FABRICATION OF SRAM MEMORY DEVICES USING Co-DOPED SnO_2 NANOPARTICLES

V. RUKKUMANI[a*], N. DEVARAJAN[b] , M. SARAVANAKUMAR[c]
[a]*Asst.Professor,Department of Electronics and Instrumentation Engineering, Sri Ramakrishna Engineering College, Coimbatore, India*
[b]*Department of Electrical and Electronics Engineering,Government College of Technology, Coimbatore, India*
[c]*Asst.Professor,Department of Physics, SVS College of Engineering,Coimbatore, India.*

SRAM memory cell consists of many input signals like precharge, write enable, sense amplifier enable, read enable and row and column encoders. To develop a novel SRAM design, different transistor circuits are available. So, SRAM design cell depend the properties of magnetic and optical properties of semiconductors. The saturation magnetization and coercivity values of the sample prepared using 0.3 M, 0.4 M $SnCl_2.2H_2O$ are 6.3540 x 10^{-3}, 1.7939 x 10^{-3} and 96.826, 89.852. The magnetic studies carried out on the prepared samples shows that only the sample prepared using 0.3 M concentration of $SnCl_2$ exhibits good magnetic properties. So, the transition metal Co have been doped only in 0.3 M $SnCl_2$ preparedo SnO_2 samples. The average grain size is found to lie in the range of 9.9 – 24.6 nm. The chemical compositions of the prepared samples have been studied using the energy dispersive X-ray analysis. From this study concluded Cobalt doped SnO_2 material is suited for making memory devices.

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1. Introduction

Oxide based diluted magnetic semiconductors have been attracting passionate interest to the current researchers due to their potential applications in Spintronics .The materials can exploit both charge and spin degrees of freedom of electrons to create new functionalities beyond conventional semiconductors. Memory organizations have become an indivisible part of modern VLSI systems. Semiconductor memory act as a standalone memory chips but also as an integral part of complex VLSI systems.The basic storage elements of semiconductor memory have remained essentially unchanged for quite some time (1). The most common approach to drive a semiconductor ferromagnetic is that of diluted magnetic semiconductors (DMSs), which is obtained by doping a non-magnetic semiconductor with a few atomic percent of transition metal (TM) elements (V,Cr,Mn,Fe,Co, Ni and Cu). Recently, magnetic semiconductors have been studied extensively with the doping of magnetic transition metal ions (Co, Mn, Cr and Ni) for multidisciplinary magneto electronic devices. Further the dilute magnetic semiconductors with high T_c is needed for real life advanced spintronics device fabrication technology (2).In this view among the elements, ,Co and will be most suitable non-magnetic transition metal ions with good conductor of heat and electricity (3) . Furthermore, ion radius of Co are smaller as compared to other transition metals and it can be easily substituted by Co into any semiconductor oxide. Among the various host semiconductor oxides for dilute magnetic semiconductors a unique structural featured ZnO, SnO_2 and TiO_2 have been received a great research interest. In the form of nanosize powders and thin layers of nanostructures exhibited reasonable room temperature ferromagnetism (RTFM) which is observed with the presence and absence of transition metal

[*] Corresponding author: rukkumani.v@srec.ac.in

doping that was studied by many research group. It is cleared that synthetic conditions, temperature, particle size and micro structure of the semiconductor oxides also greatly influences on the magnetic and optical behavior (4). Therefore, it is note worthy to control the material structure using different synthetic route to obtain the desired property.

2. Experimental details

SnO_2 nano particles doped with three different concentration of Co 2%, 4% and 6% were prepared by chemical co-precipitation method. The precursors for dopant and host were cobalt nitrate hexahydrate $Co(NO_3)_2.6H_2O$ and tin chloride ($SnCl_2.2H_2O$) respectively. Using the tin chloride solution and various concentration of Co $(NO_3)_2.6H_2O$ has been used to prepare 2%, 4% and 6% M respectively. The brown colored precipitate was formed during the process. The obtained product was placed in oven for 8h at 100^oC.

3. Result and discussion

Fig.1 shows the X-ray diffraction pattern of the 2%,4% and 6% cobalt-doped SnO_2 samples. The peak position in the diffraction pattern match with the rutile phase tetragonal system (JPCPDF 41-1445)). The obtained crystallite size of the samples in the range of 11-17 nm which was calculated by Scherer's relation. It is observed that the crystallite size increases with increasing the dopant Co concentration. This implies that Co ions get accommodated at the Sn site without changing the rutile structure of Co doped SnO_2 nano particles . However, when Co doping concentration increases, a metastable or the tetragonal phase of SnO_2 arises and the crystallite size increases abruptly.

Fig.2 shows the room-temperature magnetization versus magnetic field (M–H) curves of the Co-doped SnO_2 samples, in which the diamagnetic data of the background have been subtracted. All the curves exhibit clear hysteresis phenomenon, demonstrating the room temperature ferromagnetism of the samples.

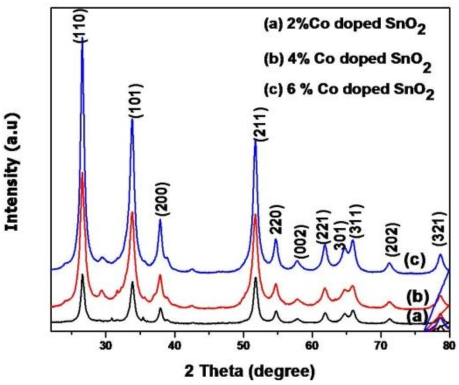

Fig. 1. XRD Pattern of (a) 2% Co Doped SnO_2 (b) 4% Co Doped SnO_2 (c) 6% Co Doped SnO_2

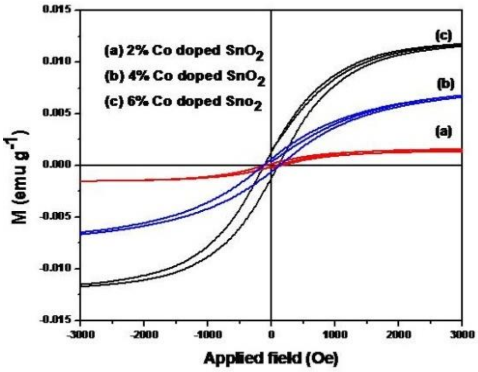

Fig.2. Magnetisation curve of Co doped SnO_2

The localized spins of the Co ions interact with the charge carriers which are bound to oxygen vacancies, resulting in a magnetic polarization and forming the bound magnetic polaron (BMP) (6). When incresing the Co doped concentration, the magnetic behavoiur of the samples are incresed. Due to the reduction of oxygen vacancies suppresses the intensity of emission. It suggests that the introduction of the surfactant decreases the oxygen vacancies in the SnO_2 nano particles(7) . Thus, it is confirmed that the enhanced ferromagnetism in the nano particles has originated from the reduction of oxygen vacancies, which are induced by the surfactants. 6% of Co doped SnO_2 nanoparticles is the best ferromagnetic behaviour of the 2%,4% and 6 % Co doped SnO_2 samples.6 % Co doped SnO_2 nano particles is used in optoelectronic devices. Design and prepared the 10 T SRAM Cell using 6 % Co doped SnO_2 nano particles for the power factor reduction in different temperatures.

3.1. Design of sram cell using cobalt doped SnO_2

Most of the memory devices are made up of semiconductor materials like Silicon and Germaniam. In this paper Cobalt doped SnO_2 is used to fabricate 10T SRAM memory cell. The simulation of 10T SRAM cell with write driver enable circuitis also obtained and shown in figure 3. The power for both static and dynamic is calculated for various temperature range.Further increase in transistor count but the write speed increased compared to 8T SRAM cell. The simulation results, it has been proved that, the write driver circuit for a banked organization structure gives better response in suppressing delay and minimizing the total power consumption in 10T SRAM cell shown in figure.3.Table 1 shows various parameter measurement in 10T SRAM memory cell with various temperature conditions and the simulation of 10T SRAM cell as shown in figure 4, which concludes the reduction of power by increasing temperature

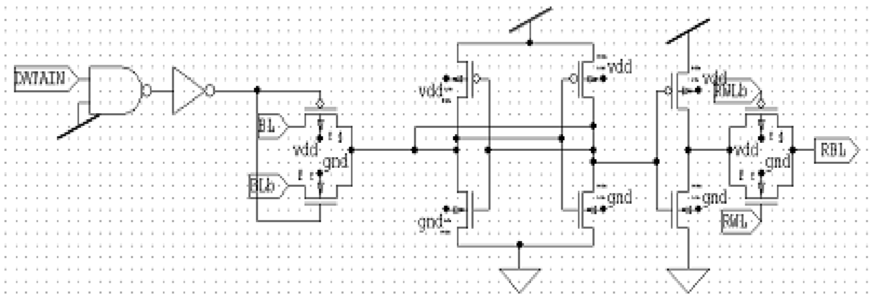

Fig. 3. Write driver and control circuit for 10 T SRAM Cell

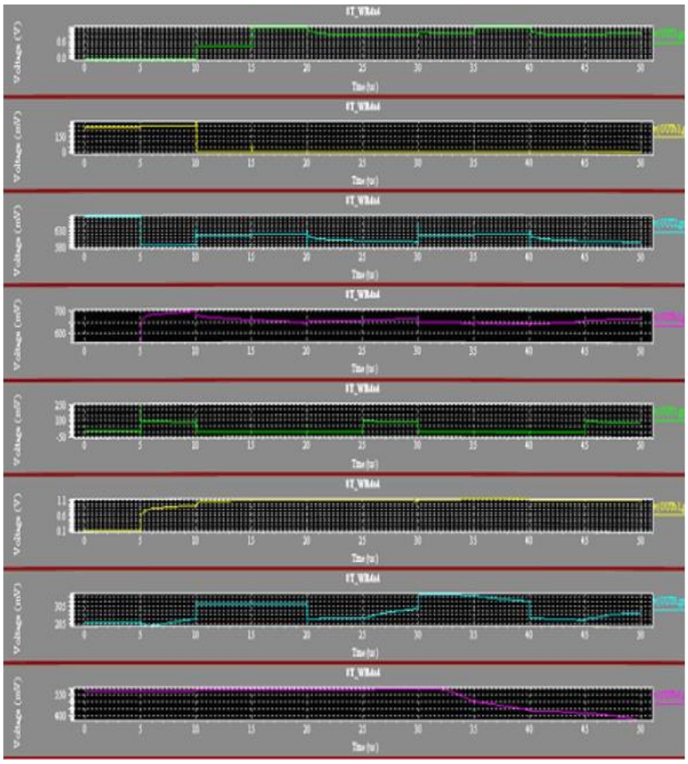

Fig. .4 Simulation output of 4X4 10T SRAM Cell

Table.1. Performance of write driver circuit in 10T SRAM memory cell using Cobalt doped SnO_2 Nanoparticles

Parameters	Temperature (°C)			
	25	**50**	**75**	**100**
Transient Analysis time (Sec)	7.778	81.61	154.39	203.61
Total time (Sec)	3.78	4.01	3.54	3.90
Static Power (Watts)	4.13	4.61	3.81	4.49
Dynamic Power (Watts)	0.112	0.131	0.192	0.192
Total Power (Watts)	0.057	0.056	0.050	0.050
Transient Delay (Sec)	4.334	6.429	14.372	14.372

4. Conclusions

Detailed investigations have been carried out on Co doped SnO_2 chemical co precipitation method used to design and prepare the 10T SRAM cell. In the present work the effect of concentration on the magnetic properties of Co doped SnO_2 nano particles has been investigated in detail. Nano particles of basic composition 2% ,4% and 6% Co doped SnO_2 have been prepared by the chemical precipitation method. The doping of Co in SnO_2 brought significant changes in the physical properties of the samples.

Magnetization measurement shows that saturation magnetization increased with doping which is attributed to large amount of induced defects and oxygen vacancies are formed in the sample.10 T SRAM Cell is prepared by using 6% Co doped SnO_2 The present investigation clearly points out that by increasing temperature the prepared samples produced a sweep decrease in power consumption. So that the integrated circuits and memories like SRAM and DRAM can be made by using Cobalt doped SnO_2 with various temperature conditions.

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