RELIABILITY OF OXIDE MATERIALS AND EFFECT OF POLLUTANTS

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Abstract:* This paper is devoted to the study of reliability of oxide materials and effect of pollutants. Mass law of mixing for oxide materials has been used for the analysis of the effect of pollutants. A difference between the clever design and improved materials has been stated. Estimation of the failure probability P from experimental data has been made by means of the weibull function. Reliability of oxides depending on various parameters, has been discussed. Current attainments are then compared with the minimum reliability demands of some of the economically important, applications foreseen for composites. Fuzziness of various parameters has been dissertated. It has been analyzed to optimize the process parameters for the superior quality of oxides and alloys. The purpose of this research is to familiarize the design engineer with those aspects of the strength properties related to the electronic resistivity of the composites, alloys, mixtures of oxides. We have developed techniques to make strong oxides of higher reliability, and higher resistivity which can be used for the manufacture of various electronic instruments.

1. INTRODUCTION:

Reliability is a material parameter. The pollutant will be mixed using the mass law of mixing in the oxide materials. The problem becomes very simple when mass law, logarithmic law and Fuzzy set theory are used for pollutants. The pollutes are also oxides. H_2S, SO_2, SO_3, Cl_2, NO_x, HF NH_3, O_3 these pollutants live together react on the oxides CuO, Cu_2O_3, Fe_3O_4, Fe_2O_3, ZnO, MgO, SiO_2, Al_2O_3, AlO, NiO, CrO, SnO_2, SnO and other oxides. The Fuzzy cardinal may provide better results.

The reliability for electronic transducers is an important parameter under pollution hazards fig. 1, fig. 2 explain the reliability of coupled mixtures or alloys of oxides or materials. $\alpha = 1.2\frac{(\sigma)^{-1}}{\mu}$ is used to predict the results. The oxides actually exhibits considerably wider dispersion of instantaneous strength properties as well as Fatigue characteristics. A space of the clever design and another space of material improvement can be formed. Here, an assumption can be made that the reliability of the final structure is always less than the reliability of materials. In exceedingly clever design, this assumption may be excessively conservative.

Techniques have been developed to make strong oxides of higher reliability, and higher resistivity.. The direct method to study the failure of the parameters is satisfactory.

Low temperature resistance measurement by four probe method indicates reliability directly by the low resistivity. The super conductors are highly reliable than the normal conductors. It has been analyzed to optimize the process parameters for the superior quality of samples of oxides and alloys. In the present context, reliability, R is a measurable quantity. $R = 1 - P$ where, P is the failure probability. The target levels of R are revealed to us by imperial observation of the failure probability tolerance of prospective users of goods in various applications. This information is mostly readily available in industries and industrial applications, Where the economic consequences of failures are estimated routinely before any new installation is contemplated monitoring the incipient failure can also be expected in Industries. Given the impossibility of direct measurement of the direct reliability levels, obtaining the data might be done by mathematical analysis, starting from the much smaller number of experimental data. In order to do this one must first visualize the relationship between the expected distribution of external stresses and that of responding strength in the materials under the study. The introduction of new materials for use in load bearing capacity applications in a market place with very high standard of reliability posses an important design problem because designers had come to take the reliability of their materials for granted Many decades of manufacturing development brought the commonly used materials to their present perfection. There is a vast difference between the resistivity of oxide and its element and therefore the results cannot be compared. This is the electronic reliability of conduction and electrical reliability of insulation. The results are not comparable. The density space is practical and comparable because this is a mechanical reliability. One or two components have been mixed to form a good material. Many components can be alloyed or mixed to form the cermets, Ferroxdures, Ferrites and cermets. There are ten elemental materials represented by equation (16). One can develop the behavior to a material depending on all these parameters for conductors, semiconductor and dielectrics. The reliability of these materials mostly changes with the resistivity. Pollution effects will be mixed using the mass law of mixing in the oxide materials. The problem becomes very simple when mass law, logarithms law and Fuzzy set theory are used for pollutants. The pollutes are also oxides H_2S, SO_2, SO_3, Cl_2, NO_x, HF NH_3, O_3 these pollutants live together react on the oxides CuO, Cu_2O_3, Fe_3O_4, Fe_2O_3, ZnO, MgO, SiO_2, Al_2O_3, AlO, NiO, CrO, SnO_2, SnO and other oxides.

2. RELIABILITY OF OXIDE MATERIALS:

The oxides actually exhibit considerably wider dispersion of instantaneous strength properties as well as Fatigue characteristics. The data collected in this thesis suggest that one cannot foretell at present where the ultimately attainable reliability limits of different kinds of composites may be, oxides are filled in the pipes of the solid elemental materials. Current attainments are then compared with the minimum reliability demands of some of the economically important, applications foreseen for composites. We will make a difference between the clever design and improved materials. We can form a space of the clever design and another space of material improvement.Here one can make assumption that the reliability of the final structure is always less than the reliability of materials [6]. In exceedingly clever design this assumption may be excessively conservative. The manufacture can control on steels and aluminium alloys for most applications have reduced properties to virtually negligible levels and thereby guaranteed a very high base level of reliability [12].Techniques to make strong oxides of higher reliability, and higher resistivityhave been developed. The tensile strength of an alloy will be directly proportional to the resistivity of solids like Al, Cu, Fe, Cr, Co, Ni.For the technological potential, the reliability attributes have been developed depending on the parameters such as $\rho, D, \varepsilon_r, \mu_r, T, \tan\delta, etc.$. For example, if the resistivity of copper is increasing the reliability as conductor is diminishing. X-Ray diffraction for phase evaluation and lattice parameters for the reliability evaluation have been used.

Low temperature resistance measurement by four probe method indicates reliability directly by the low resistivity. The super conductors are highly reliable than the normal conductors. Some as required the result of these investigation. Such as mass law of mixing and log law of heterogeneous alloys and mixtures. It will be analyzed to optimize the process parameters for the superior quality of samples of oxides and alloys.

In the present context, reliability, R is a measurable quantity.

$$R = 1 - P \qquad (1)$$

Where, P is the failure probability. The target levels of R are revealed to us by imperial observation of the failure probability tolerance of prospective users of goods in various applications. This information is mostly readily available in industries and industrial applications, where the economic consequences of failures are estimated routinely before any new installation is contemplated monitoring the incipient failure can also be expected in Industries.The purpose of this research is to familiarize the design engineer with those aspects of the strength properties related to the electrical resistivity of the composites, alloys, mixtures of oxides. The nuclear oxides have very great strength. As a matter of fact the tensile strength may be increased by injecting a current in the materials by reducing the resistivity.Given the impossibility of direct measurement of the direct reliability levels, one may try to obtain the data by mathematical analysis, starting from the much smaller number of experimental data. In order to do this, the relationship between the expected distribution of external stresses and that of responding strength in the materials under the study must be visualized.

Again one can note that two oxides will show poor Reliability in Figure 1.

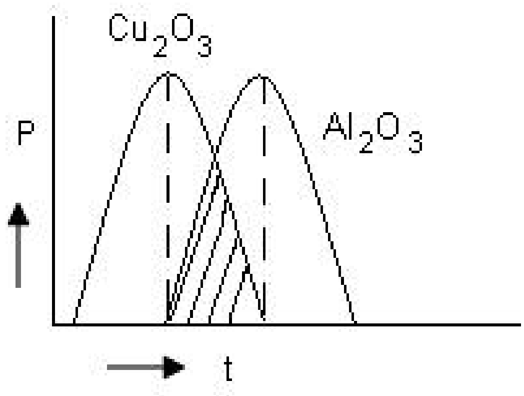

Figure 1- Reliability coupling of Al_2O_3 and Cu_2O_3

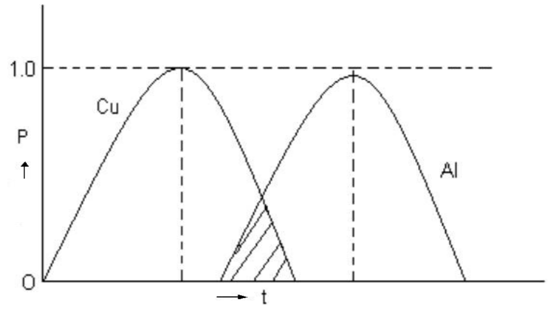

Figure 2- Reliability Coupling of Cu and Al elements.

(1) <u>Estimation of the Failure probability</u> P <u>from experimental data by means of the weibull function</u>

Probability of failure by means of the weibull function is obtained as follows:

$$P = 1 - e \times p\left[- FF^{*}/\alpha\right] \tag{2}$$

Where F is the applied stress

F* is a characteristic stress near the mean ultimate strength of the material under the study, α : is the shape parameters of the distribution, can be assumed as

$$\alpha = 1.2\frac{(\sigma)^{-1}}{\mu} \tag{3}$$

Where σ: is the standard variation of the measured static ultimate strength μ: is the mean ultimate strength this is of course the coefficient of variation If one equates F* with the mean ultimate strength then

$FF^{*} =$ Safety factor (4)

Would be the factor of safety required to obtain the desired level of P and thus of the reliability.

$$R = (1 - P) \tag{5}$$

The shapes of these relations may be approximate in Figure 3 for some oxides using the Fuzzy membership functions and parameters as described above.

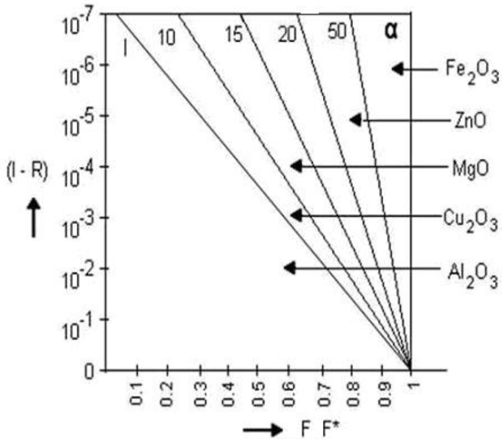

Figure 3 Fuzzy members of probability and Reliability

(2) Reliability of oxides depending on the relative density

Table 1

11.1	6.67	6.4	6	5.606	5.25	5.18	3.8	3.6	3.1
HgO	NiO	CuO	Cu_2O_3	ZnO	Fe_2O_3	Fe_3O_4	Al_2O_3	MgO	SiO_2

We mix all the oxides to make a material using mass law of mixing. The maximum density is

$$D_{\max} = 11.1 \quad (6)$$

and minimum density $D_{\min} = 3.1$ The mean density would be $D_{mean} = \frac{11.1-3.1}{2} = 4$ (7)

The average density would be 5.676 g.cm^3. The mean density is given in Figure 5-4.

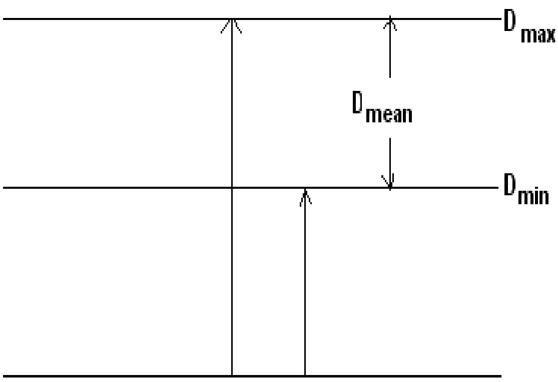

Figure 4

The mean Reliability would be

$$\lambda = \frac{1}{4} = 0.25$$

$$R_{mean} = e^{-\lambda t} = .7788 \quad (8)$$

$$\lambda_{av} = \frac{1}{5.676} = .17618$$

$$R_{av} = 0.8384$$

Fuzzy logic has been used to obtain FM as follows in table 2.

Table 2

	D	λ	FM
HgO	11.1	0.090	1.0
NiO	6.67	0.149	0.60
CuO	6.4	0.156	0.576
Cu_2O_3	6.0	0.166	0.54
ZnO	5.606	0.178	0.505
Fe_2O_3	5.25	0.190	0.473
Fe_3O_4	5.18	0.193	0.466
Al_2O_3	3.8	0.263	0.3423
MgO	3.6	0.277	0.3243
SiO_2	3.1	0.322	0.2792

The Fuzzy cardinality of the mixture would be

$$A = \sum_{i=1}^{10} FM = 5.0728 \quad (9)$$

And Related Fuzzy cardinality would be:

$$\overline{A} = \frac{1}{n}\int_{1}^{10} FMdx = .50728 = R \quad (10)$$

This is the reliability of the system. The Fuzzy member would be:

$$FM = \frac{D_{\max}}{D_{\min}} = \frac{(FM)_{\max}}{(FM)_{\min}} \quad (11)$$

$$FM = \frac{D_i}{D_{\max}} \quad (12)$$

Failure rates of the density of oxides are as follows:

$$\lambda = \frac{1}{D_i} = \lambda_i \quad (13)$$

The cardinality of the failure rate would be:

$$A = \sum_{i=1}^{10} \lambda_i = 1.984 \quad (14)$$

and $\overline{A} = 0.1984,\ R = 0.82$ (15)

An alloy is assumed to be:

$Hg, Ni, Cu, Zn, Fe, Al, Mg, Si, Fe, Cu$

$$(D) = (13.65, 8.9, 7.13, 7.87, 2.7, 1.74, 2.3, 7.13, 8.96) \quad (16)$$

The Fe and Cu have to be added twice to achieve this problem and compare to the ten oxides. What complications will be made by Al and Si as their oxides densities are increased

Density of, $Al, D = 2.7$

Density of, $Al_2O_3, D = 3.8$
The density of $Si, D = 2.7$
The density of $SiO_2\ D = 3.1$

The disturbance in the alloys of elements and mixture of oxides will be calculated. The density is an important parameter which can govern the resistivity of oxides, alloys and mixtures of Ferrites, cermets, ceramics Ferroxdures and Magneto dielectric materials. Fuzzy the density vector have been shown by the above method; as follows:

$$F(z) = 1, .652, .6564, .522, .576, .1978, .127, .168, .522, .656 \tag{17}$$

Fuzzy cardinality and relative Fuzzy cardinality has been obtained as follows:

$$A = 5.0772 \tag{18}$$

and

$$\overline{A} = 0.50772 \tag{19}$$

$$\lambda = (.07326, .1123, .1116, .1402, .12706, .3803, .5747, .4347, .1402, .1116) \tag{20}$$

The total failure rate $\lambda = 2.19592$ and average $\lambda = 2.19592$ (21)

(3) <u>Reliability of oxides depending the Electrical resistivity</u>

Here Fuzzy set theory has been used to predict the reliability and failure rates of oxides.

$$F(z) = (ZnO, Fe_2O_3, Fe_3O_4, HgO, NiO, SiO_2, MgO, Al_2O_3, CuO, Cu_2O_3) \tag{22}$$

$$F(\rho) = (200, 200, 300, 100, 90, 100, 90, 200, 100, 90) \tag{23}$$

This set is fuzzified as follows:

$$F(FM) = (0.666, 0.666, 1, 0.0333, 0.30, 0.333, 0.30, 0.666,\ 0.333, 0.30) \tag{24}$$

The Fuzzy cardinality would be:

$$A = 4.897 \tag{25}$$

and Relative Fuzzy cardinality

$$\overline{A} = 4.897 \tag{26}$$

The reliability in this space would be :

$$R = .6128 \tag{27}$$

The failure rate set has been used as follows

$$\lambda = \frac{1}{\rho} \tag{28}$$

$$F(\lambda) = (.005, .005, .0033, .01, .011, .01, .0111, .005, .01,\ .0111) \tag{29}$$

Average failure rate would be:

$$\lambda_{av} = .0816 \tag{30}$$

Reliability : $R = 0.9216 = e^{-\lambda t}$ (31)

Now we use the elements as an alloy following mass law of mixing:

$$(Zn, Fe, Fe, Hg, Ni, Si, Mg, Al, Cu, Cu)$$

$$F(\rho) = (5.9, 10, 10, 50, 60, 100, 4, 2.65, 1.7, 1.7)10^{-8} \tag{32}$$

This set is fuzzified as follows.

$$F(FM) = (.059, .01, .01, .5, .6, 1, .04, .0265, .017, .017) \tag{33}$$

We find the fuzzy cardinality:

$$A = 2.4595, \overline{A} = .24595 \tag{34}$$

The reliability would be hardly

$$R = 25\% \tag{35}$$

There is a vast difference between the resistivity of oxide and its element and therefore one cannot compare the results. This is the electrical reliability of conduction and electrical reliability of insulation. The results are not comparable. The density space is practical and comparable because this is a mechanical reliability.

(4) <u>The Dielectric constant Indices of oxides</u>

A fuzzy set of the ten oxides has been formed, as follows:

$ZnO, Fe_2O_3, Fe_3O_4, HgO, NiO, SiO_2, MgO, Al_2O_3, CuO, Cu_2O_3$

$$F(\varepsilon_r) = (4.8, 7, 6, 10, 10, 8.13, 11, 8, 6, 7) \quad (36)$$

This set is fuzzified, as follows :

$$(.4363, .6363, .5454, .9090, .9090, .739, 1, .7272, .5454, .6363) = F(z) \quad (37)$$

The fuzzy cardinality would be:

$$A = 7.083 \quad (38)$$

and

$$\overline{A} = 7.083$$

Reliability would be:

$$R = 70.83 \quad (39)$$

A failure rate mechanism of the mixture can be selected

$$F(\lambda) = (.208, .142, .166, .1, .1, .123, .0909, .125, .166, .142) \quad (40)$$

$$\sum_{i}^{10} \lambda = 1.36629 \quad (41)$$

and $\lambda_{av} = .13629$

$$R = .8725 \quad (42)$$

A Reliability set has been found, as follows .

$$F(R) = (.8122, .8676, .847, ..9048, .9048, .8842, .913, .8824, .847, .8676) \quad (43)$$

The average Reliability would be

$$R_{av} = .87306 \quad (44)$$

(5) <u>Union and Intersection of Density and Resistivity</u>

One or two components are mixed to form a good material. Many components can be alloyed or mixed to form the cermants, Ferroxdures, Ferrites and cermets. There are ten elemental materials represented by equation (16). The behavior to a material has been developed, depending on all these parameters for conductors semiconductor and dielectrics. The reliability of these materials mostly changes with the resistivity.

Fuzzy set of D and ρ are formed, as follows:

$$F(D) = (13.65, 8.9, 8.96, 7.13, 7.87, 2.7, 1.74, 2.3, 7.13, 8.96) \quad (45)$$

and material set would be

$$F(M) = (Hg, Ni, Cu, Zn, Fe, Al, Mg, Si, Fe, Cu) \quad (46)$$

$F(D)$ set is fuzzified, as follows.

$$F(z)_D = (1, .652, .6564, .522, .576, .1978, .127, .168, .522, .656) \quad (47)$$

The resistivity set of the materials would be

$$F(p) = (5.9, 10, 10, 50, 60, 100, 4, 2.65, 1.7, 1.7)10^{-8}$$

This set is fuzzified, as follows:

$$F(z)_\rho = (.059, .1, .5, .6, .1.04, .0265, .077, .0171) \quad (48)$$

The union of the two sets would be:

$$(u) = D \cup P \quad (49)$$

and intersection would be:

$$(I) = D \cap P \quad (50)$$

We have

$$D \cup P = (1, .652, .6564, .6, 1, .1978, .127, .168, .522, 1) = 5.9232$$

This is the cardinality of the union and one can broadly represent it as follows:

$$A_D = 5.9232 \quad (51)$$

and Relative cardinality $\overline{A} = 0.59232$ (52)

The intersection would be:

$$D \cap P = [.059, .1, .5, .522, .576, .04, .0265, .017, .017, .656] \quad (53)$$

The Fuzzy cardinality would be:

$$A = 2.5135 \quad (54)$$

The relative fuzzy cardinality has been developed, as follows:

$$\overline{A} = 0.25135 \quad (55)$$

The union is the maximum Fuzzy logic membership function.

$$FM = \mu = 0.59232 = \overline{A} \quad (56)$$

and intersection has a relative cardinality:

$$\overline{A} = 0.25135 \quad (57)$$

The Fuzziness of resistivity and density spaces would be:

$$E = \frac{D \cap P}{D \cup P} = \frac{2.5135}{5.9232} = .424 \quad (58)$$

(6) <u>The Fuzziness of the Resistivity</u>:

Fuzzy set of the resistivity can be found from equation (50), as follows:

$$F(z)_{\rho} = (.059, .1, .5, .6, 1, .4, .0265, .017, .017, 1) = A \quad (62)$$

We find the complementary function A^c of the Fuzzy set $A = F(z)_e$ as follows:

$$Ac = F(z)_e^c = (.941, .9, .5, .4, .0, .96, .97, .983, .983, 0) \quad (59)$$

$$A \cup A^c = (.941, .90, .5, .6, 1, .96, .983, .983, 1) \quad (60)$$

The cardinality of the union would be

$$A \cup A^c = M = 8.837 \quad (61)$$

and

$$\overline{M} = .8837 \quad (62)$$

The intersection will be found as follows:

$$A \cap Ac = (.59, .1, .5, .4, 0, .04, .0265, .017, .017, 0) \quad (63)$$

The cardinality of the intersection would be:

$$M = 61595$$
$$\overline{M} = 61595 \quad (64)$$

The Fuzziness in the resistivity set may be:

$$E = \frac{A \cap A^c}{A \cup A^c} = \frac{1.1595}{8.837} = .1312 \quad (65)$$

(7) The Fuzziness in Density set

The Fuzzy set of density is obtained from equation (48) as follows:

$$A = (1, .652, .6564, .522, .576, .1978, .127, .168, .522, .556) \quad (66)$$

The complementary function of the set A is, as follows:

$$Ac = (0, .348, .3436, .478, .424, .8022, .837, .832, .478, .344) \quad (67)$$

The cardinality of A and A^c is as follows :

$$M = 5.0772$$
$$M^c = 4.8868 \quad (68)$$

The union is found, as follows :

$$A \cup A^c = (1, .652, .6564, .522, .576, .8022, .837, .832, .522, .656) \quad (69)$$

The magnified of the union may be:

$$|A \cup A^c| = 7.0556 \quad (70)$$

The intersection would be:

$$A \cap A^c = (0, .348, .3436, .478, .424, .1978, .127, .168, .478, .344) \quad (71)$$

and

$$|A \cap A^c| = 2.9084 \quad (72)$$

The Fuzziness in the density set would be :

$$E = .4122$$
$$E = 41.22\% \quad (73)$$

3. POLLUTION EFFECTS:

The pollution will be mixed using the mass law of mixing in the oxide materials.

The problem becomes very simple when mass law, logarithms law and fuzzy set theory are used for pollutants. The pollutants are also oxides: H_2S, SO_2, SO_3, Cl_2, NO_x, HF NH_3, O_3 these pollutants live together react on the oxides Cu_2O, Cu_2O_3, Fe_3O_4, Fe_2O_3, ZnO,MgO, SiO_2, Al_2O_3, AlO, NiO, CrO, SnO_2, SnO and other oxides. the pollution impair the parameters of materials are modified by the mass law and Fuzzy union and intersection.

4. CONCLUSION:

In this paper the effect of pollution on oxides are studied . When mass law, logarithmic law and Fuzzy set theory are used for the study of pollutants. Estimation of failure probability by experimental means and use of weibull function is done.This data helps us to calculate the reliability of oxide materials.

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