Journal Homepage: - www.journalijar.com
INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)
Article DOI: 10.21474/IJAR01/2804
DOI URL: http://dx.doi.org/10.21474/IJAR01/2804
ISSN NO. 2320-5407

RESEARCH ARTICLE

SYNTHESIS AND X-RAY ANALYSIS OF COMPLEX FERRITE $BILIFE_2O_5$

M.M. Mataev[1], M.R. Abdraimova[1,*], S.M.Saxena[2], D.Zh.Nuketaeva[1], Zh.I.Tursinova[1] and H.Hamidov[3].
1. Kazakh State Women`s Teacher Training University, Almaty, Kazakhstan.
2. University of Cambridge, Cambridge.
3. National university of Uzbekistan, Tashkent.

Manuscript Info

Manuscript History

Received: 15 November 2016
Final Accepted: 17 December 2016
Published: January 2017

Key words:-
ferrites, crystal system, radiographic and pycnometric density, unit cell parameters

Abstract

The paper describes the synthesis and X-ray study of a complex structure of ferrite BiLiFe2O5. Ferrite with mixed complex oxide $BiLiFe_2O_5$ was synthesized by high temperature solid state reaction. The structure of the ferrites, type of syngony, parameters of the unit cells, radiographic and pycnometric densities were determined by X-ray phase analysis for a first time: -a=5,277, c=13,86Å, Vun.cell = 1054,6 $Å^3$, Z=12, ρrad = 7,7022, g/cm3, ρpicn = 7,7031 г/см^3. A comparative analysis of the relationship between crystal lattice parameters with parameters of the crystal lattice of initial oxides and complex ferrites has been performed.

Introduction:-

Semiconductor materials, which functionality is stipulated by electron charge are generally used in modern electronics. Increasing requirements to electronic devices expose the problem of search and implementation of alternative materials, working on non-classical principles. The basis of future electronic can become spintronics devices that use both electron charge and its spin [1].

Spintronics became known after opening the effect of discovery of “giant” magnetoresistance (GMR), which is stipulated by different scattering on ferromagnetic impurities of two groups of electrons’ spins with “up” and “down”. This selection requires the significant difference between the average lengths of free path of the electrons with “up” and “down” directions of the spins. This occurs in ferromagnetic materials characterizing by differences in the density of the free states of electrons caused by exchange splitting of 3d zone. This principle lays in the basis of magnetoresistive devices implementing the effects of the giant and tunnel magnetoresistance [2].

Literature data analysis shows that ortoferrites $BiFeO_3$ or socalled multiferroics are the most studied of ferrities that simultaneously have the electric polarization and magnetic ordering. The ortoferrites are prospective for implementation as the working environment in the data storage and processing devices. At the present time, the search of new materials with ferroelectric properties and specific electronic and magnetic structures is performed using the most famous multiferroic for. Substituted perovskites based on the bismuth ferrites often combine ferroelectric and weak ferromagnetic properties with the dominant antiferromagnetic ordering [2, 3].

This study is to investigate the conditions for obtaining and X-ray features of new classes of complex mixed bismuth ferrites, in which Bi+3 is partially substituted by the ions of rare-earth elements and sodium.

Experimental part:-

Corresponding Author:- M.M. Mataev.
Address:- Kazakh State Women`s Teacher Training University, Almaty, Kazakhstan.

New polycrystalline complex of bismuth ferrites were synthesized by ceramic processing technology. Bismuth oxide (III) (mark "chemically pure"), lithium carbonate (mark "highly-pure") and iron oxide (III) (mark "chemically pure") were used as the initial components. Solid-phase synthesis was carried using the thermal data of the initial components taking into account Tamman conditions for ceramic reactions [4,5]. Stoichiometrically calculated mixtures of initial components preliminary annealed in a muffle furnace at 400ºC for one hour, were thoroughly stirred and the calculated mixture of the starting components are thoroughly mixed and grinded in an agate mortar, placed in an alundum crucibles, and annealed in a silite furnace. Annealing was performed by two stages: first stage at 600ºC for 48 h and second stage at 800ºC for 20 h [6].

Formation of new phases was controlled by X-ray scattering analysis performed using the radiologic diffractometer X-ray MiniFlex 600 (Rigaku). The conditions of analysis included: CuKα – radiation, Ni – filter, U=40 kV, I=10 mA, rotation rate – 1000 impulses/s, and time constant τ =5 s, $2\theta = 10° - 90°$. Diffraction peaks were evaluated using hundredpoint scale. Radiographs of the synthesized polycrystalline powders were indexed by the homology method (homologue is distorted structure type of perovskite) [7]. Pycnometric density of manganites was determined by the method described in [8]. Toluene served as indifferent liquid. The density of each ferrite was measured 4 – 5 times and the data were averaged. Table below shows the results of indexing of radiographs of ferrites. In a [Table 1] shows the results of X-ray indexing ferrites.

Table 1:- Indexing of radiographs of the synthesized phase composition $BiLiFe_2O_5$

№	[°2Th.]	d[Å]	Int. [%]	$10^4/d^2$ эксп.	hkl	$10^4/d^2$ теор.
1	12.29	7.198	0.1	193	(1,1,0)	197
2	17.41	5.089	1.2	386	(2,0,0)	384
3	21.37	4.156	2.6	578	(2,1,1)	579
4	24.72	3.599	18.1	772	(2,2,0)	777
5	27.69	3.219	100.0	965	(3,1,0)	963
6	30.40	2.938	24.3	1158	(2,2,2)	1156
7	32.90	2.720	67.9	1351	(3,2,1)	1355
8	35.24	2.545	3.1	1543	(4,0,0)	1547
9	37.45	2.399	5.7	1737	(3,3,0)	1735
10	39.56	2.276	6.9	1930	(0,2,4)	1935
11	41.58	2.170	10.4	2123	(3,3,2)	2121
12	43.52	2.078	10.5	2315	(4,2,2)	2318
13	45.40	1.996	13.7	2510	(1,3,4)	2515
14	48.97	1.858	5.2	2896	(5,2,1)	2893
15	50.69	1.799	0.2	3089	(4,4,0)	3086
16	52.37	1.746	31.4	3280	(0,3,5)	3284
17	54.01	1.696	15.4	3476	(6,0,0)	3474
18	55.61	1.651	23.1	3668	(5,3,2)	3669
19	57.19	1.609	0.4	3862	(6,2,0)	3867
20	58.74	1.571	2.3	4051	(5,4,1)	4055
21	60.26	1.535	2.2	4244	(6,2,2)	4242
22	61.76	1.501	15.3	4438	(6,3,1)	4436
23	63.24	1.469	1.4	4634	(4,4,4)	4638
24	64.70	1.440	6.8	4822	(3,4,5)	4825
25	66.15	1.412	1.7	5015	(0,4,6)	5017
26	67.57	1.385	3.5	5213	(7,2,1)	5211
27	68.99	1.360	1.5	5406	(2,4,6)	5408
28	70.39	1.337	1.1	5594	(0,3,7)	5592
29	73.15	1.293	3.2	5981	(6,5,1)	5981
30	74.52	1.272	0.3	6180	(8,0,0)	6184
31	75.87	1.253	2.0	6369	(1,4,7)	6366
32	77.22	1.234	0.8	6567	(0,2,8)	6567
33	78.57	1.217	9.4	6751	(3,5,6)	6755
34	79.90	1.200	8.6	6944	(6,6,0)	6946

35	81.23	1.183	7.1	7145	(1,3,8)	7147
36	82.56	1.168	0.2	7330	(6,6,2)	7334
37	83.88	1.153	1.9	7522	(2,5,7)	7520
38	85.20	1.138	0.5	7721	(8,4,0)	7724
39	86.51	1.124	2.0	7915	(9,1,0)	7917
40	87.83	1.111	2.6	8101	(8,4,2)	8103
41	89.14	1.098	3.6	8294	(9,2,1)	8296
42	90.45	1.085	0.5	8494	(6,6,4)	8492
43	91.77	1.073	2.7	8685	(7,5,4)	8684

Results:-

On the basis of X-ray diffraction of the synthesized compounds indexing $BiLiFe_2O_5$ found that ferrite crystallized in the tetragonal structure with the following unit cell parameters: -a =5,277, c=13,86Å, Vun.cell = 1054,6 $Å^{3,}$ Z=12, ρrad = 7,7022, g/cm3, ρpicn = 7,7031 г/см^3.

The correctness of the results of the ferrite indexing confirmed the good agreement of the experimental and calculated values of the reciprocals of the squares of the distances between planes ($10^4/d^2$), consistency of values of X-ray and pycnometric densities.

Conclusions:-

$BiLiFe_2O_5$ crystallizes in the tetragonal system, analysis of the relationship between the parameters of the crystal lattice parameters of the original δ-Bi_2O_3 shows equality and parameter and increase the value of the parameter to twice the sum of the values of the even squares Miller index ($h^2 + k^2 + l^2$) shows a body nature of the crystal lattice.

Corresponding Author:-
Dr. Mataev, Kazakh State Women`s Teacher Training University, Almaty, Kazakhstan

References:-

1. *Mustafin E. S., Mataev M. M., Kasenov R. Z., Pudov A. M., Kaikenov D. A. and Bogzhanova Zh. K.* X-ray Diffraction Study of the $YbFe_5O_{12}$ (MII = Mg, Ca, Sr) Ferrites // Inorganic Materials, 2014 - Vol. 50, No. 6, pp. 622–624.
2. *Cobva L.M., Trunov B.K.* X-ray phase's analyze// M.: Pub.house MGU.-1976.-256 p.
3. *Kivilis S.S.* Technique density measurement of liquids and solids. M.: Standartgis.-1959.-191 p.
4. *Ramesh R. and Spaldin N. A.* Multiferroics: progress and prospects in thin films// Nature Materials 6, 21 (2007).
5. *Gavrilova L.Ya., Aksenova T.B., Cherepanova V.A.* Phase equilibria and crystal structure of complex oxides in the system Ln-M-Fe-O (M-Ca,Sr) //Journal of Inorganic Chemistry, 2008. – T.53, №6. – p.1027-1033.