Bulk and Surface Electronic Properties in synthesized CoO clusters

Moumita Barman, Somnath Paul, A.Sarkar
Department of Physics
Bijoy Krishna Girls College
5/3 M.G. Road, Howrah 711101 W.B. India
E-mail alokesarkar@vsnl.net

Abstract

The Cobalt (II) oxide CoO clusters are chemically synthesized following natural self assembling in thermal process. The resulting specimen was examined DC I-V characteristics and conductivity measurement of solid specimen at room temperature. The developed CoO is found behave as a manipulative magnetic semiconductor under Mn doping.

1. Introduction

Cobalt (II) oxide (CoO) is an inorganic compound is prepared from cobalt acetated. Its appearance is a greyish black powder at RT. Its potential use lies with ceramic industry. It has been reported [1] that Cobalt oxide nanoparticle systems can be prepared by chemical sol-gel process. The capped nanoparticles of the CoO nanoparticles exhibit antiferromagnetism at low temperature. The Cobalt Oxide is a dilute magnetic semiconductor although its nature of magnetism in the form of nano composite is complicated however it is known as an anti-ferromagnetic system.

Transition metal oxides often exhibit novel phenomena of great fundamental and tecnological importance. In such cases Mn may be the spin manupulative dopant.

The present work involves growth of CoO and Mn doped CoO as DMS materials by chemical sol-gel process, studies of electrical transport studies. In following brief account of the entire work is summarized.

2. Sample

The Cobalt acetate hydrate, analytical grade (Alfa Aesar) was heated (about 300 C) for 8h to prepare CoO powder (S-1). The developed CoO powder was grinding and strongly heated (about 350 C) for 10h. Mn doping in CoO was carried out by chemical sol-gel process following thermal dissociation of common acetate sol. Anhydrous CoO and Mn doped CoO were taken in form of pellets prepared by mechanical pressing at pressure 12 ton/cm2 followed by sintering.

3. Experiment

DC current voltage characteristics (CVC) the developed pure and doped CoO specimens were studied. The developed pellet was sandwiched between two graphite electrodes for such electrical measurement. The applied field direction is perpendicular to the 2-D plane of the specimen. The DC CVC was recorded at room temperature by Keithley 2400 (USA) Source meter unit and plotted by using characterization software. The said measurement always provides information on bulk electrical conduction. When the applied field direction is parallel to the 2-D plane and on the specimen with suitable electrodes, the surface electrical conduction can be measured. In this work dc bulk conductivity and dc surface conductivity in presence of external magnetic field are measured. The later was undertaken to examine the magnetic aspects of the developed specimen.

UV-VIS absorption spectra of the Mn doped CoO specimens (3% and 10%) were studied with UV-2450 UV-VIS spectrophotometer, Shimadzu, Japan, between 190nm to900 nm at adequate accuracy using integrating sphere attachment in BaSO4 background. This study is undertaken to examine it optical band in the UV-VIS region.

DC bulk CVC for developed specimens is shown in Fig. 1. Fig.2 shows dc surface CVC with external magnetic field and it also compares the same to that with zero field condition. Fig.3 shows the variation of optical absorbance with wavelengths in UV-VIS region.

4. Results and Discussions

Fig. 1 shows dc bulk I-V character of pure CoO and Mn doped composite specimens. It has been analyzed that estimated conductivity, using sample geometry, increases regularly with increase in Mn concentration. Thus the effect of increasing Mn doping in CoO is leading to high conducting state in the CoO composite. The possibility enhancement of magnetic properties in the specimen may be expected to be high.

Fig.2 shows a delectable effect of external magnetic field on the Mn doped specimen. It is an indicator of spin manipulation by inclusion of Mn in CoO atleast in surface mode.

The UV-VIS absorption spectra of sample A(3%Mn) and sample B(10%Mn) is shown in the fig.3. The absorption peak for the second sample is blue shifted by $\Delta\lambda$=18.92777nm. with respect to first sample. The blue shift is due to quantum size effect which also indicates the presence of nano sized Mn2O3 particles with shorter dimension [4,5].

The indiect band gap of Mn doped CoO was estimated from the measured optical absorbance shown in Fig.3. and found to be 2.43eV (3% Mn) and 2.39.eV respectively for 3% and 10% Mn doped specimens.

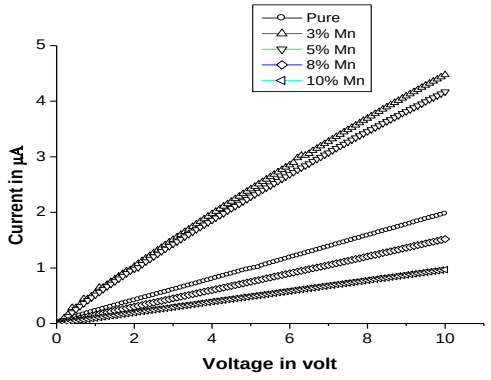

Figure 1. Dc bulk CVC of Pure and Mn doped CoO

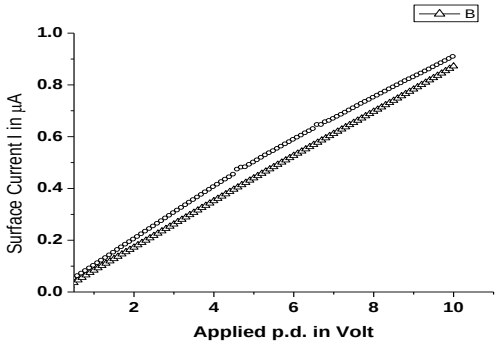

Figure 2. D.C surface CVC characteristics of the developed material with 5% Mn doped CoO at external Magnetic field 500 G (upper Curve) and at Zero field. (Lower Curve)

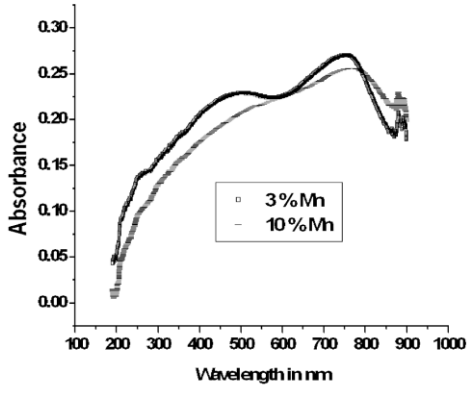

Figure 3. UV-VIS absorbance spectra for Mn doped CoO

5. Conclusion

CoO is magnetic semiconductor with moderate band gap. By varying the size of the nano-particles size and doping its electronic properties can be tailored. Mn could be good dopant in CoO system for manipulation of magnetic properties it.

6. Acknowledgment

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7. References

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