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A STUDY ON OXYGEN GAS SENSOR PROPERTY OF LITHIUM DOPED IRON OXIDE THIN FILM

M. KARUNAKARAN* and S. GOMATHI

Rev. Jacob Memorial Christian College, AMBILIKKAI, Dist. Dindigul (T. N.) INDIA

ABSTRACT

Thin film science now covers a wide span of disciplines such as solid state physics, surface science, crystallography, crystal growth process, optics, electronics, material science, etc. This subject initially confined only a few topics of physics such as general preparative methods by evaporation and condensation, sputtering, etc. Film properties are also sensitive not only to their structures but also to many other parameters including their thickness especially in thin film regions. A "thin film" may be arbitrarily defined as a solid layer having a thickness varying a few Å to about 10 μm or so. The objective of the work is to measure the sensor property of the **Lithium doped iron oxide** film for various temperatures in different medium such as air, vacuum and oxygen gas.

Key words: Resistance, Lithium doped iron oxide, Thin film.

INTRODUCTION

Thin film science now covers a wide span of disciplines such as solid state physics, surface science, crystallography, crystal growth process, optics, electronics, material science, etc. Film properties are also sensitive not only to their structures but also to many other parameters including their thickness especially in thin film regions[1-4]. A "thin film" may be arbitrarily defined as a solid layer having a thickness varying a few Å to about 10 μm or so. Some of the factors, which determine the physical, electrical, optical and other properties of a film are following viz, rate of deposition, substrate temperature, environmental conditions, residual gas pressure in the system, purity of the material to be deposited, inclusion of foreign matter in the deposit, in homogeneity of the film, structural and compositional variations of the film in localized or wider areas etc. Karunakaran et al.[5] have studied the oxygen gas sensor property of lithium doped iron oxide film by spray pyrolysis method. The objective of the work is to measure the sensor property of the lithium doped iron oxide film for various temperatures in different media such as air,

* Author for correspondence; E-mail: phy_karuna@yahoo.co.in

vacuum and oxygen gas.

EXPERIMENTAL

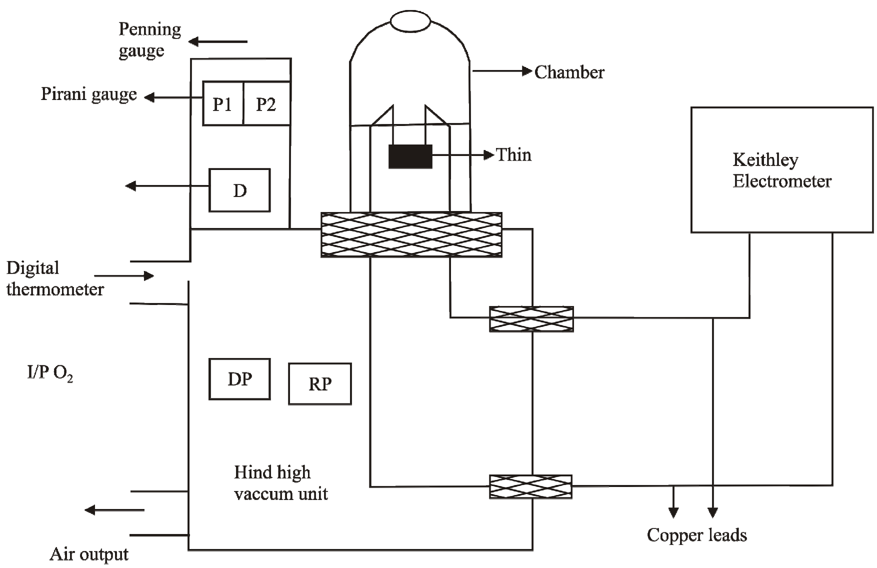
Methods and materials

Preparation of lithium doped iron oxide film

The lithium doped iron oxide film were prepared by RT Model spray pyrolysis method

Experimental design

The experimental design for the measurement of resistance to the thin film is shown in following the Fig. 1.



DP = Diffusion pump; RP = Rotary pump; P1 = Penning gauge; P2 = Pirani gauge

Fig. 1

This experimental set up contains a vacuum unit and a Keithley electrometer, used for the measurement of thin film resistance. The Keithley electrometer can make ohms measurement from 10 MΩ to 210 GΩ. The resistance of the thin film is measured in three media. These are air, vacuum, oxygen gas. It contains three steps.

First, the resistance in air thin film fixed in the chamber of the vacuum unit is measured. When the chamber is filled by air, two copper leads (positive and negative leads) are taken from vacuum chamber to be connected with Keithley electrometer. Then, thin film resistance is measured at different temperatures.

The vacuum unit contains electric heater and digital thermometer. The electric heater is used to heat the thin film and the digital thermometer is used to measure the various temperatures. The heating capacity of the electric heater is 0ºC to 500 ºC. The thin film resistance was measured at various temperatures in increasing (30 ºC to 200 ºC) and decreasing (200 ºC to 30 ºC) order.

Second, the resistance is measured in vacuum. To create high vacuum, a diffusion pump and rotary pump is used. A rotary oil pump is used to create 0 to 10^{-3} Torr. pressures The diffusion pump is used to create 10^{-3} to 10^{-6} Torr vacuum pressures. Two gauges are used for the measurement of pressures; one is pirani gauge, and another is penning gauge. The pirani gauge range is 10^{-4} to 1 Torr, and the penning gauge is 10^{-6} to 10^{-3} Torr. After creating the vacuum, the resistance of thin film is measured for various temperatures.

Third, the resistance is measured in oxygen gas. The oxygen gas is inserted into chamber unto atmospheric pressure. Similarly, the thin film resistance is measured at various temperatures by the Keithley electrometer.

RESULTS AND DISCUSSION

The resistance of the film at various temperatures was found using computer control Keithley electrometer. The resistance of the film in presence of air, vacuum and oxygen gas at various temperatures was recorded and the values are given in Table 1.

Film: Lithium doped iron oxide; Molarity: 0.1:0.01

Table 1: Resistance of lithium doped iron oxide at different temperatures

Temperature (ºC)	Resistance (GΩ)		
	Air	Vacuum	Oxygen gas
65	2.9197	5.7162	0.2050
70	2.5885	5.4470	0.2027

Cont…

Temperature (ºC)	Resistance (GΩ)		
	Air	Vacuum	Oxygen gas
75	2.4539	5.0340	0.1901
80	2.3450	4.5062	0.1801
85	2.1997	4.0176	0.1726
90	2.1960	3.4641	0.1643
95	2.1491	3.0155	0.1596
100	2.0444	2.5310	0.1530

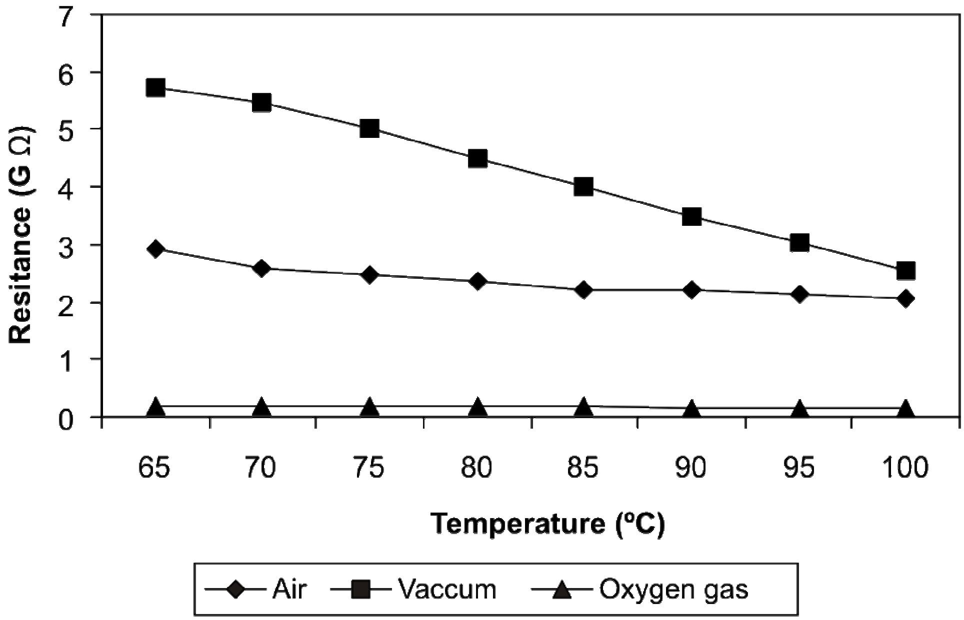


Fig 3. 1: Resistance of lithium doped iron oxide

The graph connecting temperatures and resistance of the film in vacuum, air and oxygen gas are shown in the Fig. 1. The resistance of the film in vacuum is greater than the resistance of the film in air and oxygen gas. Hence, from the graph, it is concluded that the resistance of the film decreases with increasing temperature.

The sensitivity of the film at various temperatures is also calculated and it is found to be uniform. The values are given in Table 2. The graph connecting the temperature with sensitivity is given in Fig. 2.

Film: Lithium doped iron oxide; Molarity: 0.1:0.01

Table 3.2

Temperature (°C)	$(R_O-R_A)/R_A$	$(R_O-R_V)/R_V$
65	-0.92978731	-0.96413701
70	-0.9216921	-0.96278686
75	-0.92253148	-0.96223679
80	-0.92319829	-0.96003284
85	-0.92153475	-0.95703903
90	-0.92518215	-0.95257065
95	-0.92573635	-0.94707345
100	-0.92516142	-0.93954959

RO – Resistance in Oxygen, RA – Resistance in Air and
Rv – Resistance in vacuum

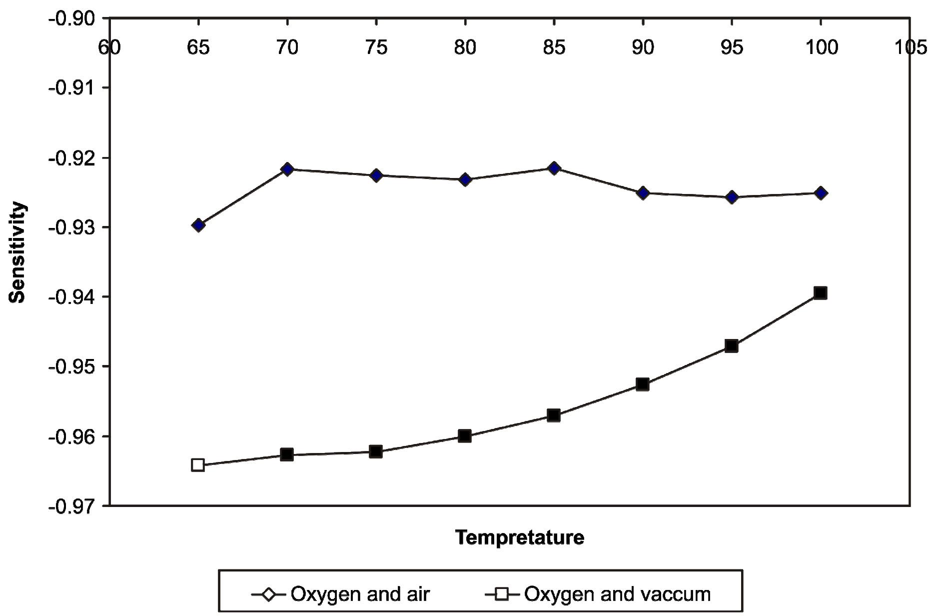


Fig. 2: Sensitivity of lithium doped iron oxide

CONCLUSION

(i) Lithium doped iron oxide films are formed by R-T Model spray pyrolysis method.

(ii) The resistance of the film at various temperatures and in presence of air, vacuum and oxygen gas was observed.

(iii) The sensitivity of the film was found in the temperature range (65^{o} to 100^{o} C).

(iv) Lithium doped iron oxide film is found to be sensitive.

(v) Further experiment, can be carried out by varying the doping concentration.

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