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INFLUENCE OF IMPURITIES ON ELECTROPHYSICAL CHARACTERISTICS OF THE ZnO- BASED VARISTORS

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1. INTRODUCTION

In developed countries working on the protection for example devices against overvoltage with deferent methods in discharging firelight we can utilize the RC or LC filters. Now a days for protection against over voltages it is common to use nonlinear resistors which is fabricated with composition of two or move substances like carbide germanium or zinc oxide[1-3]. These substances which is named varistors electro physical characteristics and have different structures. There are so many researches around varistor [3-4]. Doping with varistors substance like oxides and zinc oxide in researches shows the varistor main electro physical characteristics.

2. EXPERIMENTAL METHODS

The Russian companies worked on metal oxides and in producing then they used chemical analyzers and reagent in table 1 some of the reagent and their specifications are shown.

Table 1

Specification	ZnO	Bi_2O_3	Co_3O_4	Sb_2O_3	MnO_2	Ni_2O_3	Cr_2O_3	H_3BO_3
1.BASIC COMPONENT Quantity, wt % mass	99,96	99,97	99,97	99,96	99,95	99,93	99,93	99,96
2.dispersion degree, micron	0.3	5-10	0,5-2	0,2-1	0,3-3	0,5-4	0,5-2	0,5-3
3.density,10^3 kg/m^3	5,6	8,9	5,68	5,2	5,18	7,45	4,98	3,2
4.melt temperature, S^0	1975	817	1805	655	1785	1957		
5.Cation radius, mm	0,074	0,098	0,072	0,090	0,080	0,069	0,052	
6.type of semiconductors	n	p	p	p	p	p	P(Cr_2O_3)	p

In this research 3 types of varistor compositions will be analyzed.
First composition varistor:
97 mol% ZnO+3 mol% composition.
Composition's Structure material:
1 mol% Sb_2O_3+0.5 mol%Bi_2O_3+0.5 mol%Co_3O_4+0.5mol%B_2O_3+0.5mol%MnO_2
Second composition varistor:
96.5 mol%ZnO+3.5mol%composition.
Composition's Structure material:

1mol%Sb_2O_3+0.5mol%Bi_2O_3+0.5mol%Co_3O_4+0.5mol%MnO_2+0.5mol%B_2O_3 +
+0.5mol%Cr_2O_3
Third composition varistor: 95.5 mol%ZnO+4.5mol%composition.
Composition's Structure material:
1mol%Sb_2O_3+0.5mol%Bi_2O_3+0.5mol%Co_3O_4+0.5mol%B_2O_3
+0.5mol%MnO_2+0.5mol%Cr_2O_3+ +0.5mol%NiO_2+1 mol%SiO_2
As you can see the difference between the first and second composition is only 0.5%mol of $Cr_2O_3$and 0.5%mol NiO_2
For completing the research for 10-50 grams of each sample 8-10 washers will be made. To find the gravity portion of each substance in 100 grams of main component we can use the following formula.

$$m_t = \frac{v_t M_t . 100}{v_t M_t + v_2 M_2 + \cdots v_n M_n} \quad (1)$$

in this formula m_i-is the it component from the 100 grams of the sample and v_i- is the percentage of it mol of the component and the M_i- is the molecular mass of the component. Composition of components, especially when the amount of components is very low is the important point, which should be noticed .the composition components for the synthesis process would be shown in the continuance. Several oxides which are used in synthesis process and suitable for stoihiometry are mixed together in one repository and without ZnO. In this time the bigger particles of ZnO should be squeezed so the mixing process will be done in a better way. Where we are jabbing the materials, the zinc oxide should be jabbed with a mortar and pestle. The process of compounding must occur in a alcoholic environment. at though bleakly and jabbing in an alcoholic environment will take place easily .then we will dry the mixture and then we should jab it. In this level we can composition a plasticizer with other materials .a plasticizer like C_4H_9OH or 2% polyvinyl alcohol can be used for this purpose. We will the sample that it is made granulated plasticizer and dry it to the humidity of 8-10% .if the humidity doesn't reach to 8-10% when we can by pressing, the product water will come out of it. at this time we will dry apart of product in 90-100 ^{0}C temperature. And now I is ready to composition so we will vise it with a force of 40 tons and made it like the Washers which are 2-10 mm in thickness. In this level we will separate the qualified Washers from the poor ones .for understanding the empty capacity of Washers we will weigh them and name the weight of the Washer, P1 .then in the 24 hours time we will heat it to lose its water and we will weigh it again and name it as P2. The percentage of losing weight will be calculated from formula (2).

$$F_0\% = \frac{P_2}{P_1} . 100\% \quad (2)$$

and if this percent age is more than 7% we should put them under pressure again.

3. EXPERIMENTAL RESULTS AND DISCUSSION

The synthesized varistors, volt-ampere characteristic in room temperature is shown in figure 1-2-in this figure it is shown that all 3 varistor's characteristic diagram in the low quantities of voltage is changing respected ohm law, but in large quantities of the voltage the volt-ampere characteristic diagram of three varistors are completely different.

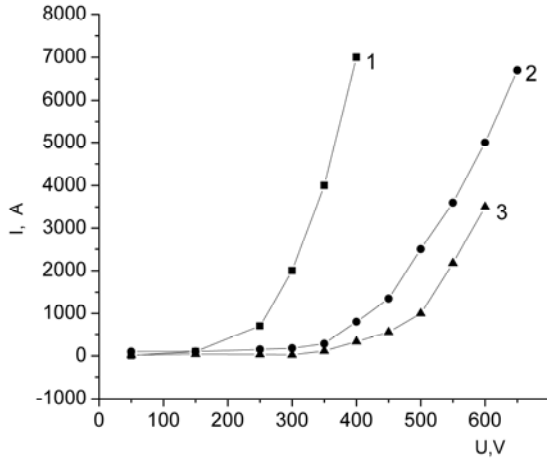

Fig.1. Dependence of an electric current on voltage

It is obvious in all 3 volt ampere characteristic that, when the voltage it increasing (e.g.,1-st varistor -270V ,2-nd 320V,3-rd-550V) the varistors resistance against current is charging from high quantities to very low quantities moreover current is charging from high quantities

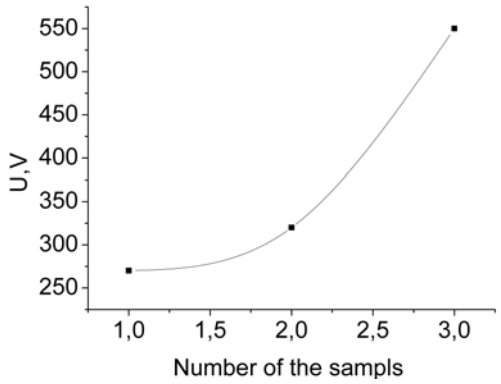

Fig.2. Dependence of opening voltage on number of the samples

to very low quantities moreover varistors has different non linearity coefficients (β_1,β_2,β_3) and ,$\beta_1>\beta_2>\beta_3$ where β_1, β_2, β_3 are the nonlinearity coefficient of 1st, 2nd and 3rd type of varistors to describe the results, in all of synthesized varistors the main composition (ZnO) is constant , and in other side the impurities amount from the 1st composition to the 3rd one varies about 1.5mol% which make the difference in volt-ampere characteristic as the terms of combining , pressing ,synthesizing and chilling of three varistors will be done in a same way ,so we can say : I=f(V) and then we can tell as a result that changing in impurity of varistors cause changing in nonlinear characteristic of them which is base on the specifications of composition oxides of impurities .as you can see in table2[5]

Table 2

Composition	Effects of adding composition
Cr_2O_3, SiO_2	Has some effects on grain boundaries which increases the breaking voltage
Sb_2O_3,NiO,Cr_2O_3, Glas phaza	In high temperatures increase varistor's stability against electrical field and humidity
Bi_2O_3,Pr_2O_3 v.s	It helps to create the liquid in the inter crystal space and to formulize the borders of inter crystal spaces

The attendance of Cr_2O_3 has a positive effect on the grain boundaries, and makes them more stable against the external effects on the concentration of the charge carriers .the chrome ions exiting will be happened in near breakdown voltage s. Moreover another reason for being $\beta_2 < \beta_1$ is that ,effects is placed it is a great resistance on the way of the exited chrome from eternal effects to place instable crystal emptiness, and so , the 2nd type of varistors resistance is less dependent to the voltage. we think that the reason that increases the break down voltage and shift it to 550v is the effect of adding SiO_2. The 4 coordination like, SiO_2 will help to create the grain boundaries in other word when we add SiO_2 to the composition to make the crystal more a amorphous. In other side making the grain boundaries amorphous results in decreasing external effect on the varistor and it will reinforce the barrier characteristic of varistor.

4. CONCLUSION

The highlights of the experimental results obtained from this investigation can be summarized as:

1. Some reasons of electrical guidance process of polycrystalline structure materials are .

a) The impurity metal oxide particles which is added to the ZnO atoms have strong chemical bond which results in hard solution

b) To transmit across the potential barrier between crystal particle

c) The process of electrical transmission along the particles of crystal

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AŞQARLARIN SİNK OKSİDİ ƏSASLI VARİSTORLARIN ELEKTROFFİZİKİ XASSƏLƏRİNƏ TƏSİRİ

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İşdə müxtəlif tipli metall oksidlərinin sink oksidi əsaslı varistorlarının elektrofiziki xassələrinə təsiri tədqiq edilmişdir. Göstərilmişdir ki, xrom və silisium oksidləri sintez edilmiş varistorlarında sink oksidi dənəcikləri arasında aralıq fazanın yaranmasında mühüm rol oynayırlar. Bundan əlavə bir tərəfdən varistorların qeyri-xətti əmsalının qiymətinə təsir edirlər (azaldırlar) və digər tərəfdən onların açılma gərginliklərinin qiymətini tənzinləməyə imkan yaradırlar.

ВЛИЯНИЕ ПРИМЕСЕЙ НА ЭЛЕКТРОФИЗИЧЕСКИЕ СВОЙСТВА ВАРИСТОРОВ НА ОСНОВЕ ОКСИДА ЦИНКА

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В работе исследовано влияние окислов различных металлов на электрофизические свойства варисторов на основе оксида цинка. Показано, что в синтезированных варисторах основная роль в образовании фазы между зернами оксида цинка принадлежит окислам хрома и кремния. Кроме того, указанные окислы влияют на величину (уменьшают) коэффициента нелинейности варистора и позволяют регулировать величину напряжения его открывания.