p-ISSN 2715-2871
e-ISSN 2714-5247

# Design of an Internet of Things (IoT) based Early Fire Prevention System Due to LPG Gas Leakage Using NodeMCU ESP8266 Module

Atmiasri
*Electrical Engineering*
*University of PGRI Adi Buana*
Surabaya, Indonesia
Atmi.asri@unipasby.ac.id

Rufi'i
*Electrical Engineering*
*University of PGRI Adi Buana*
Surabaya, Indonesia
rufii@unipasby.ac.id

Habib Maulana
*Electrical Engineering*
*University of PGRI Adi Buana*
Surabaya, Indonesia
habib@gmail.com

***Abstract*— Gas is a molecule that is unbound, shapeless, invisible, and can transform into liquid or solid forms. Liquified Petroleum Gas (LPG) has become a part of people's lives, especially in cooking, and there are many benefits to using LPG. However, there are dangers posed by leaks of LPG gas that can lead to house fires. Improper installation of regulators is one such risk. Preventive measures against fire hazards caused by leaks can be anticipated by using the design and construction of an Early Warning System for LPG Gas Leaks based on the Internet of Things (IoT) using the Blynk application with the NodeMCU ESP8266 module. This device is equipped with an MQ-2 sensor, a relay, a 12V DC fan, and the Internet of Things. The system works as follows: when the MQ-2 sensor detects the presence of LPG gas, the relay turns on the fan, which will remove the gas from the vicinity of the open flame on the stove. The system can be monitored through the Blynk IOT application, which also provides notifications.**

***Keywords—LPG Gas Leakage, IoT, ESP8266)***

## I. Introduction

Every part of existence involves energy in some way. Liquified petroleum gas, or LPG, is one important energy source. LPG is a blend of several hydrocarbon components obtained from compressed and liquidized natural gas. Because of its efficiency and reduced emissions when compared to other fossil fuels, LPG is widely used for transportation, industry, and residential use.[1].

Throughout the year 2020, there were 1,505 fire incidents reported in Jakarta, based on data from the DKI Jakarta Fire and Rescue Agency. The causes of these fires were electricity (62.33%), gas (11.96%), burning of trash (8.17%), cigarettes (2.39%), candles (0.47%), and others (14.68%). According to this data, fires caused by gas-related issues were the second-highest factor after electricity-related incidents. Gas explosions resulted from accessories such as regulators, gas hoses, rubber, and valves that did not meet standards, as well as improper installations. The fact that 30.63% of fire cases occurred in residential areas also raises concerns among the community in addressing this issue.

Until now, there have been several studies focusing on this problem. One previous study was conducted by [2]-[3]. In this study, a design using Wemos ESP2866 as the microcontroller and gas leak notifications sent via WhatsApp application on mobile phones were developed. Additionally, [4] conducted a similar study in 2021, designing a gas leak detector for LPG. The setup consisted of an MQ-2 sensor as the gas detector and used an SMS Gateway system with the SIM 800L module for sending notifications and a buzzer as an alarm [4].

Based on the above data, incidents of LPG gas cylinder explosions are caused by the negligence of the public in using them and the lack of awareness and socialization regarding the standardized use of LPG gas. Therefore, there is a need for special attention to this type of fuel. Hence, an early warning system for LPG gas, particularly in the area of regulators, is essential to mitigate gas leaks that could lead to casualties [5]. An Early Warning System utilizing the Internet of Things (IoT) as a tool will make such warnings more effective.

Preventive measures against the risk of fire due to gas leaks were implemented by creating and constructing an Internet of Things (IoT) based LPG Gas Leak Early Warning System utilizing the ESP8266 NodeMCU module and the Blynk application. This was done based on issues and updates from prior research. This gadget has an IoT platform, a 12V DC fan, a relay, and a MQ-2 sensor.

## II. Methods

The researchers have designed a device that facilitates security handling in anticipating gas leaks. This device is designed to be as effective, minimalist, and fast as possible in delivering information and providing early prevention of gas leaks. Taking into account these considerations, the overall device design can be seen in the diagram below.

### *A. Diagram Block*

A gas leak prevention system based on the Internet of Things (IoT) was created to address the issue of potentially hazardous gas leaks. This system uses a number of interconnected parts to identify, alert, and lower the airborne concentration of dangerous gasses. This system employs gas sensors, microcontrollers, and an Internet of Things platform to provide remote monitoring and control using a smartphone application, in addition to sounding an alarm upon detection of a leak. The architecture and workflow of an Internet of Things (IoT)-based gas leak prevention system, intended to enhance safety and enable prompt reaction to gas leak occurrences, are shown in the block diagram below.

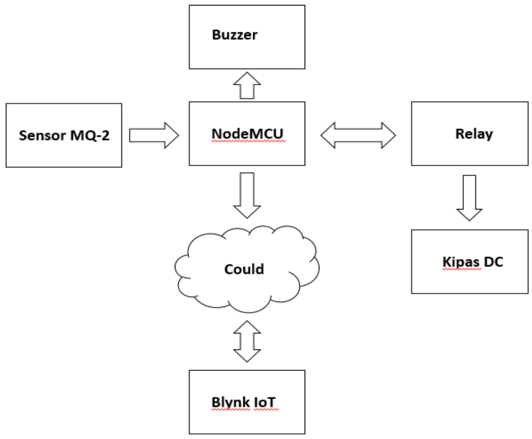


**Fig. 1.** Block diagram of IoT-based gas leak prevention work

From the picture above which is a description of the function of all components that build the tool, namely:

1. Gas sensor readings
   If there is a gas leak in the area around the sensor, the device sensor [6] will immediately detect the presence of gas in the form of data sent to the NodeMCU ESP8266 board. This sensor will be set with batas tertentu thus sending data into the NodeMCU board.
2. NodeMCU
   NodeMCU will process the data sent from the gas sensor. If the data meets the limit and can be ascertained the gas casting. If it is fulfilled, it will continue the program into the relay to turn on the DC fan, trigger the buzzer, and send data into the Blynk IoT could [7].
3. Blynk IoT
   Blynk IoT [8] quickly processes data for display in applications. Can monitor the amount of gas that is around the sensor, get a warning notification if there is a leak detected by the sensor.
4. Buzzer
   Not only through notifications from Blynk, there is a buzzer as a warning in the form of sound. Function when someone is around the kitchen area will sound the warning.
5. Relay
   Relay functions as an automatic switch Relay will be set if the sensor detects the gas that has been determined, then the relay will contact from NO to NC so that it turns on the DC fan.

### *B. Product Design*

In a cube-shaped design with acrylic material with a thickness of 2mm for a width of 45cm x 45cm with a height of 45cm. The fan holder is under the shaped box above which the NodeMCU ESP8266 is placed. The NodeMCU ESP8266 should be placed above the fan holder, centrally located on an internal platform or directly attached to the side of the cube.

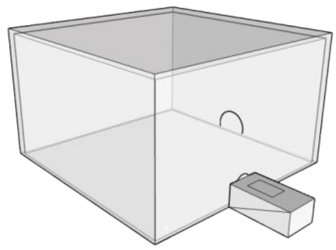

Fig. 2. Prototype box (side view)

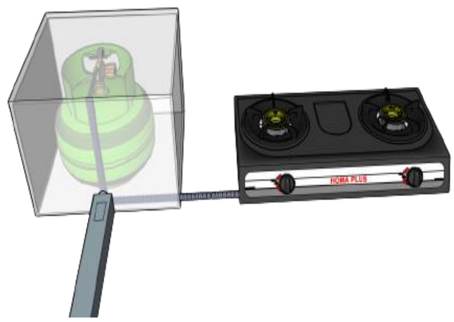

Fig. 3. Placement of LPG and stove on the prototype

### *C.* Gas detector wiring diagram

This wiring diagram illustrates how the MQ-2 gas sensor is connected to the NodeMCU to process data which then activates the relay to turn on the fan and buzzer as an alarm.

.

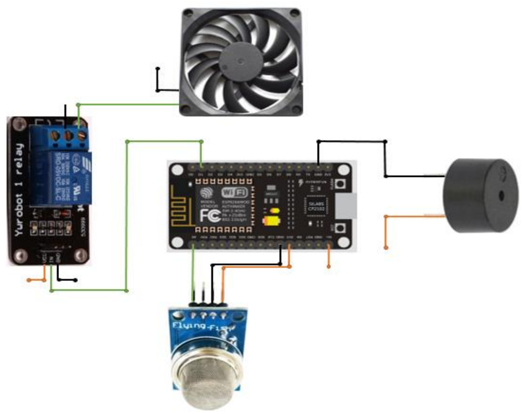

Fig. 4. wiring schematic for a gas leak prevention system

The first component is the :

1. MQ-2 sensor, which is capable of detecting gases like smoke, alcohol, hydrogen, i-butane, propane, methane, and LPG.
2. NodeMCU: a microcontroller with an ESP8266 base

p-ISSN 2715-2871
e-ISSN 2714-5247

that processes sensor data and manages output devices.
3. Relay: The fan is controlled by an electromechanical switch.
4. Fan: An air-circulating device that is powered by a relay.
5. Buzzer: An apparatus that, upon sensing the presence of gas, sounds an alarm.
An explanation of wiring
1. MQ-2 to NodeMCU:
- The MQ-2's VCC is linked to 3V3 on the NodeMCU.
- The GND on NodeMCU and the GND of MQ-2 are linked.
- In order to read analog data that detects gas concentration, pin A0 of NodeMCU is connected to A0 of MQ-2.
2. NodeMCU to Relay: - The relay control pin is linked to one of the NodeMCU's digital pins (D1, for instance).
- The NodeMCU's 3V3 and GND are linked to the VCC and GND relays.
3. Relay to Fan: A fan terminal is linked to a NO (Normally Open) relay.
- The fan's positive power supply is linked to the COM (Common) relay.
- The fan's other terminal is linked to ground.
4. NodeMCU to Buzzer:
- The buzzer's positive pin is linked to one of the NodeMCU's digital pins (D2, for instance). The buzzer's negative pin is linked to ground.

## *D. Flowchart*

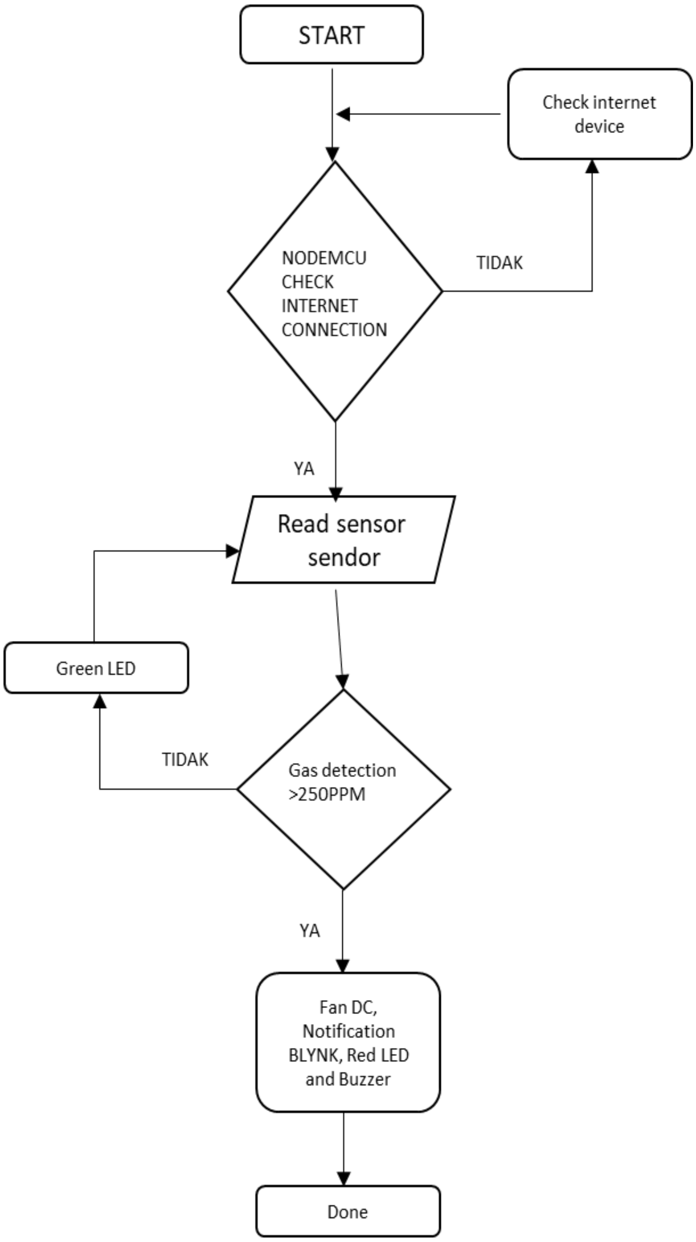


Fig. 5. Flowchart of the gas leak prevention system performance process

## *E. Variables and Operational Definitions of Variables*

Variables that are elements that can change can also change other elements. A value that can change by customizing the object. In this study there are several variables to determine the sensor value used, including:

1. Free Variable
   - Gas Concentration
     Gas here as an object that will be measured in concentration using the MQ-2 sensor, where the sensor will detect the presence of gas in units of parts per million (ppm).
   - Distance

p-ISSN 2715-2871
e-ISSN 2714-5247

The distance here is the benchmark of the MQ-2 sensor that will be used to know the sensitivity of the sensor [9] at a certain distance.

2. Bound Variables
   - DC Fan
     DC fan is a device which in this system functions to keep gas away from the source of fire on the stove.
   - Notification
     The notification is a warning of gas leaking around LPG which will be connected to a smartphone through the BLYNK application.

### *F. Data Analysis Methods*

The method in the research to be carried out is comparative, by comparing the microcontrollers used to test the reliability of the tool itself. The reliability and accuracy of the tools to be tested include:

1. At the first stage, namely the creation of tools according to the previous block diagram.
2. The second stage tested the accuracy of the MQ-2 sensor to detect gases.
3. The third stage tests the relay connected to the fan to respond to the gas trigger.
4. The fourth stage is to connect the tool to the Blynk application.

The last stage is a conclusion about how the performance of the tool and the advantages of the tool in early fire prevention

## III. RESULTS AND DISCUSSION

This early fire prevention system due to LPG gas leakage can be used in areas connected to wifi with an internet connection. Of course, it will provide a sense of security when a gas leak occurs, it can also be detected as a notification as a warning if there is a gas leak. The series of early fire prevention tools due to gas leaks consists of the main components, namely NodeMCU 8266 as a microcontroller, MQ-2 as a gas detector, Buzzer, DC Fan, with Power Supply as a voltage source. Smartphones that have the Blynk IoT application installed and Blynk settings on the web can be connected to the smartphone. Notification data and gas monitors in ppm can be viewed on smartphones.

### *A. Data Presentation*

1. Gas Responsive Test

At this stage, the data taken is the sensitivity of the sensor in detecting a match gas leak, which is in the range of 200-400 ppm. This MQ-2 sensor [10] test will send a quantitas value that will appear in the blynk application as well as turn on notifications.

TABLE. I. MQ-2 Responsive Test

| Kondisi | Quantitas gas (PPM) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Durasi Waktu (Second) | Pengujian 1 | | Pengujian 2 | | Pengujian 3 | |
| | | ppm | Notif 250>ppm | ppm | Notif 250>ppm | ppm | Notif 250>ppm |
| Normal | Normal | 210 | Off | 244 | Off | 195 | Off |
| Mendeteksi Gas | 5 sec | 316 | On | 320 | On | 216 | Off |
| | 10 sec | 342 | On | 346 | On | 301 | On |
| | 15 sec | 348 | On | 349 | On | 325 | On |
| | 20 sec | 350 | On | 355 | On | 344 | On |
| | 25 sec | 356 | On | 359 | On | 356 | On |

2. Gas Sensor Distance Test

This test is carried out in order to find out what is the ideal distance from the sensor to quickly detect gas leaks in LPG. The two distances to be tested will also be compared to the same leak rate how quickly the sensor will detect a gas leak.

TABLE. II. MQ-2 Distance Test

| Pengujian sensor diletakkan pada sisi atas box | | | |
|---|---|---|---|
| Timestime | PPM | Kipas DC Jika >250 ppm | Buzzer Jika >250 |
| 10:18:01 | 234 | Kipas off | Buzzer off |
| 10:19:01 | 237 | Kipas off | Buzzer off |
| 10:20:01 | 242 | Kipas off | Buzzer off |
| 10:21:01 | 247 | Kipas off | Buzzer off |
| 10:23:01 | 255 | Kipas on | Buzzer on |
| 10:24:01 | 257 | Kipas on | Buzzer on |
| 10:25:01 | 261 | Kipas on | Buzzer on |
| 10:26:01 | 264 | Kipas on | Buzzer on |
| 10:27:01 | 266 | Kipas on | Buzzer on |
| 10:28:01 | 268 | Kipas on | Buzzer on |
| Pengujian sensor diletakkan di sisi samping box | | | |
| Timestime | PPM | Kipas DC Jika >250 ppm | Buzzer Jika >250 |
| 11:15:06 | 234 | Kipas off | Buzzer off |
| 11:16:06 | 277 | Kipas on | Buzzer on |
| 11:17:06 | 285 | Kipas on | Buzzer on |
| 11:18:06 | 287 | Kipas on | Buzzer on |
| 11:23:01 | 289 | Kipas on | Buzzer on |
| 11:20:06 | 289 | Kipas on | Buzzer on |
| 12:21:06 | 291 | Kipas on | Buzzer on |
| 11:22:06 | 293 | Kipas on | Buzzer on |
| 11:23:06 | 293 | Kipas on | Buzzer on |
| 11:24:06 | 294 | Kipas on | Buzzer on |

### *B. Data Analysis*

A data processing that is used as information that can be understood easily. The data obtained becomes a solution to problems related to research.

1. Gas Responsive Test

Gas Responsive Test or Gas Responsiveness Test is a testing method used to analyze the response of a system or material to certain gases. The following is responsive gas data :

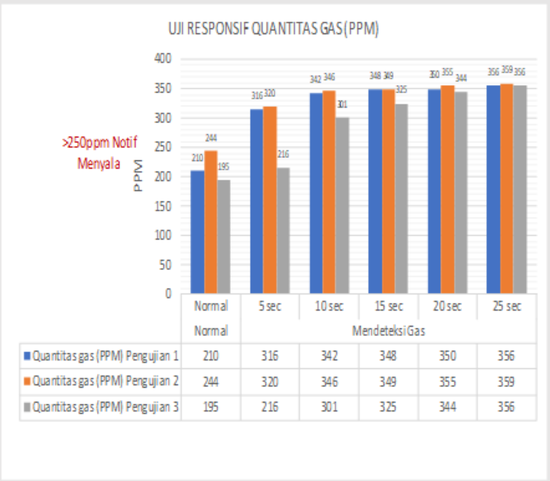


Fig. 6. Graphic of gas responsive test

In the picture, there is a display of data obtained from the results of responsive gas sensor testing. This test was conducted within 25sec. To find out the sensitivity of the gas sensor also the success of notifications above 250ppm will be sent on the smartphone. The average calculation is done by adding up all sample data values, then dividing by the number of samples. The result of this test is the average value of the gas sensor is 327.1 ppm.

2. Gas Distance Test

At this stage the data has been presented in the presentation of previous data will be processed by comparing the difference in sensor speed in detecting gas concentration placed on the top side of the box with the side of the box. The data taken is data from the serial monitor in each test.

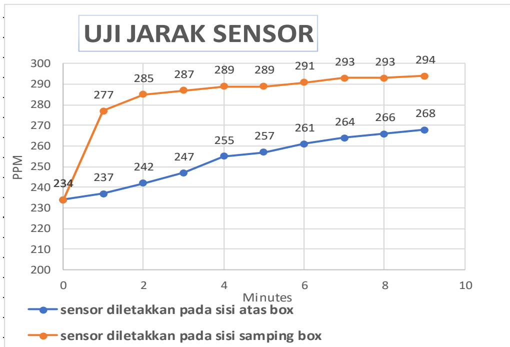


Fig. 7. Graphic of gas distace test

When testing the sensor distance on the side of the box, the minimum value was 234 ppm, the same as the sensor on the top side of the box, and the maximum value was 294 ppm. The sensor distance on the top side of the box had a minimum value of 234 ppm and a maximum value of 268.

## IV. Discussion

The study conducted on the gas sensor aimed to evaluate its responsiveness and sensitivity to detect gas concentrations within a specified timeframe and the effectiveness of its notification system when the concentration exceeds a certain threshold. The testing was conducted over a 25-second interval, and the results provide insights into the performance and reliability of the sensor.

The average concentration detected by the gas sensor was calculated to be 327.1 ppm. This average was determined by summing all sample data values obtained during the test and dividing by the number of samples. This figure indicates that the sensor is capable of detecting gas concentrations above the 250 ppm threshold, which is crucial for ensuring timely alerts in case of gas leaks.

## V. Conclusion

The study evaluated an early fire prevention system designed to detect LPG gas leaks using a gas sensor connected to a microcontroller and smartphone notification system. The key findings from the testing phases provide valuable insights into the system's performance and reliability Gas Responsiveness The gas sensor's average detection level was 327.1 ppm, well above the critical threshold of 250 ppm. This indicates a high sensitivity of the MQ-2 sensor in detecting gas leaks within a short timeframe of 25 seconds. The system successfully sent notifications to the smartphone when the gas concentration exceeded the 250 ppm threshold, ensuring timely alerts. Sensor Placement and Distance The position of the sensor affects its responsiveness. Sensors placed on the side of the box detected a maximum gas concentration of 294 ppm, while those on the top detected up to 268 ppm. Both positions recorded the same minimum value of 234 ppm, suggesting consistent baseline sensitivity. Notification System The integration with the Blynk IoT application enabled real-time monitoring and notification, providing a reliable and efficient warning system for gas leaks. Overall, the system demonstrates robust performance in detecting gas leaks and effectively notifying users, which is critical for early fire prevention. The placement of sensors should be optimized based on specific environments to ensure the fastest and most accurate detection of gas leaks. The successful implementation of this system can significantly enhance safety in areas where LPG is used, providing peace of mind and preventing potential fire hazards.

## VI. References

[1] M. R. Swain, J. Shriber, C. Gables, and M. N. Swain, “Garage,” vol. 1989, no. 2, pp. 83–89, 1998.

[2] A. Saefullah, Arisantoso, and H. Samantha, “Perancangan Pendeteksi Kebocoran Gas Lpg Menggunakan Sensor Mq2 Berbasis Wemos Esp 8266 Melalui Whatsapp seagai Media Informasi,”

p-ISSN 2715-2871
e-ISSN 2714-5247

*Proceeding SENDIU*, pp. 978–979, 2020.

[3] Manuel Mendonca s. dkk., "Sistem Pengaman Kebocoran Liquified Petroleum Gas (Lpg) Dan Pemadam Api Pada Rumah Makan Restoran," *J. Ilm. Widya Tek.*, vol. 21, no. 2, pp. 19–26, 2013, [Online]. Available: https://publishing-widyagama.ac.id/ejournal-v2/index.php/widyateknika/article/view/86.

[4] R. Inggi and J. Pangala, "Perancangan Alat Pendeteksi Kebocoran Gas LPG Menggunakan Sensor MQ-2 Berbasis Arduino," *Simkom*, vol. 6, no. 1, pp. 12–22, 2021, doi: 10.51717/simkom.v6i1.51.

[5] L. Dewi and Y. Somantri, "Wireless Sensor Network on LPG Gas Leak Detection and Automatic Gas Regulator System Using Arduino," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 384, no. 1, 2018, doi: 10.1088/1757-899X/384/1/012064.

[6] I. K. N. Trisnawan, A. N. Jati, N. Istiqomah, and I. Wasisto, "Detection of Gas Leaks Using the MQ-2 Gas Sensor on the Autonomous Mobile Sensor," *2019 Int. Conf. Comput. Control. Informatics its Appl. Emerg. Trends Big Data Artif. Intell. IC3INA 2019*, pp. 177–180, 2019, doi: 10.1109/IC3INA48034.2019.8949597.

[7] C. Beretas, "Internet of Things and Privacy," *COJ Electron. Commun.*, vol. 1, no. 1, 2018, doi: 10.31031/cojec.2018.01.000503.

[8] K. P., "A Sensor based IoT Monitoring System for Electrical Devices using Blynk framework," *J. Electron. Informatics*, vol. 2, no. 3, pp. 182–187, 2020, doi: 10.36548/jei.2020.3.005.

[9] H. M. Tayyab, Y. Javed, I. Ullah, A. A. Dogar, and B. Ahmed, "A Hybrid MPPT Technique for Solar Photovoltaic System under Partial Shading †," *Eng. Proc.*, vol. 12, no. 1, 2021, doi: 10.3390/engproc2021012028.

[10] D. Kohl, "Function and applications of gas sensors," *J. Phys. D. Appl. Phys.*, vol. 34, no. 19, 2001, doi: 10.1088/0022-3727/34/19/201.