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REVIEW ON ELECTRICAL RESISTIVITY OF OXIDE MATERIALS USING FUZZY LOGIC

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Abstract—*The electrical resistivity of pure, or nearly pure, metallic elements are presented here as a function of temperature for the range from 1 to 300°K. These metallic elements include only those that exhibit an increase in resistivity with increasing temperature. Propose implementing fuzzy logic using memristors. Min and max operations are done by antipodally configured memristor circuits that may be assembled into computational circuits. The historical background of transparent conducting oxides and then make some general remarks about their typical properties.[1] This is followed by a short discussion of the desired properties for future applications (particularly photovoltaic devices). These are ambitious objectives but they provide targets for future basic research and development.[3] Although it may be possible to obtain these properties in the laboratory, it is vital to ensure that account is taken of industrial perceptions to the development of the next generation of materials.*

Keywords— *Electrical Resistivity, conductivity, Critical field, X-ray diffraction (XRD).*

I. INTRODUCTION

Resistivity is a measure of the resistance to electrical conduction for a given size of material. Its opposite is electrical conductivity (=1/resistivity). Metals are good electrical conductors (high conductivity and low resistivity), while non-metals are mostly poor conductors (low conductivity and high resistivity). The more familiar term electrical resistance measures how difficult it is for a piece of material to conduct electricity - this depends on the size of the piece: the resistance is higher for a longer or narrower section of material. To remove the effect of size from resistance, resistivity is used - this is a material property which does not depend on size.

Resistivity is affected by temperature - for most materials the resistivity increases with temperature. An exception is semiconductors (e.g. silicon) in which the resistivity decreases with temperature. The ease with which a material conducts heat is measured by thermal conductivity. As a first estimate, good electrical conductors are also good thermal conductors. When considering the resistivity of the metallic elements at low temperatures, the phenomenon of superconductivity should also be noted. Superconductivity is attributed to the complete absence of resistance to an electric current.[2] Presentation of the electrical resistivity of the superconducting elements does not include data in the superconducting temperature range.

An exception is the data sheet for lead, where electrical resistivity data extending into the superconducting region appeared in the reference and were included in this compilation. These data below the transition temperature were based on actual observations of electrical resistance in lead in a super critical magnetic field at temperatures which would normally make lead a superconductor. As in the case of lead, elements in the superconducting state when subjected to an external magnetic field of a given strength, will regain normal resistance to an electric current field depends on the element concerned and temperature. This relationship may be approximated by:

$$H_c = H_0[1 - \left(\frac{T}{T_c}\right)^2] \qquad (1)$$

where H_o is the value of the critical magnetic field (in oersteds) at 0^0K, Tc is the transition temperature (in ^{0}K) and Hc is the value of the critical field at a temperature T. Values for Tc and Ho are given in Table 1.

Table 1: Transition Temperature for Superconducting Elements

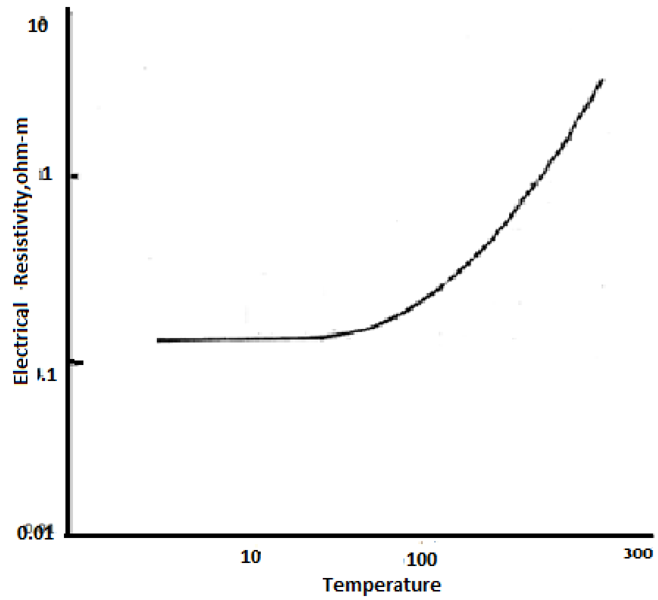
Elements	Transition Temp., ^{0}K	Critical magnetic field

		H_0,Oersteds
Aluminum	1.175	106
Cadmium	0.56-0.65	27-28.8
Hafnium	0.37	34
Gallium	1.103	47-50.3
Mercury	4.160	400 - 419
Indium	3.37 -3.43	269 - 275
Lanthanum	4.8, 5.8	745
Niobium	8.7 - 8.9	1960

II. THEORETICAL ANALYSIS

Electrical Resistivity of Al_2O_3,

Alumina is one of the most cost effective and widely used materials in the family of engineering ceramics. The raw materials from which this high performance technical grade ceramic is made are readily available and reasonably priced, resulting in good value for the cost in fabricated alumina shapes.[6] Aluminium oxide, commonly referred to as alumina, possesses strong ionic interatomic bonding giving rise to it's desirable material characteristics. It can exist in several crystalline phases which all revert to the most stable hexagonal alpha phase at elevated temperatures.

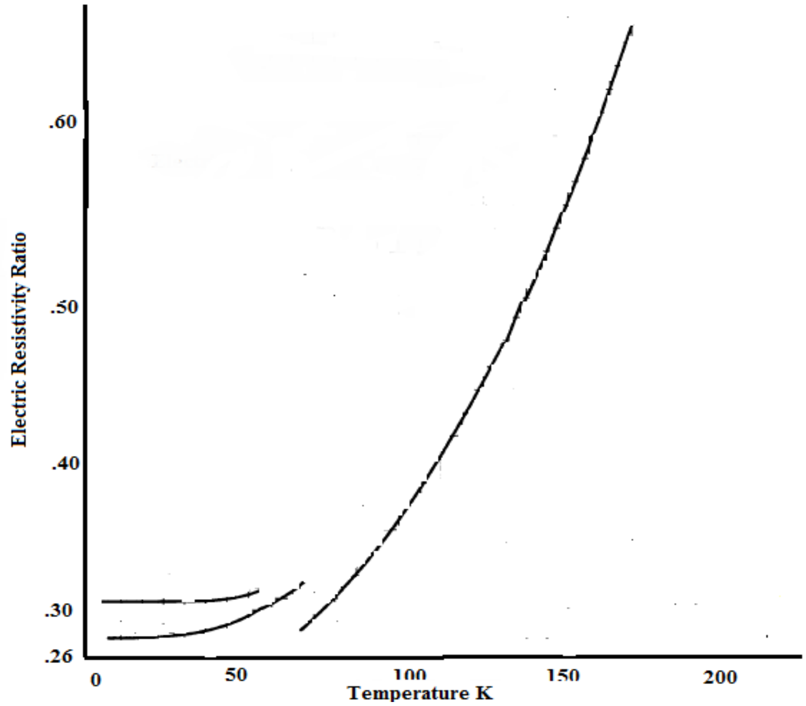


This is the phase of particular interest for structural applications and the material available from accuratus. The beginning of the Electrical Resistivity section for an explanation of the graph. The value of electrical resistivity at 270^0K for aluminium to be used in calculating values is labelling each individual curve on the graph.

The use of aluminium oxide applied by plasma and gas flame deposition onto a backing as insulation in coaxial or plane systems has gained widespread acceptance in the engineering industry. The structure of the oxide produced by the deposition differs substantially from the baked oxide. To obtain pure corundum the oxide has to be heated to high temperature under specific conditions.

Electrical Resistivity of BeO,

Beryllium oxide insulators have a dielectric strength of approximately 22.8 x 103 volts/mm for .81mm material (580 volts/mil for .032" material), and 17.7 x 103 volts/mm for 1.57mm material (450 volts/mil for .062 material). The thermal conductivity of beryllium oxide is 221.94 $W m^{-1} °C^{-1}$ (128.2 Btu/hr.ft.°F). Beryllium oxide. However, is toxic when dust, mist or fumes containing particles small enough to enter the lungs are inhaled. Therefore, grindings, sanding, and pulverizing the material should be avoided.[5]

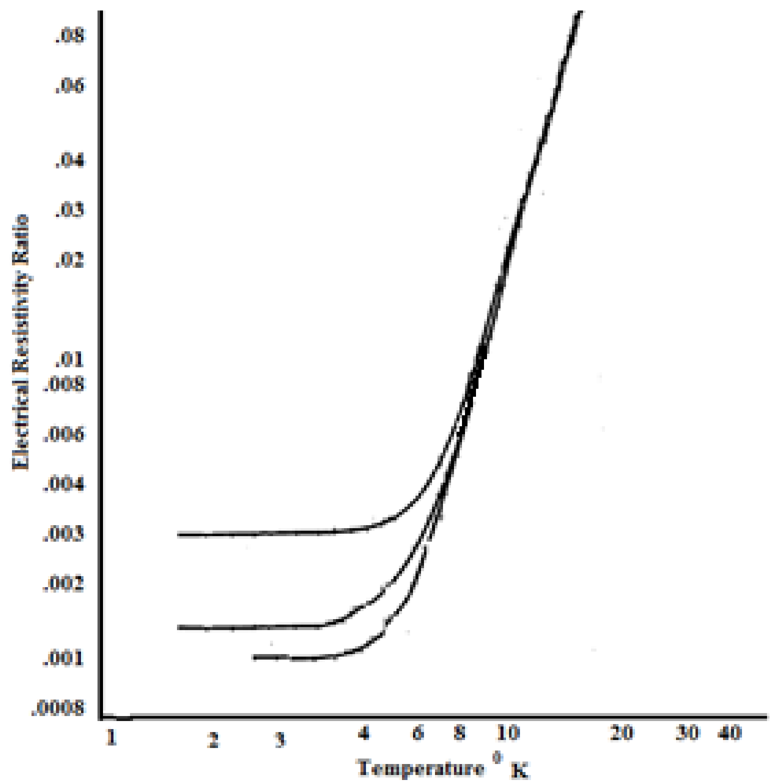


Beryllium oxide is chemically inert and completely safe to use in its fired state. Handling of finished parts presents absolutely no health hazards. Its high thermal conductivity and good electrical resistivity, BeO is used as an electronic substrate to give an effective heat sink. This material is found in high power devices or high density electronic circuits for high speed computers. The Electrical Resistivity section for an explanation of the graph. The value of electrical resistivity at 273^0K for beryllium t o be used in calculating values of electrical resistivity is 3.2 x 10^{-6} ohm-cm.

Electrical Resistivity of AuO,

The Electrical Resistivity section for an explanation of value of the graph. Gold Oxide is generally immediately available in most volumes. Ultra high purity, high purity, submicron and nano powder forms may be considered. Additional technical, research and safety (MSDS)information is available The value of elect r ical resistivity at 273^0 k for gold to be used in calculating values of electrical resistivity is 2.06 x 10-6 ohm-cm.

Oxide compounds are not conductive to electricity. However, certain perovskite structured oxides are electronically conductive finding application in the cathode of solid oxide fuel cells and oxygen generation systems.

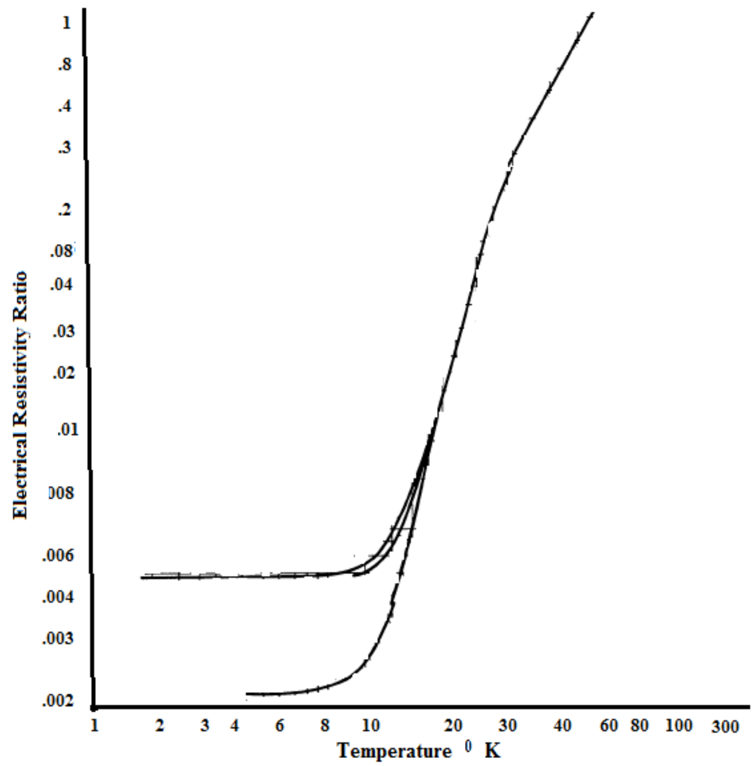


Gold is a metal and in the bulk form shows a deep yellow appearance. It has an atomic number of 79,a relative atomic mass of 196.9665,and is a member of subgroup IB of the periodic table. [4]

Gold Oxide **is** a highly insoluble thermally stable Gold source suitable for glass, optic and ceramic Gold oxide is a red-brown solid that is the most stable oxide of gold, but decomposes at 160 °. They are compounds containing at least one oxygen anion and one metallic cation. They are typically insoluble in aqueous solutions (water) and extremely stable making them useful in ceramic structures as simple as producing clay bowls to advanced electronics and in light weight structural components in aerospace and electrochemical applications such as fuel cells in which they exhibit ionic conductivity.

Electrical Resistivity of AgO,

The beginning of the Electrical resistivity section for an explanation of the graph. The value of electrical resistivity at 273^0k for silver to be used in calculating values of electrical resistivity is 1.47x 10^{-6} ohm-cm. Silver is a metal with a gray-white lustrous appearance. There are two stable naturally occurring isotopes; one with mass number 107 has a natural abundance of 51.82%,and the other with mass number 109 has a natural abundance of 48.18%. The thermal decomposition of silver paste with the addition of a metallic-organic decomposition (MOD) compound generally requires a curing time of greater than 10 min and a curing temperature greater than 250 °C, which does not meet the requirement for high-speed production in flexible substrates. attempts to modify the curing conditions of MOD silver pastes through the substitutions of silver flakes with silver(I) oxide (Ag_2O) and silver(II) oxide (AgO) were performed. Differential thermal analysis (DTA), derivative thermo-gravimetric analysis (DTG), and X-ray diffraction (XRD) results indicated that the presence of residual silver oxide, which effectively catalyzes the evaporation of α-terpineol and the decomposition of silver 2-ethylhexanoate, decreases the curing temperature and shortens the soaking time.

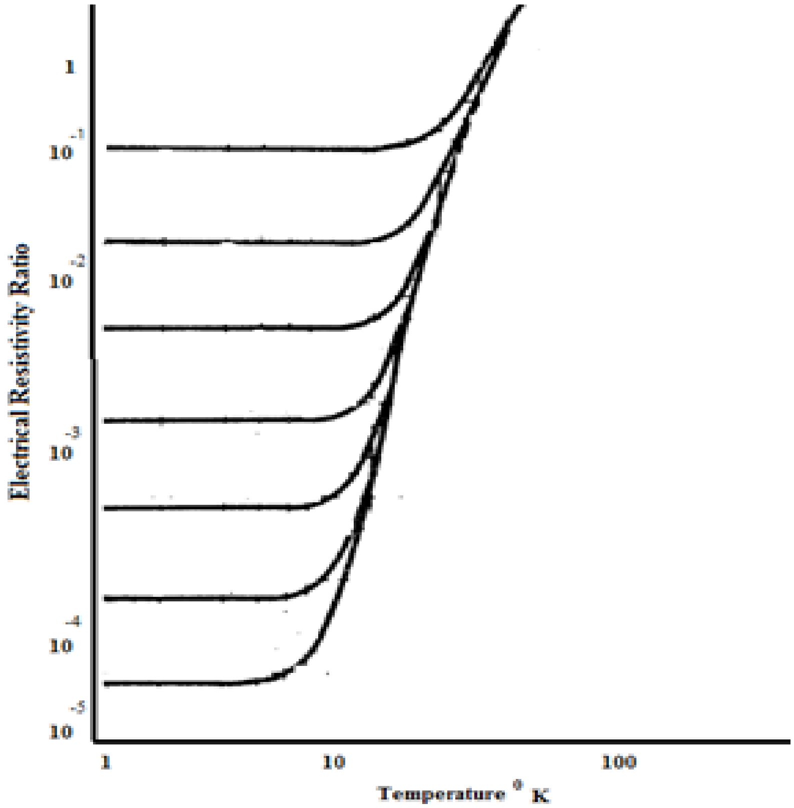


Silver-oxygen system (AgO) was extensively attracted by researchers due to its novel applications in high density optical storage devices, gas sensors, photovoltaic cells, photo diodes, and antibacterial coatings [1–6]. This system exists in different defined compounds, namely, Ag_2O, AgO, Ag_3O_4, Ag_4O_3, Ag_2O_3, and Ag_4O_4. Among these oxides, Ag_2O is the most thermodynamically stable. The compound Ag_2O possesses a simple cubic structure at room temperature.

Electrical Resistivity of Cu_2O,

The beginning of the Electrical Resistivity section for an explanation of the graph. The value of electrical resistivity at 273°K in recalculating values of electrical resistivity at 273^0k for copper to be used in calculating values of electrical resistivity is $1.55x10^{-6}$ ohm-cut.[11] Cuprous oxide (Cu_2O) is a metal deficient semi-conductor of p-type conductivity which shows a varying optical behaviour because of stoichiometric deviations arising from it's preparation methods and parameters [1-3]. It has been reported that many of the growth methods for cuprous oxide result in a combined growth of copper (I) oxide Cu_2O and copper(II) oxide CuO, i.e. Cupric oxide.

The two basic requirements for materials to be used as solar cell windows are a high optical transmittance in the visible and low electrical resistivity. Despite its high optical transmittance in the visible, cuprous oxide is known to have a high electrical resistivity which varies with the method of preparation.



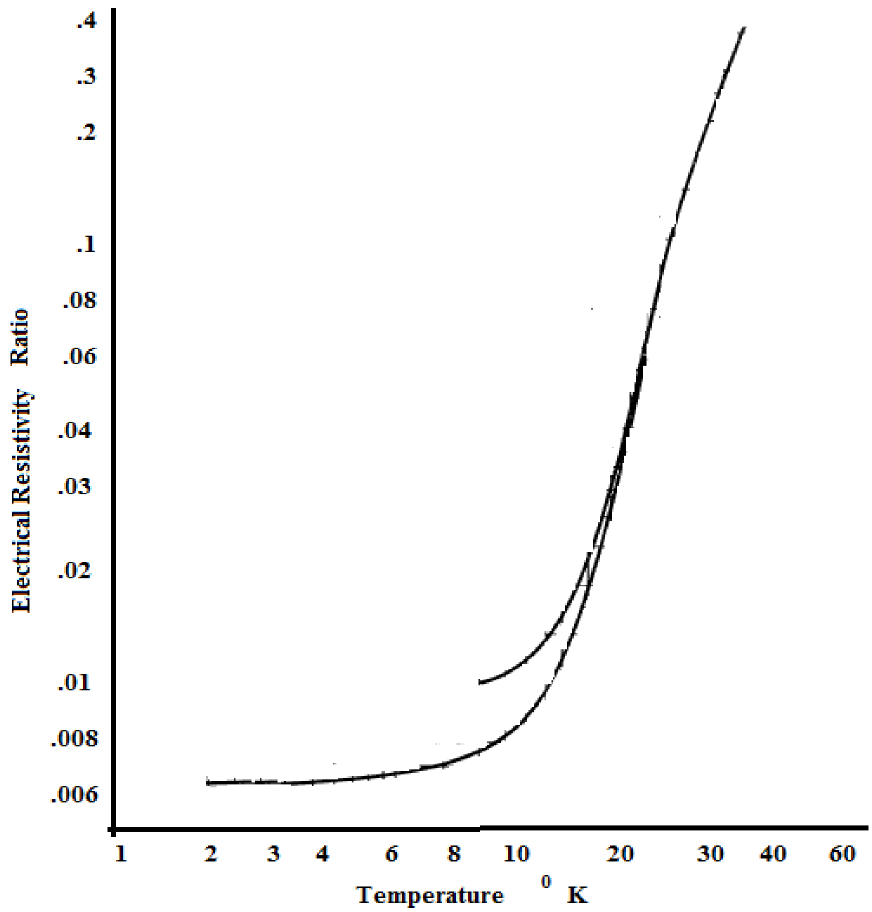
Oxides of copper during thin film deposition is dependent on a number of factors [19-21], namely
1) The nucleation rates of Cu, Cu_2O and CuO during the deposition process
2) The sticking coefficient / sticking probability of the particles reaching the substrate
3) Re-evaporation and migration by the impinging copper and oxygen species
4) The different growth rates of the nucleated species

All of the above factors will depend on the RF power and gas pressure in the deposition chamber during the sputtering process.[8] The effective sticking probability Copper oxide thin films were deposited on glass substrates by reactive rf sputtering from a copper target in an argon-oxygen atmosphere.

Electrical Resistivity of Fe_3O_4,

The electrical resistivity of Fe_3O_4 to pressures of 48 GPa at temperatures between 258 and 300 K in order to evaluate compression-induced changes in electron exchange between divalent and trivalent iron ions. At ambient pressures, inverse spinel-structured magnetite is well known for its electron hopping between divalent and trivalent iron octahedral sites, and our results thus provide constraints on the role of inter valence charge transfer in altering the electrical resistivity of iron-rich phases.

This finding implies that the electronic exchange between Fe^{2+} and Fe^{3+} ions is notably enhanced by the initial 7% of volumetric compression but is marginally impeded at higher compressions. We associate this discontinuity in slope with a phase transition from the inverse spinel structure to a monoclinic structure at ~20 GPa. Both previous Mossbauer work and the small change in magnitude of the resistivity indicate that electron hopping persists as the mechanism of charge transport through the transition.[12] The resistivity at these pressures is within an order of magnitude of characteristic metallic values, but measurements of the temperature dependence of resistivity demonstrate that the high-pressure phase remains semiconducting the beginning of the. Electrical Resistivity section for an explanation of the graph. The value of electrical resistivity at 273°K for iron to be used in calculating values of electric resistivity is $1.8x10^{-6}$ ohm-cm.



III. CONCLUSION

Metal oxides offer many unique properties for microelectronics and sensing applications, and are often too quickly disregarded in favour of silicon-based devices. a unique material has been able to completely revolutionize the technology, in this case the detection and imaging of mid-infrared radiation with room-temperature un-cooled detector arrays.

The interrelationship between the dopant concentration and physical properties of oxide thin films grown by pyrolytic decomposition in aqueous solution. In particular, we have investigated the influence of aluminium doping on the structural, morphological, optical, electric and dielectric properties with their photoelectron chemical performance. Unique potential for its electro chromic, thermoelectric, and anisotropic conductivity effects. Efforts are under way at several institutions to develop these materials to the point of commercial applications.

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