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Magnetic Study of BiPbSrCaCuZnO Super Conducting thin film Synthesized by pulsed Laser Deposition (PLD) Method

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ABSTRACT

In this research, the effect of transition metal Zn doping to Bi PbSrCaCuO were studied. Various weight ratio (0.2, 0.4, 0.6, 0.8, and 1) of Zn to BiPbSrCaCuO were prepared by using pulsed laser deposition Method (PLD). The effect of Zn doping to BiPbSrCaCuO were examined using a variety of characterization techniques, X-ray diffraction and vibrating sample magnetometer (VSM) this examination was done in the Islamic republic of Iran at University of Tehran. The XRD, reveals that Zn-doped BiPbSrCaCuO film crystallizes in tetragonal structure with mixture of two phases 2212 and 2223. The high phase 2223 increase with increasing Zn dopant especially was found higher at (Zn= 0.6, 0.8). The electrical properties of undoped and doped samples, were measured by four probe technique, the phase transition from normal resistivity to absence resistivity occurring at temperature called critical temperature Tc the values of T_C for variable Zn substitution in BiPbSrCaCuO recorded (97, 90, 95, 102) and super conducting behavior. The saturation magnetization (MS) was found higher for undoped as compared to doped samples.

KEYWORDS: Bi PbSr CaCuO; Zn; XRD; VSM.

INTRODUCTION

Since the discovery of the Bi-based high temperature ceramic superconductors, many researches have been carried out to characterize properties of the materials [1-3]. Preparation method, chemical doping, substitution, addition and diffusion play a very important role on critical super conducting parameters of high- T_C super conducting. [4,5]

There are several phases in the BSCCO system. The composition of each phase is expressed by the general formula of (Bi, Pb) $Sr_2Ca_{n-1}Cu_nO_x$ (n=1,2,3) and T_C of ~ 20, 95 and 110 k respectively. The phases are called Bi-2201, Bi-2212 and Bi-2223 for n= 1,2,3 respectively [6]. In these series Bi-2223 is the most attractive because its super conducting transition temperature TC, is the highest one, about 110 K. The system contains non-toxic elements and its preparation is cheap, which makes it a very promising material for technical. There are several studies that analyze various doping elements in different sites of BSCCO, such as rare earth elements, oxides as Cr_2O_3, and some alkali metals and transition elements (Na, Ba, Zn, Fe, Hg, Pb) [7,8].

Those studies have shown changes in crystal structure, electric morphologic and magnetic properties above a certain dopant content. In this work, have been studied the doping effects on the crystal structure, electrical and magnetic properties of the $BiPbSrCaCu_{3-x}Zn_xO$, thin film samples were prepared by pulsed laser deposition (PLD).

EXPERIMENTAL PART

$BiPbSrCaCuZn_xO$ bulk samples for x (0.2, 0.4, 0.6, 0.8 and 1) prepared by solid state reaction using weight of pure material Bi_2O_3, Pb_3O_4, $SrNO_3$, CaO, CuO and ZnO. The weight was measured by using a sensitive balance type (Metter H35 AR). Mixing the powder and grinding it using agate mortar for about (50-60) minute adding propane on it to obtain homogenize, the mixture then enters to a furnace at 1093 K for 24h after that mill calcinations mixture to fine powder for 30 minutes, pressing the mixture at 0.5 Ga as a pellet shape thickness between (2-3) mm, 13 mm diameter using hydraulic pressure type (Spectroscopy Sample Packs) (Specac). Finally enter these pellets to furnace at 1133K for 140h.

Experimental setup of pulse laser deposition; shown in Figure 1. BiPbSrCuZnO target mounted in vacuum chamber with 10-4 mbar and ablated frequency by a double frequency with Q-switched Nd: YaG pulse laser operated at 532 nm, pulse duration of a bout 7n sec with (0.4 -8 J/cm^2) energy density focused on the target to generate plasma plume. All samples were grown at Si substrate with (111). Oxygen background pressure of 2×10^{-3} m bar used. BiPbSr CaCuZnO samples were deposited by pulse laser deposition at substrate temperature 573K

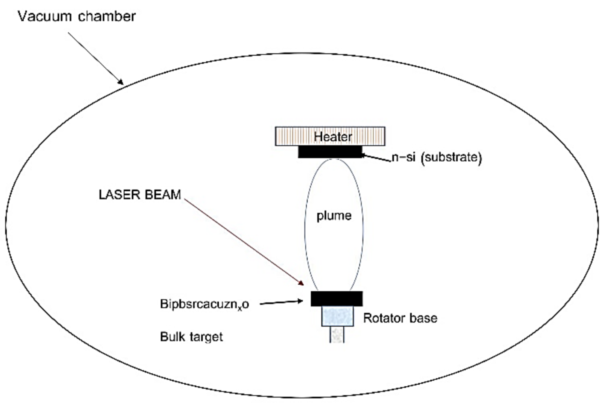

Figure 1. Experimental setup of pulse laser deposition.

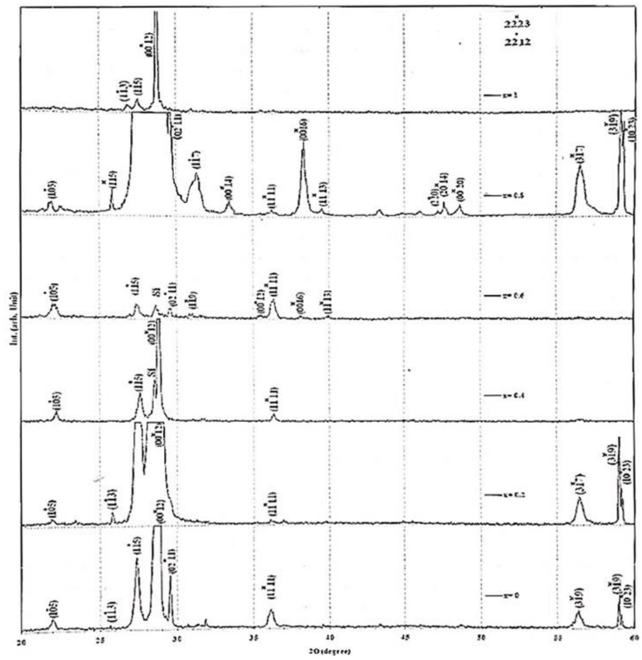

Figure 2. XRD patteren of BiPbSrCaCuOZnO thin films with different X (0.2, 0.4, 0.6, 0.8, and 1) deposited on (111) silicon.

RESULTS AND DISCUSSION

Figure 2 shows the XRD patterns of pure and different concentrations of Zn-doped BiPbSr CaCuO thin films. It can be seen that undoped and doped samples exhibit diffraction peaks of low phases (105), (113) and high phases (0012), (115), (1111) and (1113), also the Bi (2223) increase with increasing Zn concentration where acts as a phase stabilizer, due to the annealing temperature at 1093K enhance growth the high phases.

The ρ-T measurement by four probes, have been observed that the TC increase with increasing Zn. The more increasing was at x=0.8 where T_C= 102 K Show in Figure 3.

The high T_C at x= 0.8 due to interaction between cation Cu and onion O which reduced potential barrier and lead to creation path for super pairs to penetrate a potential energy barrier with energy greater than the total energy of the particle this phenomenon is Quantum tunneling, also increase oxygen ratio in CuO_2 layer where Tc depend on oxygen ratio.

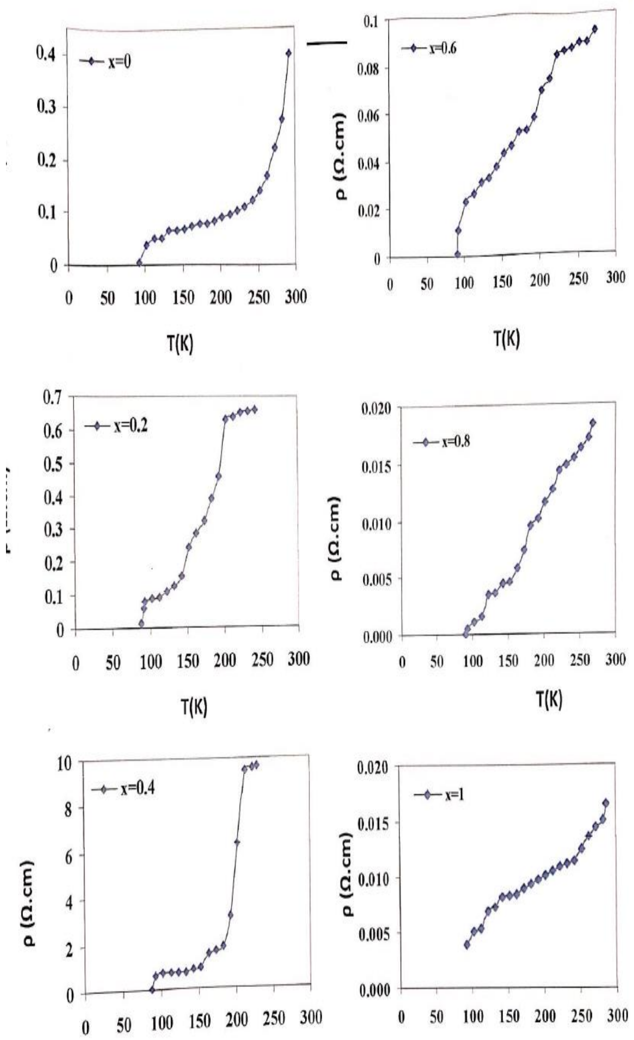

Figure 3. ρ-T curves of Bi PbSrCaCuZn$_x$O film samples for x (0, 0.2, 0.4, 0.6, 0.8 and 1).

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The magnetic properties of undoped and Zn-doped BiPbSrCaCuO films super conducting are investigated with vibrating sample magnetometer VSM as shown in Figure 4

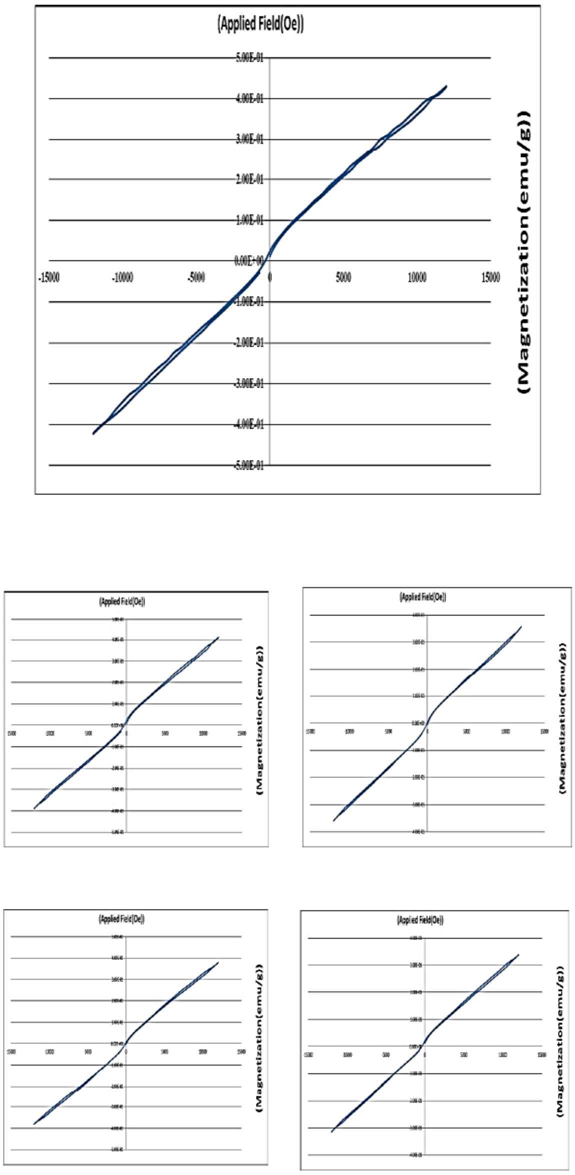

Figure 4. magnetization versus magnetic field M-H for Bi PbSrCaCuZn$_x$O at variable concentration Zn (x= 0.2, 0.4, 0.6, 0.8, and 1).

The obtained curves show typical weak hysteresis loops, the undoped sample recorded maximum saturation magnetization MS which depends up on induced lattice strain [9], and less values at x=0.6, 0.8, this due to presence of spinless divalent like Zn^{+2} (nonmagnetic impurities) in the planes CuO_2 which destroys long rang order of spin system which almost of the magnetic domains lose their alignment. [10,11] So that magnetization M do not retain in the material and behaves diamagnetic material. Both residual magnetization (Mr) and saturation magnetization (Ms).

Table 1. Extracted magnetization parameters from M-H curves of pure and Zn-doped BiPbSrCaCuO film

X	Ms (emu/g)	Mr (emu/g)
0	0.45	0.03
0.2	0.42	0.01
0.4	0.41	0.01
0.6	0.37	0
0.8	0.35	0.002
1	0.39	0

decreased with increasing Zn-no remain magnetized Mr after the external field was removed and recorded minimum values at 0.6, 0.8,1. This paper describes magnetic effect ZnO in perovskite lattice depend on paper studied structural and magnetic properties of super paramagnetic $Fe_3O_4@SiO_2$ core/shell nanocomposite for biomedical applications.[11]

CONCLUSIONS

Can be conclude the following:

1. The crystalline grow occurred toward C-axis, due to existence Zn impurities can affect all stages of crystallization process. Since they simultaneously influence kinetic and thermodynamic factor, they induced, at least conflicting effects on nucleation and growth mechanisms toward C-axis.
2. The height TC and x= 0.8, the correlation of cooper pairs is very strong, no distortion in their path, this means no penetration of magnetic field.
3. The material recorded less Ms, Mr at x=0.8 refer to spin of electrons P shells of Zn atom are in opposite direction, so the resultant total magnetic momentum equal to zero.

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