-O systems systematically studied. Close similarities in their behavior suggest that the mechanism of superconductivity for the two systems is unlikely to be different.Beales et al. [21] analyzed a new series of layered copper oxides with the elements lead and cadmium in the rock – salt dopant layer is reported. Materials with the nominal composition (Pb0.5Cd0.5) (Sr1+xLa1-xCuO5 from as the (Pb, Cd)-1201 phase when x=0 and are superconducting with a maximum Tc of 40 K as measured by the onset of diamagnetism. These data and additional measurements on the previously reported (Pb, Cd)-1212 phase demonstrate the improved properties arising from the lead and cadmium mixture in comparison to either lead and zinc or lead and copper mixtures in the rock-salt dopant layer for samples with the same stoichiometry prepared under the same condition. Kuhberger and Gritzner [22] discussed the influence of Zn doping on the physical and electrical properties of the TI-1223 phase has been investigated for samples with the composition (TI0.5Pb0.5) (Sr0.9Ba0.1)2 Ca2 (Cu1-xZnx) 3 O8+s (x=0, 0.01, 0.05 and0.1) Sr. –Ba-Ca-Cu-Zn containing precursor materials were prepared the addition of Zn increased the content of the Tl-1212 phase, changed the microstructure, decreased the transition temperature slightly and reduced the critical current density at 77K.Li et al. [23] studied zinc oxide powder prepared by decomposition of zinc peroxide and zinc nitrate show evidence of acceptor states from iodometric titrations. Chemical analysis also shows the presence of nitrogen in the samples by nitrate decomposition.As zinc oxide particles become small there is an increase in unit cell dimensions and a red shift of the absorption edge. Ozawa et al. [24] synthesized for chemical vapor deposition, in which vapors or metallic organic compounds are introduced and decomposed over a substrate to form thin films, data on the volatility of the compounds are of essential importance as basic data. Thermal analysis is a useful tool for observing volatility . Nawazish A-Khan and M.Rahim et al. [25] used cadmium doped Cu0.5 Tl0.5 Ba2Ca3Cu4-y cd y0 12-s (y=0, 0.25, 0.5, 0.75, 1.0) samples have been synthesized and their superconducting properties are studied using X-ray diffraction (XRD), resistively, ac-susceptibility and Fourier Transform Infrared (FTIR) absorption measurements. The FTIR absorption measurements of these samples have shown hardening of apical oxygen modes of type. Jacek Kasperczyk et al.[26] followed unusual properties of high temperature superconductors of the YBa2CU3O7-y type and its modifications are not to understand within the standard phonon-mediated mechanisms. Crystal field effects are also discussed in connection with substitutions of copper with other transition metals. Boeck et al.[27] showed samples with Bi2-0.5 Sr1.9Ca1.05 (Cu1-x Fex)2 O8+ ($0\leq x \leq 0.15$) compositions were synthesized by a liquid mix process able to give single phase compounds. The EDX results are more consistent with a Bi2Sr2CuO6- Bi2Sr2CaCu2O8 intergrowth metal in which Fe is accommodated in the Bi2Sr2CuO6 microdomains than with the model of substitution in a Bi2Sr2CaCu2O8 single phase.Jirsa et al. [28] was carried out pinning homogeneity and the content fluctuation of light rare earth ions in a (Nd0.33Eu0.38Gd0.28)Ba2Cu3Oy melt textured (MT) pellet 16 mm in diameter, doped by 0.035 mol% ZnO. The strip-like structure observed on the crystal surface was evidently of another origin than the lamellar substructure in the MT samples and did not significantly contribute to vortex pinning. The secondary peak in Jc(B) of the single crystal was quite strong, showing a well-set point-like disorder. Tiginyanu et al. [29] focused on the description of nanostructured metal oxides representing the most common, diverse and richest class of materials in terms of electronic structure and structural, chemical, and physical properties. These nanomaterials with controlled composition surface terminations, and crystalline structures are important for future applications in novel devices. Santoro et al. [30] discovered the layered structures of the known superconducting copper oxides described in terms of alternating slices having the rock salt and perovskite structure. Each slice is made up of a number of layers and each layer can be represented by specifying its chemical composition and its atomic configuration. This layer by layer representation of the crystal structures of oxide superconductors offers a convenient method for classifying and comparing to one another these important materials, and for predicting new compounds which may exhibit interesting electronic properties. Shirage et al. [31] developed a high pressure (HP) technique to synthesize a series of newly-discovered iron (nickel)- based superconductors. For the LnFeAsO-based superconductors (Ln = lanthanide). The effect of O-deficiency, variation of Ln ions, and the external pressure on Tc are examined. Upper critical field measurement on single crystalline sample of PrFeAsO1− y shows the superconducting anisotropy of 5. Shein and coworkers [32] Investigated based on first principle FLAPW-GGA calculations, we have investigated structural and electronic properties of the recently synthesized tetragonal (space group P4/nm.) nickel – based pnictide oxide superconductors 3.3k (Ni2P2) (Sr4Sc2O6) and 2.7k (Ni2As2) (Sr4Sc2O6). Optimized structural data, electronic bands, total the partial densities of states, and Fermi surface topology have been obtained and discussed. Hsu and Gokcen [33] found that the superconductivity transition temperature Tc of Bi2Sr2CaCu2O8 (designated as 2212) decreased from 90 to 75 K at 4000C under 176 bar of oxygen pressure, P (O2). Above 5000C, this cup rate dissociated to 2201 and other non-superconducting oxides. The standard Gibbs change for the dissolution of oxygen pas determined as G0 (J/mol of O)= 86,500-67.5 T (in K) and compared with G0 for other types of cup rate superconductors in pitch Tc increases pith P (O2) .Doverspike *et al.* [34] reported the 1:2:4 yttrium barium copper oxide superconductor prepared and sintered to high density by high pressure techniques. This material is phase pure and shows a sharp transition temperature of 80 K. High temperature X-ray powder diffraction of the 1:2:4 material shows a small anisotropy in thermal expansion. The result in less microcracking in polycrystalline materials due to thermal expansion anisotropy in devices based on 1:2:4. Watanabe *et al.* [35] examined riveted analysis of the powder X-ray diffraction of a new layered oxyarsenide, LaNiOAs, which was synthesized by solid-state reactions, revealed that LaNiOAs which was synthesized by solid – state reactions, revealed is compared of alternating stacks of La-O and Ni-As layers. The diamagnetic susceptibility measured at 1.8K corresponded to 20% of perfect diamagnetic susceptibility, substantiating that LaNiOAs is a bulk superconductor.Gyuov *et al.* [36] reviewed a small calcium – substituted $YBa_2Cu_4O_8$ (1-2-4) high temperature superconductor synthesized from a precursor obtained by spray-drying of a nitrate solution containing the corresponding metals in a stoichiometric ratio. The transition in Ca-substituted $YBa_2Cu_4O_8$ occurs at a temperature by about 8 K higher than Tc of the Ca-free phase. Raman spectra suggest that during the substitution calcium does not occupy barium positions in the $YBa_2Cu_4O_8$ lattice. Shoji Ishibashi *et al.* [37] worked position lifetime spectra were measured on YBa_2 $(Cu_{1-x}$ $M_x)_3$ O_{7-y} (M=-Fe, Ni) as a function of temperature between 20K and room temperature. The positron lifetime and its thermal behavior strongly depend on the iron concentration while are less affected with the nickel substitution. J.W. Lynn *et al.* [38] produced a brief review on both the rare earth and Cu magnetism in the $Ba_2Cu_3O_{6+x}$, $Ba_2Cu_4O_8$, $(La\text{-}Sr)_2$ CuO_4 and $(Nd\text{-}Ce)_2$ CuO_4 systems. The Cu magnetism is dominated by the strong in plane exchange interactions. The rare earth ions, on the other hand, order at low temperatures irrespective of the presence or absence of superconductivity.

Eickemeyer and coworkers [39] utilized cube textured substrate tapes were prepared by cold forming and annealing from nickel and microlayer nickel in order to manufacture long flexible superconductors of the YBCO ($YBa_2Cu_3O_{7-}$) type. Perrin *et al.* [40] characterized a systematic study of the influence of annealing under various atmosphere (vacuum, nitrogen, oxygen and NF_3), on the superconducting properties of the Bi_1, Sr_1, Ca_1 Cu_2 O_x compositions has been performed. The 110 K T_c onset progressively decreases to about 90 K as a function of annealing time and/or temperature when the samples are treated under vacuum or under nitrogen gas and increases again after further thermal treatments under oxygen even at a temperature as a low as 100^0C, reaching 110 K when annealed at 250-300^0C. In contrast, the 85 K transition is slightly modified under the same conditions. Erdogan *et al.* [41] evaluated the present paper reports on a systematic study of the influence of Zn alloying on the structural and optical characteristics of CuZnO thin films. Nanocrystalline CuZnO thin films were prepared on p-type Si (1 0 0) substrates by spin coating from a CuO solution mixed with Zn of 0.8.0 at %. When the Zn doping concentration was above 4.0 at % the crystalline quality and preferential orientation of the thin film weakened in turn. The XRD and FT-IR results showed single phase CuZnO for the lower (at % $\leq$ 6.0) Zn Concentration. The works showed that the structural and optical properties of CuO films doped with Zn can be improved and the 4.0 at % Zn-doped CuO thin films have the best crystallization quality and the strongest emission ability. Giedri Nenartaviciene *et al.* [42] checked superconducting YBa_2 $(CU_{1-x}Cr_x)_4O_8$ (x=0.01; 0.03; 0.05; 0.01; 0.20) oxides synthesized by the aqueous sol-gel method. Effects of chromium substitutions on the properties of compounds were studied by resistively measurements, X-ray powder diffraction, infrared spectroscopy, electron microscopy and elemental analysis. The point defect chemistry approach, which explains the change of T_c by substituting chromium for copper in the$YBa_2Cu_4O_8$ superconductor, is presented. Sagsoz *et al.* [43] analyzed in the study, diffusion mechanism of iron impurities in bulk $YBa_2Cu_3O_7$ (YBaCuO) superconductor prepared by standard solid state reaction method and its effect on lattice structure under different magnetic field have been examined. The effects of different magnetic field intensities on crystal structure of iron diffused samples have been investigated by quantitative Energy Dispersive X-Ray Fluorescence (EDXRF) and X-Ray Diffraction (XRD) techniques. Katase *et al.* [44] discussed the epitaxial growth of Fe-based superconductors such as CO-doped $SrFe_2As_2$ ($SrFe_2As_2$: Co) was reported recently but has still insufficient properties for a device application because they have rough surfaces and are decomposed by reactions with water vapor in an ambient atmosphere. These films also have atomically – flat surfaces with step-and – terrace structures and exhibit chemical stability against exposure to water vapor.

Hamada *et al.* [45] found that the pressure of superconducting transition temperature (T_c) $FeSr_2YCu_2O_8$ samples were synthesized by solid-state reaction with multiple annealing process. Ekino *et al.* [46] synthesized tunnel break junction method adopted to study polycrystalline samples of iron oxypnictide superconductor NdFeAs ($O_{0.9}$ $F_{0.1}$) with T_c=48K. Measurements were carried out at 4.2K. Break –junction (BJ) conductance versus voltage curves showed gap-edge peaks with the peak to peak distances at 4.2 K where the superconducting energy gap e>0 is the elementary change. This ratio implies strong – coupling superconductivity in the framework of Bardeen- Copper – Schrieffer theory, being, however, much, smaller than that for high T_c copper oxides. Raj *et al.* [47] used the chemical reactivity between superconducting ceramic materials ($YBa_2Cu_3O_{7-x}$, $Bi_2Sr_2CaCu_2O_{8+x}$ and Bi_2SrCuO_{6+x}) and the cathode material of solid oxide fuel cells ($La_{0.65}Sr_{0.3}MnO_3$) was investigated by long-term annealing experiments of pressed powder mixtures lasting two weeks at 850^0C. The formation of undesirable products, especially $SrCrO_4$, due to diffusion processes across the interface was confirmed by investigations of metallographic cross-sections. Janaki and coworkers [48] followed tetragonal iron selenide and telluride superconductors through solid state reaction at 450^0C and 550^0C, respectively. These synthesis temperatures have been established by optimization. The partial substitution of Se by Te leads to an enhancement of Tc to 13K. The non-superconducting telluride F $e_{1.09}$Te exhibits a metal-insulator phase transition at 82K. Substitution studies of this telluride systems by S and Si have in addition been carried out to investigate if chemical pressure induces superconductivity. Ren *et al.* [49] reported detailed measurements of the temperature dependence of the lower critical field H_{c1} of the FeAs – based superconductor $SmFeAsO_{0.9}F_{0.1}$ (Sm-1111) and$Ba_{0.6}$ $K_{0.4}Fe_2As_2$ (Bak-122) by global and local magnetization measurements. Excellent fitting to the data can be reached with two s-wave superconducting gaps. Comparison of the absolute values of $H_{c1}(0)$ between Sm-1111 and Bak-122 shows a relatively large superfluid density for the latter. Jiao *et al.* [50] showed the upper critical fields (H_{c2}) of the single crystals (Sr, Na) Fe_2As_2 and $Ba_{0.55}K_{0.45}Fe_2As_2$ determined by means of measuring the electrical resistivity, using the facilities of pulsed magnetic field at Los Alamos such a difference mainly results from the multi-band effect, which might be modified via doping. Mukuda *et al.* [51] carried out novel superconducting characteristics and unusual normal state properties in iron based prictide superconductors by mean of studies in $REFeAsO_{1-y}$ (RE=La, Pr, Nd) and $Ba_{0.6}$ $K_{0.4}$ 57_{Fe} NMR and 75_{AsN} NQR/NMR. Fe_2As_2 [52]. Katsuyamaet *et al.* [53] discovered the magnetic hysteresis loops of YBa_2Cu_3Oy, $Ln_{1+x}Ba_{2-x}Cu_3Oy$ (Ln=Sm, Nd) and $YBa_2(Cu_{1-x}Fex)3$ O_y systems measured by a superconducting quantum interference device (SQUID), magnetometer, and the relationship between the microscopic structure and effectiveness of pinning centers for the flux lines.

CONCLUSION:

Above mentioned literature shows wide applications of metal /mixed metal oxides as Superconductor in various reactions like tetragonal iron selenide and telluride superconductors through solid state reaction at 450^0C and 550^0C, respectively. These synthesis temperatures have been established by optimization. The partial substitution of Se by Te leads to an enhancement of Tc to 13K. The non-superconducting telluride $Fe_{1.09}Te$ exhibits a metal-insulator phase transition at 82K. Substitution studies of this telluride systems by S and Si have in addition been carried out to investigate if chemical pressure induces superconductivity. So, metal/mixed metal oxides have broad applications as superconductor in various chemical reactions.

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