A review on Heterojunction Gas sensor

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***Abstract*— For easy and safe life there are many gas detecting devices present in our day to day life. The sensors are the electronic devices that can detect one form of energy and convert that into appropriate signal which is useful to use. There are many types of sensors available in the market. One of the alternatives is, the interface formed by two similar or dissimilar types of the materials which is called as heterojunction. The review focuses on the various types of heterojunction sensors that can detect the stimulus at very low concentrations of gases. All the sensors are characterized by certain standard parameters such as response time, recovery time, sensor stability, durability etc., which are discussed in detail in this review.**

***Index Terms*—heterojunction, Gas sensors, polymers, sensing materials.**

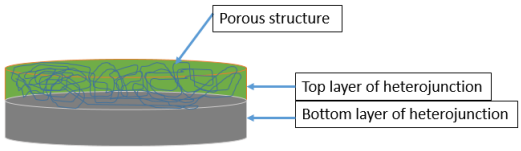
I. INTRODUCTION

We are living on the planet on which a life is possible because of the atmosphere which contains nitrogen in higher concentration followed by the oxygen and other gases. There should be a proper balance among all but due to industrialization and urbanization, day by day we are disturbing balance of nature. There are many industries which emits harmful and hazardous gases into atmosphere. The vehicles and the other combustion engines emit lots of carbon monoxides and other pollutant into the atmosphere. In order to control or monitor or to detect the presence of these hazardous or harmful gases, we need a device which can detect the presence.

The electronic device which gives information about the presence of external gases is called as sensor. The simple and cost effective Chemical Bath Deposition (CBD) [1-2], Successive Ionic Layer Adsorption and Reaction Method (SILAR), Electrodeposition or Physical methods, have been successfully employed to establish heterojunctions as a sensing materials [3-5]. The principle of the sensing is, the change in the one or more physical properties such as resistance, absorbance, transmittance etc [1-2]. The metal oxide based gas sensors are widely used for detection of the many gases [6]. The sensitivity of the sensor depends upon the properties of the material like surface area, morphology, porosity, good structural stability [7].

II. THE HETEROJUNCTION AND ITS TYPES

The interface formed by two dissimilar materials is heterojunction. Generally, one material gets deposited over the other material. Deposited layers have thickness up to few microns. There can be a junction between the two similar types of materials called homojunction. The heterojunction can be classified based on the material used in the fabrication or width of junction.



2.1 Heterojunction between two metal oxides

The deposited materials are metal oxides which are synthesized by different routes. The bottom as well as upper layer is of metal oxides. The gas sensing mechanism in metals oxide mainly based on the change in resistance of the metal oxide upon exposure to the gas [6]. The material morphology plays important role in the metal oxide sensor. The sensor material should be porous enough to respond to the stimulus. The heterojunction or heterostructure are fabricated using different routes. Various methods are used to fabricate the heterojunction such as physical vapor deposition (PVD), chemical vapor deposition (CVD), hydrothermal, electrospinning, spin-coating, sputtering or atomic layer deposition and chemical methods like chemical bath deposition (CBD), Successive Ionic Layer adsorption and reaction method (SILAR) [3]. Shulin Yang et.al [8] in his review article summarized fabrication methods and gas sensor properties of various heterjunctions deposited using hydrothermal, CBD, electrodeposition techniques. However, the main disadvantage of metal

oxide based gas sensors is the high temperature. They responds to stimulus at very high temperatures. where as polymer based heterojunctions shows the gas sensitivity at room temperatures.

2.2 Heterojunction between metal oxide/ chalcoganide and polymer

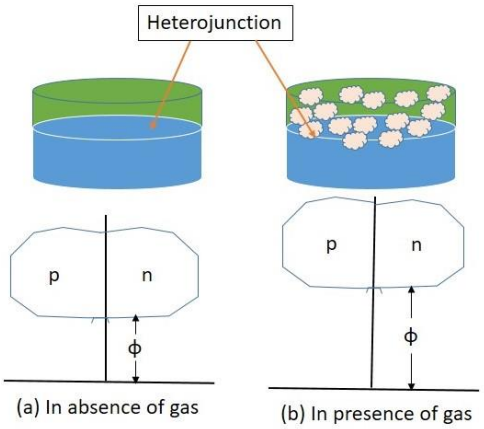
In this type, the bottom layer deposited on the conducting surface is generally of the metal oxide or metal chalcoganide and top layer is of conducting polymer such as Polyaniline. Dhawale et.al [9] fabricated heterojuncion between n-CdS/p-polyaniline by electrodeposition method and used it as room temperature LPG sensor. The polymers are generally amorphous and porous materials because of which the sensor parameters such as sensitivity, response or recovery times changes. Patil et.al. [10] Studied the liquefied petroleum gas (LPG) sensing performance of p-polyaniline/n-PbS heterojunction at room. The conducting polymer are easy to synthesis and forms the graded heterojunction. The sensitivity, response and recovery times and performance of these heterojunctions are better as compared to other types of heterojunctions.

2.3 Heterojunction between two polymers

In this type, the bottom as well as top layer deposited on the conducting surface is generally of the conducting polymers such as Polyaniline, Polypyrrole, Polythiophene. Room Temperature Liquefied Petroleum Gas Sensing performance of n-polypyrrole/p-polyaniline Based Heterojunction is reported by Patil et.al [11]. The porous polymers materials are very sensitive to adsorbed gas molecules giving fast response to the stimulus. The conducting polymers are easy to synthesize. Abhishek Kumar et.al [12] fabricated a novel polyporphine/phthalocyanine heterostructures for ammonia sensing. Inta Muzikante et.al [13] reported the organic heterojunction formed by a n-type and p-type phthalocyanine at room temperature, and found very sensitive to a donor gas as NH3.

3. SENSING MECHANISM

The sensing mechanism is based on adsorption reactions at the surface of heterojunction. The change is current for heterojunction is observed for the forward biased polymer based heterojunction. Layer by layer deposition forms a junction in between the deposited layers. Some amount of forward biased voltage is needed to break the potential barrier developed at the heterojunction. The oxidizing or reducing gases when get adsorb on the top layer donates or takes electrons form the top layer causing the increase or decrease in carrier concentration of heterojunction which results in change in current in absence and presence of gas.



Fig(a) shows the heterojunction with some barrier height and fig(b) shows the change in the barrier height of the heterojunction upon exposure to the gas.

IV. CONCLUSIONS

The room temperature gas sensing can be an alternative to the high temperature metal oxide based gas sensors. The metal oxide/chalcoganide and polymer heterojucntion sensors have comparatively good stability, durability and fast response and recovery times as compared to other two types of heterojunctions. The heterojunction between the metal oxide and polymers also shows the good stability.

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