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EFFECT OF BI_2O_3 AND SB_2O_3 ADDITIVES ON THE GEOMETRICAL DIMENSIONS AND DENSITY OF ZNO

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Annotation: *In order to define contribution of the additives there were carried experimental work by sintering prepared samples. There were prepared following compositions.*

Key words: *liquid-phase agglomerates, the initial weight, the grain, the sintering.*

ВЛИЯНИЕ ДОБАВОК BI2O3 И SB2O3 НА ГЕОМЕТРИЧЕСКИЕ РАЗМЕРЫ И ПЛОТНОСТЬ ZNO

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Аннотация: *С целью определения вклада добавок были проведены эксперимен-тальные работы по спеканию подготовленных образцов.*

Ключевые слова: *жидкофазный агломерат, первоначальный вес, зерно, спекание.*

Additives Bi2O3 and Sb2O3 used as liquid phase sintering agents during sintering ZnO. ZnO (composition Z). There were prepared following compositions: 99% mol ZnO + 1% mol Bi2O3 (composition ZB); 98% mol ZnO + 1% mol Bi2O3 + 1% Sb2O3 (composition ZBS).
From all compositions made 7 pieces of samples, which prepared by means of uniaxial press, 100MPa presser applied to all samples. 1% of PVA as lubricant used. The samples sintered at 800 and 1100° C during different periods – 60 and 360 min. Before and after sintering determined the initial height (L_0), the initial weight (W_0) and the compact density (geometric determination).

Sintering experimental results

Sample n°	Comp.	Temp. (°C)	Time (min)	W_0 (g)	L_0 (cm)	D_0 (cm)	$\%r_0$	W (g)	L (cm)	D (cm)	%W	%L	%r	$\%W_{Avg}$	$\%L_{Avg}$	$\%r_{Avg}$	G_{Avg} (mm)
1		---	---	1.507	0.525	1.030	60.7	---	--		---	---	---	---	--	---	0.16
2				1.504	0.530	1.030	60.1	1.479	0.520	0.990	-1.7	-1.9	65.2				
3			60	1.503	0.535	1.030	59.4	1.481	0.520	0.985	-1.5	-2.8	65.9	**-1.5**	**-3.2**	**66.4**	**0.54**
4		800		1.492	0.525	1.030	60.1	1.472	0.500	0.985	-1.3	-4.8	68.1				
5				1.519	0.535	1.030	60.1	1.477	0.490	0.960	-2.8	-8.4	73.4				
6			360	1.514	0.520	1.030	61.6	1.459	0.470	0.965	-3.6	-9.6	74.8	**-2.5**	**-8.8**	**73.6**	**0.7**
7	Z			1.487	0.535	1.030	58.8	1.473	0.490	0.965	-1.0	-8.4	72.4				
8				1.500	0.530	1.030	59.9	1.471	0.445	0.875	-1.9	-16.0	96.9				
9			60	1.502	0.510	1.030	62.3	1.479	0.435	0.890	-1.5	-14.7	96.4	**-1.8**	**-15.9**	**96.8**	**3.2**
10		1100		1.483	0.530	1.030	59.2	1.457	0.440	0.875	-1.8	-17.0	97.1				
11				1.524	0.535	1.030	60.3	1.483	0.450	0.870	-2.7	-15.9	97.7				
12			360	1.506	0.535	1.030	59.5	1.477	0.450	0.870	-1.9	-15.9	97.4	**-2.4**	**-16.5**	**97.9**	**11.9**
13				1.501	0.535	1.030	59.4	1.464	0.440	0.870	-2.5	-17.8	98.7				
24		---	---	1.544	0.520	1.030	62.8	---	---		---	---	---	---	---	---	---
21	ZB			1.562	0.525	1.030	62.9	1.479	0.450	0.890	-5.3	-14.3	93.2				
22		800	60	1.501	0.520	1.030	61.1	1.473	0.445	0.890	-1.9	-14.4	93.8	**-3.1**	**-14.1**	**93.3**	**1.65**
23				1.509	0.520	1.030	61.4	1.474	0.450	0.890	-2.3	-13.5	92.8				

Sample n°	Comp.	Temp. (ºC)	Time (min)	W_0 (g)	L_0 (cm)	D_0 (cm)	$\%f_0$	W (g)	L (cm)	D (cm)	%W	%L	%r	$\%W_{Avg}$	$\%L_{Avg}$	$\%r_{Avg}$	G_{Avg} (mm)
25				1.526	0.520	1.030	62.1	1.459	0.445	0.885	-4.4	-14.4	94.0				
26			360	1.506	0.510	1.030	62.5	1.463	0.440	0.885	-2.8	-13.7	95.3	**-3.6**	**-14.2**	**95.0**	**5.7**
27				1.525	0.520	1.030	62.1	1.469	0.445	0.880	-3.7	-14.4	95.7				
28				1.538	0.525	1.030	62.0	1.477	0.440	0.895	-3.9	-16.2	94.1				
29			60	1.493	0.515	1.030	61.3	1.454	0.450	0.880	-2.6	-12.6	93.6	**-2.7**	**-14.1**	**93.7**	**12.5**
30		1100		1.506	0.520	1.030	61.3	1.481	0.450	0.890	-1.7	-13.5	93.3				
31				1.502	0.520	1.030	61.1	1.446	0.440	0.880	-3.7	-15.4	95.3				
32			360	1.573	0.520	1.030	64.0	1.455	0.440	0.880	-7.5	-15.4	95.8	**-5.4**	**-15.4**	**95.4**	**18.8**
33				1.535	0.520	1.030	62.4	1.458	0.440	0.885	-5.0	-15.4	95.0				
40		---	---	1.508	0.535	1.030	59.7	---	---	---	---	---	---	---	---	---	---
41				1.499	0.520	1.030	61.0	1.484	0.515	1.030	-1.0	-1.0	61.0				
42			60	1.503	0.530	1.030	60.0	1.491	0.525	1.030	-0.8	-0.9	60.1	**-1.2**	**-0.6**	**60.6**	**0.21**
43		800		1.518	0.520	1.030	61.8	1.489	0.520	1.030	-1.9	0.0	60.6				
44				1.498	0.520	1.030	60.9	1.475	0.495	1.015	-1.5	-4.8	64.9				
45			360	1.533	0.520	1.030	62.4	1.478	0.500	1.020	-3.6	-3.8	63.8	**-2.7**	**-4.5**	**64.4**	**0.43**
46	ZBS			1.522	0.525	1.030	61.4	1.478	0.500	1.015	-2.9	-4.8	64.4				
47				1.500	0.520	1.030	61.0	1.465	0.440	0.890	-2.4	-15.4	94.3				
48			60	1.497	0.520	1.030	60.9	1.461	0.440	0.895	-2.4	-15.4	93.1	**-2.7**	**-15.7**	**93.5**	**10.2**
49		1100		1.510	0.525	1.030	60.9	1.46	0.440	0.895	-3.3	-16.2	93.0				
50				1.541	0.520	1.030	62.7	1.446	0.430	0.885	-6.2	-17.3	96.4				
51			360	1.503	0.520	1.030	61.2	1.449	0.435	0.880	-3.6	-16.3	96.6	**-4.3**	**-16.6**	**96.5**	**11.9**
52				1.514	0.525	1.030	61.0	1.465	0.440	0.880	-3.2	-16.2	96.5				

Table 1. Change of the samples' parameters after sintering

In the Table 1 brought changes of dimensions, density and grain growth of three different samples by vary of the sintering temperature and time. The Figure 1 shows the grain growth in the compositions.

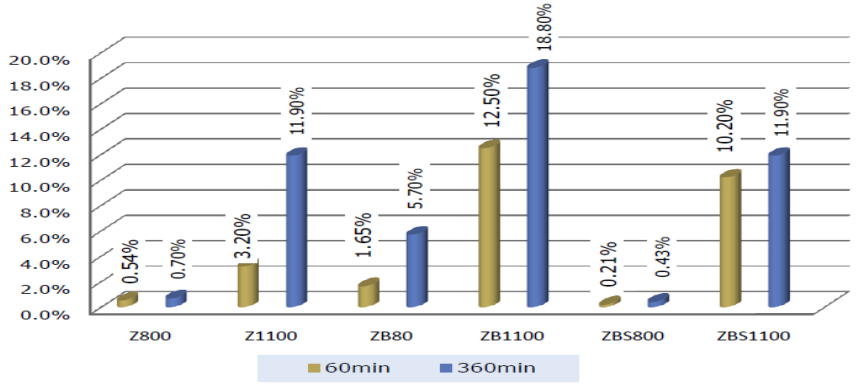

Figure 1. Grain size of the powder according to the change of sintering temperature and time

The Z sample's particles at 1100° C in 3 hours growth up to 12%, in 60 minutes the rise reached 3.2%. However by 800° C sintering in neither 60 nor 360 min the growth of the Z composite particles changed not much, only 0.54 to .0.7%.
The sintering process of ZB composition resulted differently than Z composition because of the existence of the Bismuth III oxide. The presence 1% of this oxide in the zinc oxide, comparatively with lower melting temperature oxide caused to reach 93,3% densification (Figure 2) 60 min sintering at 800°C.

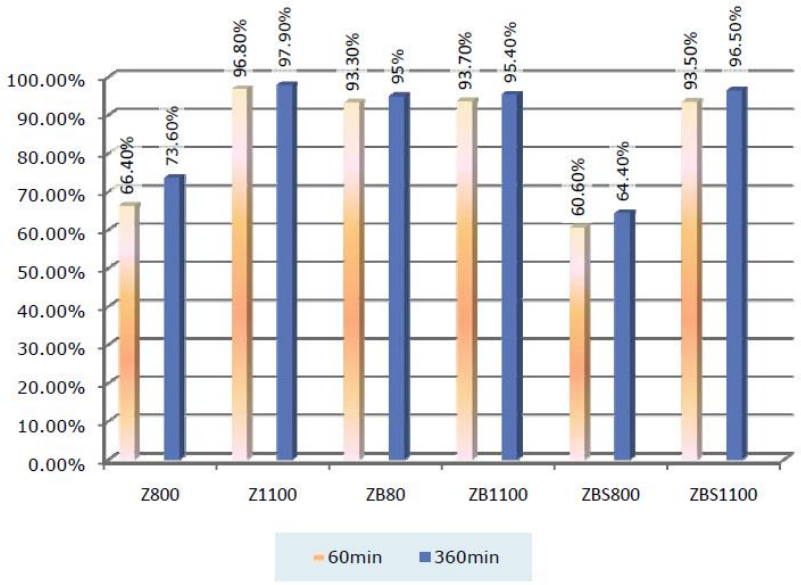

Figure 2. Densification variation according to the change of sintering temperature and time

The grain size of particles increased up to 1.65%. The time of sintering did not affect much to the densification of the particles, i.e. their size became bigger 1.7% than in 60min sintering (Figure 1). But the grain size of particles increased for 4%.
The ZBS composition contains three different oxides, i.e. ZnO+ Bi2O3+Sb2O3 Figure 21.
The structure of Sb2O3 depends on the temperature of the sample. Diametric Sb4O6 is the predominant form even at a temperature as high as 1560 °C [1]. Sb4O6 molecules are bicyclic cages, similar to the related oxide of phosphorus, phosphorus trioxide[2]. The cage structure is retained in a solid that crystallizes in a cubic habit. The Sb-O distance is 1.977 Å and the O-Sb-O angle of 95.6°.[3] This form exists in nature as the mineral senarmontite [2]. Below 606 °C, the more stable form is orthorhombic, consisting of pairs -Sb-O-Sb-O- chains that are linked by oxide bridges between the Sb centers.

One can conclude that sintering of zinc oxide with 1% presence of bismuth oxide helps to reduce porosity until 5% at 800°C.

With different additives, definite sintering temperature and time is possible control such as:
Density of the composition;
Graings' sizes of the composition.

1. Egon Wiberg, Arnold Frederick Holleman (2001) *Inorganic Chemistry*, Elsevier ISBN 0123526515
2. Wells, A.F. (1984) Structural Inorganic Chemistry, Oxford: Clarendon Press. ISBN 0-19-855370-6.
3. C. Svensson "Refinement of the crystal structure of cubic antimony trioxide, Sb2O3" Acta Crystographica, 1975, volume B31, pp. 2016-2018. doi:10.1107/S0567740875006759