Versatile Applications of Metal/Mixed Metal Oxides as Ceramics

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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 ceramics in various chemical reactions.

Keywords: Metal oxides, Mixed metal oxides, ceramics, chemical reactions, Sensors

INTRODUCTION:

In technological applications, metal oxides are used in the fabrication of microelectronic circuits, sensors, piezoelectric devices, fuel cells, coatings for the passivation of surfaces against corrosion, and as catalysts. In the emerging field of nanotechnology, a goal is to make nanostructures or Nano arrays with special properties with respect to those of bulk or single practice species [1-5]. Oxide nanoparticles can exhibit unique physical and chemical properties due to their limited size and a high density of corner of edge surface sites. Particle size is expected to influence three important groups of basic properties in any 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 and gas solid 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. A number of specific methods have been developed among which those broadly in use are:

1) Co-precipitation methods:

   This involves dissolving a salt precursor (chloride, nitrate, etc.) in water (or other solvent) to precipitate the oxo-hydroxide form with the help of a base. Very often, control of size and chemical homogeneity in the case of mixed-metal oxides are difficult to achieve. However, the use of surfactants, nonchemical methods, and high-gravity reactive precipitation appear as novel and viable alternatives to optimize the resulting solid morphological characteristics

2) Sol-gel processing:

   The method prepares metal oxides via hydrolysis of precursors, usually alkoxides in alcoholic solution, resulting in the corresponding oxo-hydroxide. Condensation of molecules by giving off water leads to the formation of a network of the metal hydroxide; Hydroxyl-species undergo polymerization by condensation and form a dense porous gel. Appropriate drying and calcinations lead to ultrafine porous oxides

3) Microemulsion technique:

   Microemulsion or direct/ inverse micelles represent an approach based on the formation of micro Nano-reaction vessels under a ternary mixture containing water, a surfactant and oil. Metal precursors on water will proceed precipitation as oxo-hydroxides within the aqueous droplets, typically leading to monodispersed materials with size limited by the surfactant- hydroxide contact.

4) Solvothermal methods:

   In this case, metal complexes are decomposed thermally either by boiling in an inert atmosphere or using an autoclave with the help of pressure. A suitable surfactant agent is usually added to the reaction media to control particle size growth and limit agglomeration.

5) Template / Surface derivatized methods:

   Template techniques are common to some of the previous mentioned methods and use two types of tools; soft-templates (surfactants) and hard-templates (porous solids as carbon or silica). Template and surface mediated nanoparticles precursors have been used to synthesize self-assembly system. Gas-solid transformation methods with broad use in the context of ultrafine oxide powder synthesis are restricted to chemical vapor deposition (CVD) and pulsed laser deposition (PLD)

Ceramics:

Metal / Mixed metal oxides have wide application as Ceramics some of them are described here. Hamid *et al.* [6] synthesized Copper – Cobalt heterobimetallic ceramic oxide this film deposition. Thin films of halide free Cu–Co mixed metal oxide have been prepared at 390 °C from the heterobimetallic complex $Co_4(THF)_4(TFA)_8(\mu\text{-}OH)_2Cu_2(dmae)_2 \cdot 0.5C_7H_8$ (**1**) [dmae = *N*,*N*-dimethylaminoethanol $((CH_3)_2NCH_2CH_2O^-)$, TFA = triflouroacetate (CF_3COO^-), THF = tetrahydrofurane (C_4H_8O)] which was prepared by the reaction of $[Cu(dmae)Cl]_4$ and $Co(TFA)_2 \cdot 4H_2O$. Pasaribu *et al.* [7] used friction reduction by adding copper oxide into alumina and zirconia ceramics. The friction and wear of alumina and zirconia ceramics doped with various weight percentages (0.5, 1 and 5 wt.%) of CuO was studied. Dry sliding tests by using a pin-on-disc tribometer were conducted on these materials against commercially available Al_2O_3, ZrO_2, SiC, and Si_3N_4 ceramic balls. The coefficient of friction of CuO doped in alumina sliding against Al_2O_3 balls reduces from 0.7 to 0.4 and hardly depends on the normal load and the velocity. These smooth patchy layers, which carry the normal load, are responsible in reducing the coefficient of friction.Whatmore *et al.* [8] prepared High Tc Yttrium barium copper oxide ceramics and thin films. Yttrium barium copper oxide ceramics with transition temperatures of up to 98K and small transition widths have been produced by conventional mixed oxide and solution routes. The compositions of these films are discussed as a function of sputtering conditions. Low temperature sintering and microwave dielectric properties of 0.5 LaAlO3-0.5 SrTiO3 ceramics using copper oxide additions [9]. The microwave dielectric properties and the microstructures of $0.5LaAlO_3$–$0.5SrTiO_3$ ceramics with CuO addition prepared with conventional solid-state route have been investigated. The dielectric constant as well as the $Q\times f$ value decreases with increasing CuO content. At 1460 °C, $0.5LaAlO_3$–$0.5SrTiO_3$ceramics with 0.25 wt.% CuO addition possess a dielectric constant (ε_r) of 35.2, a $Q\times f$ value of 24 000 (at 8 GHz) and a temperature coefficient of resonant frequency (τ_f) of −13.5 ppm/°C.Ebru Mensur Alkoy and Melih Papila [10] showed Microstructural features and electrical properties of copper oxide added potassium sodium niobate ceramics efects of 0.5, 1.0 and 1.5 mole% CuO addition on the properties of potassium sodium niobate (K0.5Na0.5) NbO3-KNN ceramics were investigated. Pure KNN and CuO added KNN pellet samples were sintered at 1100 and 1090^0C for 4th, respectively. Curie temperature has shifted from 480 to 435^0C with increasing CuO ratio. Shahid *et al.* [11] was carried out copper cobalt oxide ceramic thin films from single source precursors two heterobimetallic coordination complexes $[Co(acac)\ Cu_2\ (bdmap)_2\ Cl_3].C_7H_8$ (1) and $[Co(acac)Cu_2(bdmap)_2$ have been synthesized by simple chemical technique and characterized by their melting points. The scanning electron microscopy of copper – cobalt oxide films grown from both the precursors describe highly compact and smooth morphology with homogenously dispersed spherical particles with excellent adhesion properties to the substrates. Huang *et al.* [12] studied dielectric properties of Copper oxide doped 0.95 Ba(Zn1/3 Ta2/3)- 0.05 BaZa03 ceramics at microwave frequency. The microwave dielectric properties of conventional solid state route prepared 0.95Ba $(Zn_{1/3}Ta_{2/3})O_3$-$0.05BaZrO_3$ ceramics with CuO addition have been investigated. Ordering structure was not observed at sintering temperatures 1280-1430^0C. Copper oxide, as a sintering aid, was found to effectively lower the sintering temperature of 0.95 Ba $(Zn_{1/3}Ta_{2/3})O_3$-0.0_5BaZrO_3 ceramics. For application of high selective microwave ceramic resonator and filter, 0.95Ba $(Zn_{1/3}Ta_{2/3})O_3$-0.0_5BaZrO_3 is proposed as a suitable material candidate. Pasaribu *et al.* [13] discovered Environmental effects on friction and wear of dry sliding zirconia and alumina ceramics doped with copper oxide. The influence of the addition of copper oxide on the friction and wear characteristics of dry sliding zirconia and alumina at various humidity's and elevated temperatures is outlined in this article. At various humidity's, it is found that the addition of CuO give a significant contribution in reducing the coefficient of friction of dry sliding zirconia against alumina. Hodkin [14] developed the wetting of irradiated ceramics by liquid metals has been examined to provide guidance about the possible differences between the surface energy, SV of used and unused uranium dioxide fuel. The invariant contact angles measured for copper drops at 1100^0C in argon, resting on UO_2 fuel samples with burn-up levels of up to 1.2% suggests that little change in SV had occurred during irradiation 10. We present measurement of pool boiling heat transfer from ceramic $Y_1Ba_2Cu_3O_{7-6}$ shows a double hysteric closely related to the porosity of the samples. Ezhilvalanvan *et al.* [15] found that effect of antimony oxide stoichiometry on the nonlinearity of zinc oxide var star ceramics. The effect of antimony oxide at higher concentration (>2 mol%) and variable valence states of Sb on the nonlinearity of ZnO varistor ceramics has been investigated. Simplified compositions containing $92.5ZnO+3Bi_2O_3+ 2.5Co_3O_4+ 2Sb_2O_5$ (mol%) show nonlinearity coefficient (α) upto 65. Ceramic formulations derived from Sb_2O_5 bring about higher α than those with Sb_2O_3 or Sb_2O_4, provided the concentration of Sb_2O_5 is ≥ 2 mol. The method of formulation of the ceramics by way of higher oxygen content of the additives is critical in attaining high nonlinearity. This can be explained on the basis of formation of the depletion layer at the profiteering stage itself, because of the surface states arising out of the chemisorbed oxygen form the incipient liquid phase. Bachili *et al.* [16] reported rare-earth doped poly crystalline zinc oxide electroluminescent ceramics. Trivalent rare earth ions (Eu^{3+}, Tm^{3+}, Er^{3+}) doped zinc oxide ceramics have been prepared. They were found to he luminescent when submitted to electric fields and the luminescence spectra are those of the trivalent rare earth ions. Compared to Varistors which have the same structure (a polycrystalline semi conducting zinc oxide pellet sandwiched between two metallic solders). The variation of the luminescence intensity with the applied voltage allows an estimation of the size of the zinc oxide grains which has been compared to that measured from the scanning electron micrographs. lvanchenko *et al.* [17] examined desorption thermal degradation model of zinc oxide ceramics. The desorption degradation model of nonlinear zinc oxide ceramics with intercrystallite potential barriers is developed. It allows to connect the decreasing of surface electronic states concentration with desorption of oxygen at heating up of the grain boundary by electrical current in process of degradation. Masai *et al.* [18] reviewed precipitation of ZnO in Al_2O_3 – doped zinc borate glass ceramics. Crystallization behavior of the oxide semiconductor ZnO in zinc borate glass was investigated. The precipitated crystalline phase of glass ceramics containing a small amount of Al_2O_3 was α-$Zn_3B_2O_6$ whereas that of the glass ceramics containing a large amount of was ZnO. The present results suggest that crystallization of ZnO from multi component glass is dominated by the local coordination state of the mother glass. Sharma *et al.* [19] worked on preparation and study of magnetic properties of Silico phosphate glass and glass – ceramics having iron and zinc oxide. The magnetic properties of $25SiO_2$-$50CaO$-$15P_2O_5$-$(10-x)$ Fe_2O_3-$xZnO$ (where x=0, 2, 5 mol%) glass and glass – ceramics have been studied. The glasses are prepared by melt quench technique and heat treated at 800^0C for 6h. Electron Spectroscopy for Chemical Analysis (ESCA) revealed that the fraction of non-bridging oxygen decreases with the increase in zinc oxide content. Effect of controlled heat treatment on magnetic properties was studied by means of a Superconducting Quantum Interference Device (SQUID) magnetometer. Mossbauer Spectroscopy at room temperature was also carried out to determine the state of iron ions in glasses and glass-ceramics. Isomer shift values of the glasses suggest that Fe^{3+} and Fe^{2+} are in tetrahedral coordination. Hirota *et al.* [20] produced Preparation of zinc oxide ceramics with a sustainable antibacterial activity under dark conditions. Fabrication of ZnO ceramics with a sustainable antibacterial activity even in the dark has been conducted. Fine ZnO powders were hydrothermally treated in 0.5-3 mol ml^{-1} $Zn(NO_3)_2$ aqueous solutions at 110-180^0C for 3-20h. After an uniaxial pressing of the ZnO powders thus prepared, they were sintered at 400-600^0C for 1 h in air. ESR and chemical photoluminescence analyses have cleared that radical oxygen of super oxide (O_2) originated from the surface of ZnO might exhibit an antibacterial activity even under the dark condition. C.W. Nahm [21] utilized Microstructure and electrical properties of T_6-doped zinc oxide-based ceramics. The microstructure and electrical properties of Zn-Pr-Co-Cr-Tb oxide-based ceramics were investigated for different Tb_4O_7 amounts. The increase of Tb_4O_7 amount led to more densified ceramics, increasing from 5.73 to 5.85 g/cm^3 in sintered density. Miel Carek et.al. [22] find out $BaBiO_{2.77}$ as a promoter of the varistor property in zinc oxide ceramics. Metal oxide varistors typically are made by bulk ceramic technology. The homogeneity of ceramics and the grain interface profile are of primary concern in varistor design and processing. The nonohmic property in the ZnO varistor is attributed to the Bi enrichment at ZnO grain boundaries and Bi-rich intergranular layer. The Bi phase distribution in the ceramics is homogenous. Also, the volume of not contributing with break-down voltage intergranular phase is restrained. Kutty and Ezhilvalavan Characterized [23] zinc oxide ceramic varistors formulated with barium orthosilicate for operation in the 3-15 V battery range. Varistors working in the 3-15 V battery voltage range can be obtained from ZnO ceramics formulated with Ba_2SiO_4 as the extra additive. The presence of a large surface state density and a changing pattern of trap states at the grain boundary interfaces are more significant than large grain size in attaining lower breakdown voltages. Demidenko *et al.* [24] evaluated Scintillation properties of ceramics based on zinc oxide. Ceramic tight- ultrafiltration (UF) membranes were coated with iron oxide layers to investigate the removals of phenol and/or natural organic matter (NOM) from waters. The effects of iron oxide coating on NOM rejections were dependent on NOM characteristics in waters aluminum oxide or iron oxide surfaces of the ceramic membranes were not affected by each other. Compared with the uncoated membrane, membrane coating did not change membrane permeability. Coating iron oxides were stable and iron leaking was not observed. Coating tight UF ceramic membranes with iron oxide layers may improve NOM rejections. Sabbatini *et al*. [25] analyzed fabrication and characterization of iron oxide ceramic membranes for arsenic removal. Nanoscale iron oxide particles were synthesized and deposited on porous alumina tubes to develop tubular ceramic absorbers for the removal of arsenic, which is an extremely toxic contaminant even in very low concentrations. Its natural presence affects rural and low-income populations in developing countries in Latin America and around the world Arsenic concentrations were determined by inductively coupled plasma – optical emission spectroscopy (ICP-OES). Due to its low cost and simple operation the system can be applied as a point of use device for the treatment or arsenic contaminated ground waters in developing countries. Shama and Dixit discussed [26] a comparison of dry and air-cooled turning of grey cast iron with mixed oxide ceramic tool. They compare the performance of a mixed oxide ceramic tool in dry and air cooled turning of grey cast iron. First, the study was done in the range of process parameters where dry turning provided satisfactory performance. The contours of surface roughness and tool life were generated with the help of trained neural networks. It was observed that air-cooling significantly reduces the tool wear at high cutting speed. At higher cutting speeds, where the dry turning performs very poorly, the air-cooled turning provides an improved surface finish also apart from the reduction in tool wear. Zaspalis *et al.* [27] synthesized Arsenic removal from contaminated water by iron- oxide sorbents and porous ceramic membranes. An adsorption – filtration process using porous ceramic membranes is proposed for the purification of water from arsenic As (V) ions. Iron oxide in Nano particle and micro particle form is used as adsorbent in combination with ultrafiltration and micro filtration asymmetric multilayer ceramic membranes, respectively. The subsequent ultra-filtration process shows complete Nano particle rejection producing therefore purified water with arsenic content lower than. Bantsis *et al.* [28] used synthesis of porous iron oxide ceramics using Greek wooden templates and mill scale waste for EMI applications. The scope of this study is the synthesis of low cost iron oxide ceramics with the porous structure for light weight Electromagnetic interference (EMI) shielding applications, using mill scale waste as the initial material, utilizing Greek wood templates. Also demonstrated that the structures of the iron oxide were hierarchically porous developed according to the wood templates. Moreover, the pore shape and size distribution showed a dependence on the cancelation temperature and wood template. Specifically, the temperature increases from 1000^0C to 1200^0C created larger but less pores in μm scale. Finally these low cost iron oxide ceramics exhibited electrical (mainly) and magnetic properties suitable for electromagnetic shielding applications .Sharma *et al.* [29] followed preparation and study of magnetic properties of Silico phosphate glass and glass – ceramics having iron and zinc oxide. The magnetic properties of $25SiO_2$-50CaO-$15P_2O_5$-(10-x) Fe_2O_3-xZnO (where x=0, 2, 5 mol%) glass and glass – ceramics have been studied. These glasses are prepared by melt quench technique and heat treated at 800^0C for 6 h. Electron Spectroscopy for Chemical Analysis (ESCA) revealed that the fraction of non-bridging oxygen decreases with the increase in zinc oxide content. The micro structure as seen by scanning electron micro scopy (SEM) exhibits formation of nano size particles. The analysis of the glass without ZnO shows about 58 wt% of total iron ions is in the Fe^{3+} state. Chen *et al.* [30] prepared and study of magnetic properties of silico phosphate glass and glass ceramics having iron and zinc oxide. Porous granular ceramic adsorbents containing dispersed aluminum and iron oxides were synthesized by impregnating with salt solutions followed by precipitation at 600^0C, Characterization studies on the adsorbent by SEM, XRD, EDS and BET analysis were carried out to clarify the adsorption mechanism. The experimental data were well explained with pseudo – second- order kinetic model. Results from this study demonstrated potential utility of Al/Fe dispersed in porous granular ceramics that could be developed into a viable technology for fluoride removal from aqueous solution. Sharma *et al.* [31] showed effect of ZnO on phase emergence, microstructure and surface modifications of calcium phosphitylated glass/ glass ceramics having iron oxide. The effect of ZnO on phase emergence and micro structure properties of glass and glass – ceramics with composition – $25SiO_2$-50CaO-$15P_2O_5$-(10-x) Fe_2O_3-xZnO (where x = 0, 2, 5, 7 mol%) has been studied. Surface modifications of glass – ceramics in simulated body fluid have been studied using Fourier transform infrared reflection spectroscopy (FTIR), XPS and SEM. The microstructure of the glass – ceramics heat treated at 800^0C exhibits the formation of Nano-size (50-50mm) grains. On heat treatment at 1000^0C crystallites grow to above 50 mm size and more than one phase are observed in the microstructure.Vilarinho and Baptista [32] was carried out effect of excess of iron oxide and lead oxide on the microstructure and dielectric properties of lead iron tungstate ceramics. Lead – iron tungstate Pb $(Fe_{2/3}W_{1/3})O_3$; PFW) perovskite ceramics were prepared by the conventional mixed oxides method. Additional amounts of Fe_2O_3 and PbO were used to examine the role of excess oxides on the phase development, densification behavior and dielectric properties. The densification behavior and the microstructures obtained after firing were very dependent on the starting stoichiometry. Thomas *et al*. [33] studied Advanced ceramic interconnect material for solid oxide fuel cells: Electrical and thermal properties of calcium and nickel Yttrium chromite's. For more than 30 years aluminum oxide (Al_2O_3) ceramics have been used for implants in maxillofacial and orthopedic surgery. Up to now there are no reports and also no investigations on hypersensitivity reactions by additional presence/ absence of Al_2O_3 disk as well as the proliferative response of PBMC of non- allergic individuals. Joong. Yoon *et al*. [34] discovered Micron oar determination of sulfur oxo anions and sulfide at a renewable sol-gel carbon ceramic electrode modified with nickel powder. The structural, thermal and electrical characteristics of calcium- and nickel doped yttrium chromite’s were studied for potential use as the interconnect material in high temperature solid oxide fuel cells (SOFCs) and other high temperature electrochemical and thermoelectric devices. Nickel doping remarkably enhanced sintering behavior of otherwise refractory chromite’s, and densities 94% of theoretical density were obtained after sintering at 1400^0C in air with 15 at%. Ni. Undesirable oxygen ion “leakage” current was insignificant in dual atmosphere conditions. No interfacial interactions with YSZ were detected after firing at 1400^0C. Salimi *et al.* [35] developed preparation conditions of pure and stoichiometric NiX Fe_{3-x} O_4 d bulk ceramics the sol-gel technique was used to fabricate nickel powder carbon composite electrode (CCE). The nickel powder successfully used to deposit NiO_x thin film on conductive carbon ceramic electrode for large surface area catalytic application. The hydrodynamic amperometry at rotation modified CCE at constant potential versus reference electrode was used for detection of sulfur derivatives. Less expense, simplicity of preparation, good chemical and mechanical stability, and especially good surface renew ability by simple mechanical polishing and repetitive potential cycling. Corso *et al.* [36] investigate the $NixFe_{3-x}O_4$ ($0<x<1$) phases are spinel’s which are difficult to obtain under pure, dense and conductive ceramics forms. Treatment under inert atmosphere leads to a biphasic system of spinel and NiO monoxide. At first, a treatment under air is carried out to synthesize dense and pure spinel ceramics. This treatment is followed by an annealing under inert atmosphere to reduce a part of Fe^{3+} and to form stoichiometric ferrites with semiconducting properties. Chen *et.al*. [37] found that Leaching behavior of nickel from waste multi-layer ceramic capacitor. The leaching behavior of nickel present in waste multi-layer ceramic capacitors (MLCC) was studied using different acidic leaching regents in a stirred batch reactor. The fraction of Ni leached was found to be 97% for a pulp density of 5 g/L and temperature 90^0C in an agitation time of 90 min. The leaching rate of nickel was limited by the diffusion of HNO_3 solution throughout thin channels that were formed between $BaTiO_3$ layers during the leaching of nickel. Sharma and Dixit [38] compress the performance of a mixed oxide ceramic tool in dry and air – cooled turning of grey cast iron. First, the study was done in the range of process parameters where dry turning provided satisfactory performance. The study was extended to the range in which dry turning performed poorly in terms of tool life. Tool wear, surface roughness of the machined job and forces and vibration during the cutting were studied. At higher cutting speeds, where the dry performs very poorly the air-cooled turning provides an improved surface finish also apart from the reduction in tool wear. Ezugrwu and Tang [39] find out Surface abuse when machining cast iron (G-17) and nickel base superalloy (in cornel 718) with ceramic tools. Single- point continuous – turning tests were carried out on a G-17 cast iron and a nickel base, Inconel 718, study using round and rhomboid – shape pure oxide (Al_2O_3+ZrO_2) and mixed oxide ($AleO_3$+TiC) ceramic tools to study the extent of damage on the machined surfaces under optimum cutting conditions. Hardness, values of the outer layer of the machine surfaces (up to 0.20 mm deep) show that the cutting conditions chosen produced significant variation and values well above the average hardness of the work materials because of the high rate of work hardening, increased compressive stresses and plastic deformation, particularly for the nickel base, Inconel 718, alloy. Jain *et al.* [40] reviewed effect of the A/B ration on the microstructures and electrical properties of (Ba0.95 + Ca0.05) (Ti0.8) for multilayer ceramics capacitors with Nickel electrodes. The microstructures and electrical properties of the perovskite – type oxides with various A/B ratios were studied using X-ray diffraction (XRD) and transmission electron microscopy (TEM) with an energy dispersive X-ray spectrometer (EDS). The oxides electrical performances in multilayer ceramic capacitors (MLCCs) with nickel electrodes were closely related to the A/B ratio of the powder. It was found that with decreasing A/B ratio, the maximum permittivity was increased due to a larger grain size, and the Curie point shifted to a higher temperature. Zhang *et al*. [41] worked the ac electrical failure behaviors and mechanism of current limiting $BaTiO_3$-based positive – temperature coefficient (PTC) ceramic, thermistors coated with electroless nickel – phosphorous electrode. The failure behaviors, by the action of ac electric field, of commercial $BaTiO_3$-based positive temperature coefficient (PTC) current – limiting ceramic thermistors coated with electroless Ni electrodes were investigated. In addition, the ac shock characteristics of $BaTiO_3$-based PTCR ceramic were related to the content of phosphorus in the electroless nickel – phosphorus content, 4 wt.% in the alloy. Gao *et al*. [42] produced Preparation and electrical properties of copper – nickel ceramic magnetic desired from mixed oxalate. $Cu_{0.3}Ni_{0.66}Mn_{2.04}O_4$ negative temperature coefficient (NTC) ceramic was prepared using mixed oxalate – derived oxide powder. The mixed oxalate was synthesized by milling a mixture of copper acetate, nickel acetate, manganese acetate and oxalic acid at room temperature. The difference in the electrical property of the as-prepared ceramic is attributed to the fine – grained microstructure and the lower sintering temperature used in the present study. Azam *et al.* [43] utilized Study of electrical properties of nickel doped SnO_2 ceramic nanoparticles. Nickel doped tin oxide ($Sn_{1-x}NixO_2$, where x= 0, 05, 0.05 and 0.09) Nano particles with sub- 5 nm size were synthesized using sol-gel method. The structural and compositional analyses were carried out using XRD, FESEM and EDAX. The article size was observed to vary from 5 nm to 2 nm as the nickel content was increased. Complex impedance analysis which was used to separate the grain and grain boundary contributions to the system suggests the dominance of grain boundary resistance in the doped samples. Bulasara *et al*. [44] characterize performance characteristics of hydrothermal and sonication assisted electroless plating baths for nickel ceramic composite membrane fabrication. This paper addresses the performance characteristics of nickel – ceramic composite membranes fabricated with hydro thermal mass transfer coupled electroless plating baths. Parametric investigations were carried out for wide range of initial nickel sulfate concentration (0.04 – 0.16 mol/L) in the solution at a higher loading ratio ($393cm^2/L$). The microfiltration study on oil – in – water emulsions inferred that the membrane fabricated with HTSO coupling and Ci=0.04 mol/L gave a rejection of 90.13% and membrane permeability of 0.11 x 10^{-10} $m^3.m^{-2}s^{-1}Pa^{-1}$. Salimi *et al*. [45] check aerometric detection of insulin at renewable sol gel desired carbon ceramic electrode modified with nickel powder and potassium octa cyanomoloybdativ (IV). A renewable three-dimensional chemically modified carbon ceramic electrode (CCE) containing nickel powder and $K_4[Mo(CN)_8]$ was constructed by sol-gel technique. The electro chemical properties and stability of modified electrode was evaluated by cyclic voltammetry in pH range 4-10. The apparent electron transfer rate constant (K_s) and transfer coefficient (α) were determined by cyclic voltammetry and they were about 17.1 and 0.57 s^{-1}, respectively. The catalytic activity of the modified CCE toward insuling oxidation was investigated at pH range of 3-8 by cyclic voltammetry. Flow injection amperometry determination of insulin at pH 7.4, at this modified electrode yielded a sensitivity 8.1 nA/ nM and detection limit 40 pM (based on S/N = 3).Jiang *et al.* [46] discussed Enhancement of the analytical properties and catalytic activity of a nickel hexacyanoferrate modified carbon ceramic electrode prepared by two step sol –gel technique. Because of the high economic, environment, and safety costs associated with pure oxygen as a process feedstock, oxygen – conducting ceramic membranes have been explored as an alternative oxygen source for hydrocarbon conversion reactors. The materials of interest for membrane reactor applications are mixed ionic – electronic conducting (MIEC) ceramic materials that conduct electrons as well as oxygen ions. This describes general attributes of oxygen – MIEC membranes, followed by an overview of published work with oxygen – MIEC ceramic membranes. Specific topics include membrane composition, membrane modification strategies, and application of oxygen – MIEC membranes for synthesis gas production. Goswami *et al.* [47] find out Crystallization behavior of Li_2O-ZnO-SiO_2 glass ceramics system. They studied the crystallization behavior in two types of lithium zinc silicate (LZS) glasses: (a) LZSL composition (wt%) Li_2O, 12.65; ZnO, 1.85; SiO_2, 74.4; Al_2O_3 3.; K2O, 2.95;P2O5, 3.15; B2O3, 1.2 (low ZnO); and (b) LZSH composition (wt%); Li_2O, 8.9; ZnO, 24.03; SiO_2, 53.7; Na_2O, 5.42; P_2O_5, 2.95; B_2O_3, 5 (high ZnO carried). Significant differences in the formation of crystalline phases and their relative ratios were observed between heating and cooling schedules. For LZSL, formation of Li_2SiO_3 phase along with small fraction of cristobalite phase was seen when CS was followed. However, in the case of LZSH, formation of lithium zinc silicate as major crystalline phase along with cristobalite phase is seen when HS was followed. For LZSI, the average thermal expansion coefficient (TEC) values were found to be around 178 x 10^{-7} and 114 x $10^{-70}C^{-1}$, for CS and HS, respectively. Baruzzo *et al.* [48] synthesizes possible production of ceramic tiles from marine dredging spoils alone and mixed with other waste materials. Dredging spoils, due to their composition could be considered a new potential source for the production of monolithic ceramics. Nevertheless, abundance of colored oxides in these materials preclude the possibility of obtaining white products, but not that of producing ceramics with a good mechanical behavior. As goal of the present research we have produced and studied samples using not only dredging spoils alone, but also mixtures with other waste materials such as bottom ashes from an incinerator of municipal solid waste water absorption, density, strength, hardness, fracture toughness, thermal expansion coefficient of the fired bodies were measured; XRD and SEM images were also examined. The fired samples were finally tested in acidic environment in order to evaluate their elution behavior and consequently their environmental compatibility. Hiramatsu *et al.* [49] used Layered mixed anion compounds; Epitaxial growth, active function exploration, and device application. Optoelectronic properties and device applications of layered mixed – anion compounds such as oxychalcogenide LaCuOCh (Ch=chalcogen) and oxyupincitde LaTMOPn (T_M=3rd transition metal, Pn=pnicogen) are reviewed. Several distinctive functions have been found in these materials based on our original material exploration. By extending the material system from the copper based oxychalcogenides to isostructural compounds, transition metal – based LaTMOP (TM=Fe, Ni), we have found novel superconductors, LaFeOP and LaNiOP. Sharma *et al*. [50] followed Preparation and study of magnetic properties of Silico phosphate glass and glass – ceramic having iron and zinc oxide. The magnetic properties of $25SiO2\text{-}50CaO\text{-}151_2O_5\text{-}(10\text{-}x)Fe_2O_3\text{-}xZnO$ (where x=0, 2, 5 mol%) glass and glass – ceramics have been studied. These glasses are prepared by melt quench technique and heat treated at 800^0C for 6 h. Electron Spectroscopy for Chemical Analysis (ESCA) revealed that the fraction of non – bridging oxygen decreases with the increase in zinc oxide content. The analysis of the glass without ZnO shows about 58 wt.% of total iron ions is in the state. The samples on heat treatment show improved magnetic properties due to the formation of magnetic nonparties.Liusar *et al*. [51] showed Solid solutions of mixed metal Mn_{3-x} Mg_xFe_4 orthophosphates: colouring performance within a double firing ceramic glaze. Solid solutions of mixed metal $Mn_{3-x}MgxFe_4(PO_4)_6$ orthophosphates (x=0, 0.5, 1, 1.5, 2, 2.5 and 3) were prepared for the first time (from coprecipitate powders calcined up to 1000^0C) and characterized by thermal analysis XRD, SEM/EDX, UV-VI, NIR, spectroscopy and color measurement. The obtained solid solutions with a minimized Mn content (especially $Mg_3Fe_4(PO_4)_6$ composition, without Mn) could serve as low – toxicity Fe reservoirs to stabilize hematite in double – firing glazes and produce an interesting dark – brown coloration, being an alternative to other brown ceramic pigments containing hazardous metals (i.e., Cr., Ni, Zn, or Sb). Baruzzo et al. [52] was carried out Possible production of ceramic tiles from marine dredging spoils alone and mixed with other waste materials. Dredging spoils, due to their composition could be considered a new potential source for the production of monolithic ceramics. Nevertheless, abundance of colored oxides in these materials preclude the possibility of obtaining while products, but not that of producing ceramics with a good mechanical behavior. Water absorption, density, strength, hardness, fracture toughness thermal expansion coefficient of the fired bodes were measured. The fired samples were finally tested in acidic environment in order to evaluate their elution behavior and consequently their environmentally compatibility. The electrochemical reduction of several metal and mixed – metal sulfate aqueous solutions [53] at a palladium electrode has been studied. For magnesium, lanthanum, yttrium and scandium sulfates, metal (oxy) hydroxide films are produced by catholically induced precipitation of the metal cations, following to the local generation of hydroxide ions at the hydrogen sorting cathode No films are accessible from the sulfate solutions of electropositive metals such as sodium and potassium, where the corresponding metal oxides and hydroxides are highly soluble. Metals are electrodeposited from separate sulfate solutions of zinc nickel and indium, in presence of the catholically induced precipitation of the metal (oxy)- hydroxide. Zhidong Li *et al*. [54] worked on Performance of NiCu ferrite fine particles and ceramics synthesized using egg white. The results of X-ray diffraction showed that the main phase, NiCu ferrite with fine particles were obtained from the nitrates-egg white or nitrates-citrate acid mixture calcined at 400°C for 3 hrs. Vibrating Sample Magnetometer (VSM) measurements indicated the NiCu material with fine particles were typical soft magnetic materials. Combined results of magnetization curves, saturation magnetization (Ms), residual magnetization (Mr), coercive force (Ch.), it has been found that the NiCu ferrite material synthesized from nitrates - egg white has better magnetic performance than that from nitrates -citrate acid. Cu doping can increase the Ni-ferrite's permeability *et al.* [55] worked on treatment of complex heavy metal wastewater using a multi-staged ferrite process. Complete removal of heavy metal from complex heavy-metal wastewater (CHMW) requires advanced technology. This study investigated the feasibility of a multi-staged ferrite process (MSFP) for treating CHMW, containing Cd, Cu, Pb, Cr, Zn, Ag, Hg, Ni, Sn and Mn. The performance of MSFP in removing heavy metals from wastewater was subsequently investigated and the parameters of three treating steps in MSFP were optimized under 70 °C and 90 °C at pH 9, and 80 °C at pH 10. After the three-staged procedures, all heavy metals in supernatant and sludge could fulfill the contamination levels regulated by law. In addition, the sludge generated from the MSFP was examined by XRD and forms a stable spinel structure, which could be effectively separated by external magnetic field. Ahmed *et al*. [56] Nano-crystalline copper ferrites from secondary iron oxide (mill scale) . Meanwhile, the types of phase formed and the magnetic properties of the produced samples were investigated using X-ray diffraction, scanning electron microscope and vibrating sample magnetometer. The results indicated that with a firing temperature of 1100 °C, the compact possesses higher compressive (832 kg/cm^2) strength and higher bulk density (3.93 g/cm^3), whereas higher saturation magnetization (45.2 emu/g) and lower coercivity (6.13 Oe) were achieved for compacts fired at 1200 °C. The effect of firing time at optimum firing temperature on physical and magnetic properties of the produced compacts seems to be insignificant. The crystal structure of the copper ferrite was transformed from its tetragonal into a cubic structure accompanying the dissociation of a part of the copper ferrite into deallocate at high firing temperature.

CONCLUSION:

Above mentioned literature shows wide applications of metal /mixed metal oxides as ceramics in various reactions like Possible production of ceramic tiles from marine dredging spoils alone and mixed with other waste materials. Dredging spoils, due to their composition could be considered a new potential source for the production of monolithic ceramics. Nevertheless, abundance of colored oxides in these materials preclude the possibility of obtaining while products, but not that of producing ceramics with a good mechanical behavior. Water absorption, density, strength, hardness, fracture toughness thermal expansion coefficient of the fired bodes were measured. The fired samples were finally tested in acidic environment in order to evaluate their elution behavior and consequently their environmentally compatibility. So, metal/mixed metal oxides have broad applications as ceramics in various chemical reactions.

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