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A room temperature liquefied petroleum gas sensor based on all-electrodeposited n-CdSe/p-polyaniline junction

S.S. Joshi, C.D. Lokhande [a,b,*], Sung-Hwan Han [b,*]

[a] *Thin Film Physics Laboratory, Department of Physics, Shivaji University, Kolhapur 416 004, India*
[b] *Inorganic Nano-Materials Laboratory, Department of Chemistry, Hanyang University, Sungdong-Ku, Haengdang 17, Seoul 133-791, Republic of Korea*

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Abstract

In this paper, we report on the performance of a liquefied petroleum gas (LPG) sensor based on n-CdSe/p-polyaniline junction fabricated by a simple electrodeposition technique. The junction diode showed the sensitivity to liquefied petroleum gas (LPG) at room temperature (300 K). Forward biased current–voltage characteristics of the junction diode showed a considerable shift when exposed to various concentrations of LPG. Maximum response up to 70% was achieved for 0.08 vol% LPG. Depending on the concentration of LPG, the response time was ranged between 50 and 100 s, whereas the recovery time was 200 s.

Keywords: CdSe; Polyaniline; Heterojunction; LPG; Sensitivity; Gas sensor

1. Introduction

At present, gas-sensing materials can be classified mainly into two kinds: organic and inorganic materials. Doped or undoped SnO_2 is the most studied and used among the inorganic materials, but its operation temperature is about 423–623 K [1]. Commercial solid state gas sensors based on semiconducting metal oxides have been marketed during last 50 years, using the property that the sensing gas changes the surface charge carrier concentration of semiconductor to cause changes in its electrical conductivity. This helps to monitor hazardous gases and to detect the threshold level of gases present in the atmosphere. However, these sensors showed poor performance with respect to the sensitivity at low concentrations of gases, selectivity and long-term stability. The gas-sensing devices based on organic materials, such as polypyrrol, polyaniline, and metaphthalocyanines, have gas sensitivity at room temperature, but their long response time (min) due to the orderly structure limits their usage [2,3].

As an alternative, heterojunction-based sensors have been constructed. Usually, a heterojunction gas sensor consists of two semiconducting oxides in contact, with enhanced sensing behaviour occurring at the interface between the two materials. Gases that are adsorbed onto the sensor surface on either side of the heterojunction modify its charge-transfer characteristics by changing the structure of the interfacial barrier [4]. This process gives rise to a gas detection mechanism distinct from that of semiconductor metal oxide sensors. Heterojunction-based humidity sensors were first proposed in 1979 [6]. The responses of different heterojunction-based sensors to a range of gases including CO, H_2, H_2O, NO_2 and C_2H_5OH have been investigated [4,5]. Several rectifying junctions formed between p- and n-type semiconducting ceramics include CuO(p)/ZnO(n), [7,8] La_2CuO_4(p)/ZnO(n) [9] and $SmCoO_3$(p)/MOx(n), where M=Fe, Zn, In, Sn [10]. In addition, n-type semiconductor heterojunction ceramics with slightly different band energies have also been reported [11,12], e.g., a NO_2 gas sensor based on SiC and ZnO has been investigated. Since the resistance of the SiC component of the heterojunction was unaffected by the introduction of NO_2 and that of the ZnO component was only slightly affected, it was concluded that the increase in electrical resistance associated with the introduction of the NO_2 was due to the behavior of the n–n junction interface. A CO gas sensor was

* Corresponding authors. Tel.: +91 231 2533807; fax: +91 231 2690533.
E-mail addresses: l_chandrakant@yahoo.com (C.D. Lokhande), shhan@hanyang.ac.kr (S.-H. Han).

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