Research Journal of Recent Sciences ISSN 2277-2502
Vol. **15(4),** 30-32, October **(2026)** *Res. J. Recent Sci.*

Short Communication

Analysing the Immediate effects of Vehicle emissions on the Environment using PT-100 Sensor and using $LaCoO_3$ based Sensing System

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Available online at: www.isca.in, www.isca.me
Received 9th April 2026, revised 13th August 2026, accepted 18th September 2026

Abstract

The focused study on analysing the immediate effects of vehicle emissions using a combined sensing approach involving a PT100 temperature sensor and a $LaCoO_3$-based carbon monoxide (CO) gas sensing system. Vehicle samples of varying engine power ratings and technological configurations were examined to evaluate emission characteristics and their environmental impact. Real-time temperature variations were recorded using the PT100 sensor to assess thermal contributions from exhaust gases, while CO concentration levels were monitored using a $LaCoO_3$ perovskite-based gas sensor. The collected data were systematically analysed to understand how different engine technologies influence emission levels and thermal output, thereby contributing to atmospheric warming. $LaCoO_3$-based sensors demonstrate high sensitivity and selectivity toward CO detection due to reversible modifications in their electronic structure upon gas exposure. Their catalytic activity, stability, and cost-effectiveness make them suitable for environmental monitoring applications. The results highlight trends in engine evolution toward improved efficiency and reduced emissions, while also emphasizing the need for advanced sensing technologies for accurate, real-time environmental assessment. Further research focusing on enhancing material selectivity, response time, and long-term operational stability will strengthen the practical applicability of $LaCoO_3$-based sensing systems in industrial safety and environmental monitoring domains.

Keywords: Gas sensor, Perovskite, $LaCoO_3$, Carbon monoxide, PT100, Temperature sensing, Vehicle emissions.

Introduction

Carbon monoxide (CO) is a colourless, odourless, and highly toxic gas that can pose serious health risks, particularly in indoor environments and industrial settings[1,2]. Due to its dangerous nature, accurate and reliable CO detection is critical for ensuring safety and monitoring air quality. Traditional CO detection methods, such as chemical absorption and electrochemical sensors, are widely used; however, there is growing interest in developing advanced materials for gas sensors with better sensitivity, selectivity, and stability[3-4].

Lanthanum cobalt oxide $LaCoO_3$, a perovskite-type oxide material, has shown promise as an effective sensor for detecting CO. This report investigates the use of $LaCoO_3$-based sensors for CO detection, exploring the material's properties, sensing mechanisms, fabrication techniques, and performance characteristics[5,6]. $LaCoO_3$ is a transition metal oxide that exhibits a perovskite crystal structure, with lanthanum (La^{3+}) at the A-site and cobalt (Co^{3+}) at the B-site. It is known for its mixed-valence states of cobalt (Co^{3+}/Co^{2+}), oxygen vacancy formation, and strong catalytic properties, which make it highly suitable for gas sensing applications. The detection of CO by $LaCoO_3$ sensors is based on the material's ability to adsorb and react with CO molecules on its surface.

CO, being a reducing gas, can reduce Co^{3+} to Co^{2+} on the surface of $LaCoO_3$, leading to a change in its electronic structure and resistance. The presence of CO alters the material's charge distribution and electrical conductivity, which can be measured and used to quantify the concentration of CO in the air[7,8].

Methodology

The polycrystalline $LaCoO_3$ sample was prepared using the conventional solid-state reaction method. High-purity La_2O_3 and CoO were used as starting materials. The oxides were weighed carefully in stoichiometric proportions and mixed thoroughly in an agate mortar to obtain a homogeneous mixture.

A total of 5 g of the powder mixture was ground for 15 hours. The ground mixture was then calcined at 1250°C for 15 hours. After calcination, the powder was reground for 10 hours to ensure uniform mixing and homogeneity. The resulting powder was pressed into spherical pellets of 10 mm diameter for electrical resistance and capacitance measurements. Finally, the pellets were sintered at 1300°C for 14 hours.

The resistance of the polycrystalline $LaCoO_3$ sample was measured using a Pt-100 sensor, a Keithley nanovoltmeter (Model 2510), and a source meter (Model 2400).

The crystal structure and impurity phases of the $LaCoO_3$ sample were investigated using X-ray diffraction (XRD) analysis.

The XRD patterns were recorded using a Bruker D8 Advance X-ray diffractometer with Cu Kα radiation (λ = 1.5406 Å). The data were collected with a step size of 0.02° over a 2θθ range of 20°–80°, using an X-ray tube voltage of 40 kV and a current of 40 mA. The electrical resistance of the samples was measured at both ice-bath and liquid-nitrogen temperatures using the two-probe and four-probe methods.

Result and Discussion

The prepared sample was characterized by X-ray diffraction (XRD) to determine its crystal structure and phase purity. The XRD pattern, shown in Figure-1, confirms the formation of a single-phase $LaCoO_3$ compound with a rhombohedral crystal structure belonging to the space group *R-3c*. Figure-2 and 3 show the variation in electrical resistance as a function of time, with resistance plotted on the y-axis and time on the x-axis. The curves exhibit a decreasing trend, with higher resistance values at low CO concentrations and a gradual decrease in resistance as the CO concentration increases. Figure-4 shows the variation in electrical resistance for different BS model bikes.

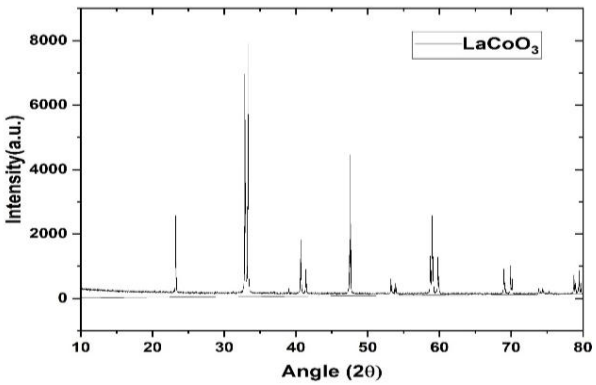


Figure-1: x-ray diffraction data of $LaCoO_3$.

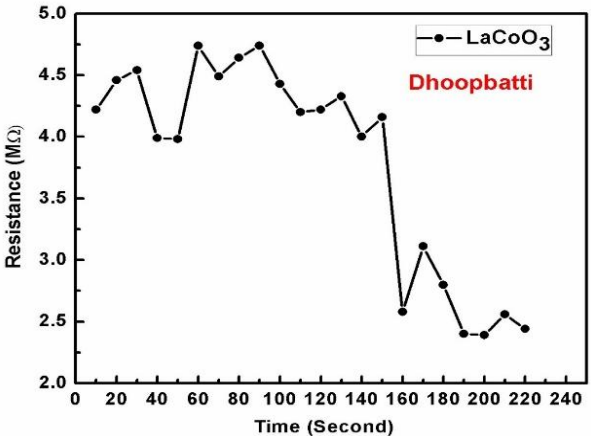


Figure-2: Time versus resistance graph of $LaCoO_3$ for Dhoopbatti.

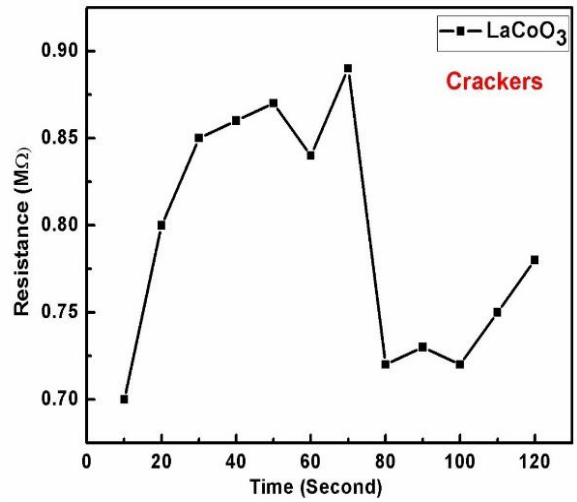


Figure-3: Time versus resistance graph for crackers.

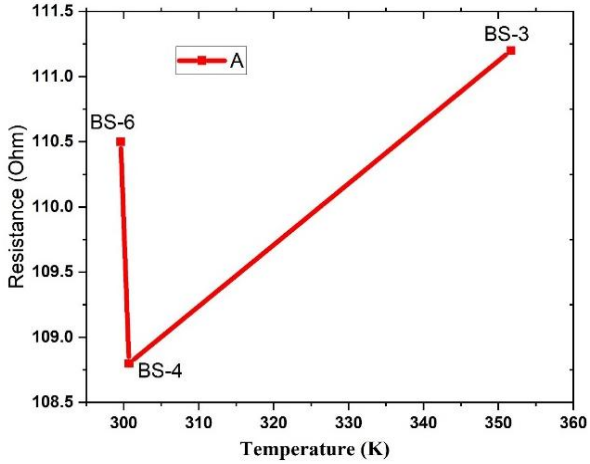


Figure-4: Time versus resistance graph for crackers.

Conclusion

$LaCoO_3$-based sensors offer a promising approach for carbon monoxide (CO) detection due to their high sensitivity, selectivity, and ability to undergo reversible changes in their electronic structure upon exposure to CO. By exploiting the unique catalytic and electronic properties of $LaCoO_3$, these sensors provide a potentially reliable and cost-effective solution for CO monitoring in various applications, including industrial safety and environmental monitoring. Further research aimed at improving sensor performance, selectivity, and long-term stability could enhance the effectiveness and practical applicability of $LaCoO_3$-based gas sensors.

Acknowledgement

The authors would like to acknowledge UGC-DAE Consortium for Scientific Research and the School of Physics, Devi Ahilya Vishwavidyalaya, Indore, MP, India for providing the necessary facilities for sample characterization.

References

1. Ling T. R., Chen Z. B. and Lee M. D. (1995). Studies on catalytic and conductive properties of $LaNiO_3$ for oxidation of C_2H_5OH, CH_3CHO, and CH_4. *Catalysis today*, 26(1), 79-86.

2. Tanaka H. and Misono M. (2001). Advances in designing perovskite catalysts. *Current Opinion in Solid State and Materials Science*, 5(5), 381-387.

3. Liu S., Li, K. and Hughes R. (2004). Preparation of $SrCe_{0.95}Yb_{0.05}O_{3-\alpha}$ perovskite for use as a membrane material in hollow fibre fabrication. *Materials research bulletin*, 39(1), 119-133.

4. Campagnoli, E., Tavares, A., Fabbrini, L., Rossetti, I., Dubitsky, Y. A., Zaopo, A., & Forni, L. (2005). Effect of preparation method on activity and stability of LaMnO3 and $LaCoO_3$ catalysts for the flameless combustion of methane. *Applied Catalysis B: Environmental*, 55(2), 133-139.

5. Liu, S., Tan, X., Li, K., & Hughes, R. (2002). Synthesis of strontium cerates-based perovskite ceramics via water-soluble complex precursor routes. *Ceramics international*, 28(3), 327-335.

6. Liu, S., Tan, X., Li, K., & Hughes, R. (2002). Synthesis of strontium cerates-based perovskite ceramics via water-soluble complex precursor routes. *Ceramics international*, 28(3), 327-335.