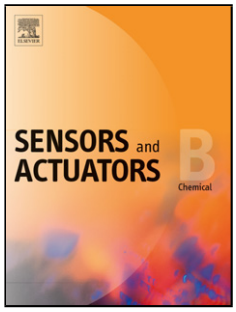

Title: Lanthanum gallate based amperometric electrochemical sensor for detecting ammonia in ppm level: Optimization of electrode compositions

Authors: R. Sharan, Mainak Roy, A.K. Tyagi, Atanu Dutta

PII: S0925-4005(17)32268-2
DOI: https://doi.org/10.1016/j.snb.2017.11.137
Reference: SNB 23631

To appear in: *Sensors and Actuators B*

Received date: 10-7-2017
Revised date: 18-11-2017
Accepted date: 22-11-2017

Please cite this article as: R.Sharan, Mainak Roy, A.K.Tyagi, Atanu Dutta, Lanthanum gallate based amperometric electrochemical sensor for detecting ammonia in ppm level: Optimization of electrode compositions, Sensors and Actuators B: Chemical https://doi.org/10.1016/j.snb.2017.11.137

Lanthanum gallate based amperometric electrochemical sensor for detecting ammonia in ppm level: Optimization of electrode compositions

R. Sharan[1], Mainak Roy[2], A.K. Tyagi[2] and Atanu Dutta[1*]

[1]Division of Physics, School of Advanced Sciences, VIT University, Chennai Campus, Chennai 600127, India

[2]Chemistry Division, Bhabha Atomic Research Centre, Mumbai 400 085, India; HomiBhabha National Institute Anushaktinagar, Mumbai - 400 094, India

*Corresponding author, Tel.- +91 44 3993 1049, Fax.-+91 44 3993 2555, email.- atanudutta@vit.ac.in

Abstract

Fabrication of a highly sensitive amperometric electrochemical gas sensor would require optimisation of the electrode materials and rigorous testing of device performance under different processing conditions. An ammonia sensor based on lanthanum gallate electrolyte having the composition $La_{0.8}Sr_{0.2}Ga_{0.8}Mg_{0.1}Ni_{0.1}O_3$ (LSGMN) has been investigated for its detecting at ppm level. A single phase solid solution of 30 mol% Zr^{4+} in CeO_2 (CZ73) as an active (sensing) electrode yielded optimum results. Similarly, $La_{0.5}Sr_{0.5}Mn_{0.8}Ni_{0.2}O_3$ (LSMN5582) was found to be the best composition for the inactive (reference) electrode. All the devices were found to have maximum sensitivity at 400ºC and a typical response and recovery times of 40s and 110s respectively. Moreover, they exhibited better efficiency in amperometric mode as compared to potentiometric mode and were stable up to several cycles of operation. It was established through mechanistic studies that even though both the electrodes were simultaneously exposed to both the gases, higher sensitivity was obtained when CZ73 was biased at +1 V with respect to LSMN5582 as against -1 V, implying that NH_3 oxidation took place preferentially at CZ73 whereas oxygen reduction took place at the inactive electrode. Step by step sensitivity at 400ºC improved from 28.2 to 35 μA/decade. Further, the electrolyte thickness was decreased to 0.4 mm in view of reducing the internal resistance and a prototype device was fabricated that yielded enhanced sensitivity of 49 μA/decade under optimised conditions.

Key words: Ce-Zr system; Amperometric; Ammonia Sensor; Lanthanum Gallate

Highlights of the paper

1. Ultra-trace detection of ammonia using amperometric mode of sensing.
2. Enhanced sensitivity of 49 μA/decade under optimised conditions.
3. High stability of sensing performance and low operational temperature.