MQ3 alcohol sensor-Based Sensing of Alcohol (Ethanol) At Room Temperature

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Abstract

The significant number of automobiles running on the roads may increase traffic accidents globally. Drunk driving is a leading cause of traffic accidents worldwide. One of the project's key goals is to develop a method that may help to determine the amount of alcohol consumed by the vehicle's driver. A rise in the incidences has been known for a long time that people who drink much alcohol have high blood pressure may lead to accidents. Several recent investigations show that sample data from different countries have a link between alcohol consumption and blood pressure readings which may cause a Heart attack or paralyze the body. The system is intended to prevent the user from driving a vehicle when they are drunk. Drunk and Drive is a severe offense worldwide and needs to take strict action on people to reduce the frequency of accidents. The most important part of the proposed system is Arduino Uno, and an alcohol detection sensor (MQ-3). The study shows that most of the samples examined were positive, and blood pressure levels increased somewhat but a more predominant rise in those who consumed three glasses of wine or more daily. Blood pressure rises were recorded in 25% of studies in lower levels of intake, while roughly 40% in higher levels of consumption. Using SnO_2 (Tin Dioxide)-PDDAC (Poly-Diallyl-Dimethyl-Ammonium Chloride) as the sensitive film, we have shown how to create an ethanol sensor that operates at ambient temperature, which is inexpensive and adaptable. We found that PDDAC not only acted as the binder but also helped to boost the sensor's functionality. SnO_2-PDDAC's upper limit of detection at room temperature is 10 ppm and has an excellent endurance of at least two months. The sensor shows high selectivity to ethanol as well. These advantageous gas sensing characteristics make the suggested system become a Potential contender for measuring ethanol at room temperature with the proposed SnO_2-PDDAC sensor

Keywords : Accidents; Arduino; Alcohol, Driving, Hypertension.
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1.Introduction

Alcohol inhibits a person’s ability to make decisions. It can also lead to risky behaviors, such as driving while drunk and causing accidents. To avoid this problem and identify the drunk & drive cases, a project is being developed to create a system that can identify people who consumed alcoholic beverages. Being inebriated can also impair one’s capacity to think clearly and plainly. This leads to a slew of issues, including higher accident risks and illegal activity. The proposed system will be built as part of the project that will allow authorities to catch the people who have consumed the alcohol and, depending upon the sensor's value, we can make a decision. It should be simple to use and applicable to many different fields, such as optoelectronic devices, gas sensor devices [1-4], and much more recently, the development of multifunctional devices that can do many of these tasks [5-8]. Their mixture with printing methods and flexible substrates does have the ability to facilitate scalable and affordable manufacturing and open up new opportunities for a wide range of biosensors in flexible and wearable cross devices, including such watches, glasses, spots, and bandages, and other areas that are presently difficult to achieve with regular semiconductor technology. Report from the Indian Government,the Government of Road Transportation and Highways reports that there were 4,64,910 accidents overall in 2017.

This is because the driver is not positioned securely to take control of the car. In that situation, the driver shouldn’t be permitted to drive his vehicle. The unsettling number of accidents and fatalities that took place between 2008 and 2017, this has been documented in five investigations [2]. A small number of experiments have reported brief decreases in blood pressure. Alcohol limitation was linked to a rise in blood pressure in patients with hypertension as well as those with normal tension. Additionally, it might result in dangerous behavior like drunk driving and accident-causing behaviors[3]. An initiative to create a device that will recognize people who have ingested alcoholic beverages is being developed in order to prevent the present critical situation on Indian Roads.

2.Experiment

An Arduino board and a gas sensor are used to design an alcohol sensor. The system proposed is depicted in Figure 1. Our main purpose is to combine a gas sensor with an Arduino alcohol detection that use the programming language C inside the Arduino Software (Integrated Development Environment). The alcohol concentration is displayed in the Serial Monitor. On a serial plotter, the output is shown as a real-time graph.The alcohol sensor consists of components such as a gas sensor, a buzzer, an LED, and a serial monitor display, as illustrated in Figure 1 below. Open-source hardware and software make up the foundation of the electronics platform known as Arduino. A motor, an LED, or data publication may all be activated by an Arduino board by reading inputs like light on the sensor, a user's thumb on a key, or a tweet. For acquiring gas concentration indications, the alcohol gas sensor is employed. The Arduino is powered by 5 V and connects to a computer by a USB Pin Vin. An Analogue to Digital Converter (ADC) is provided by Arduino, which saves and executes the code. The final findings of gas concentration are shown on a serial monitor and a real-time graph is plotted on the serial plotter of the software i.e. Integrate Development Environment, which is Arduino IDE(Integrated Development Environment) v8.80 software.

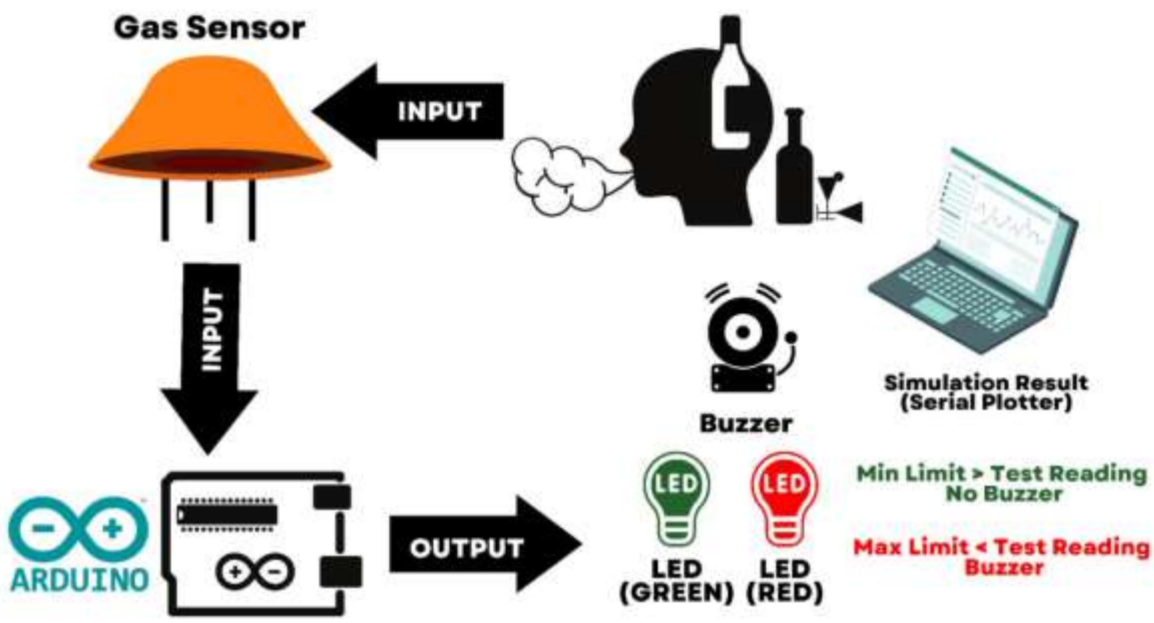


Fig. 1: Block Diagram of Real-time Alcohol Detection

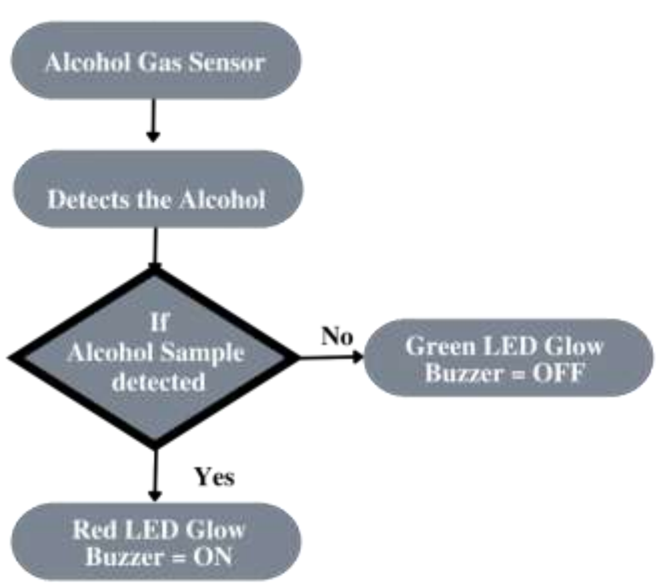


Fig. 2: System Flowchart

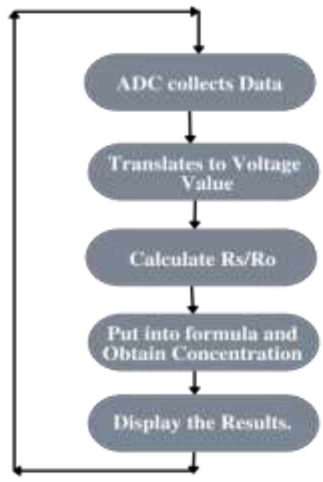


Fig. 3: Program Flowchart

We may develop code and upload it to Arduino boards using the free software known as the Arduino Software (Integrated Development Environment). Among other computer systems, the IDE programming environment is available for Windows, Mac OS X, and Linux.The programming languages C and C++ are supported. The process of developing a program or code in the Arduino IDE is referred to as "sketching." We must connect the Genuino and Arduino boards to the IDE to upload the sketch written in the Arduino IDE software. The sketch is saved with the ". ino" extension. We performed an experiment describing the quality of given alcohol samples suitable for demonstrating the principles of PCB-based Alcohol Sensors and uncertainty in the chemical analysis of particulate materials.

We took four types of alcohol samples for testing the sensor:

1. Methanol
2. Ethanol
3. Iso-propyl Alcohol
4. Real Alcohol Sample (Unknown Sample, Wine, Bear)

We tested these samples in 4 possible concentrations as shown below.:

Fig. 4: Alcohol Sample in 4 concentrations{25% 50% 75%100%}

3 Results and Discussions

In this system, the MQ3(alcohol sensor) is placed in an experimental setup for the detection of the alcohol in samples. The analog and digital pins of sensor provide values of the detected sample in the air. The 4 samples has differentiated successfully at room temperature. However, this differentiation is only possible at the same concentration of samples and the values overlap for different concentrations. This gadget is capable to detect alcohol in samples. The results obtained from sensors are plotted on a serial plotter and the same is shown below:

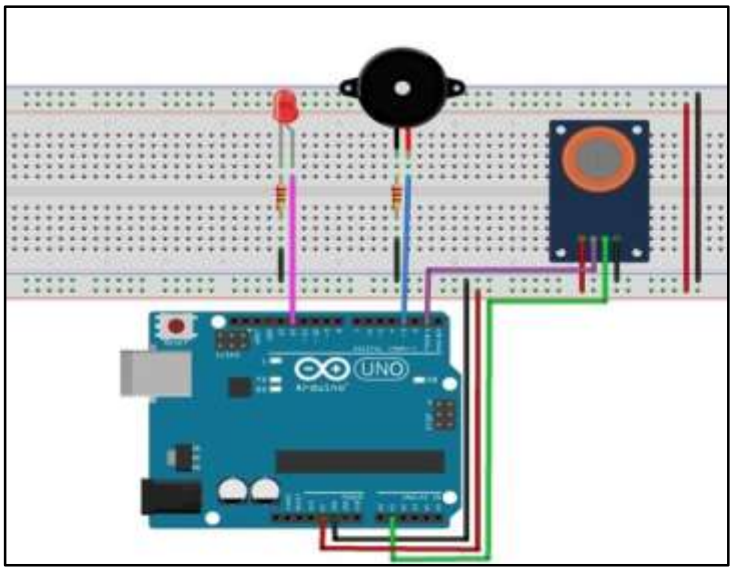
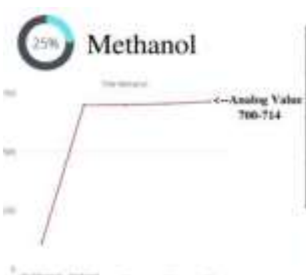


Fig. 5: Circuit Diagram of Alcohol Detector

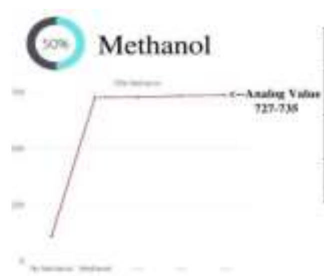
Simulation Output:

A. For Methanol



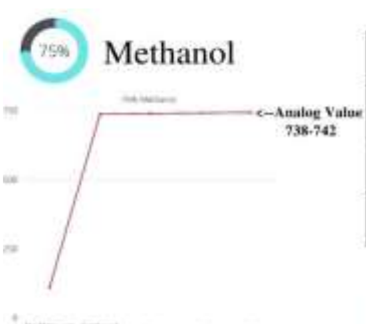
Digital Value	Analog Value	mg/l
0	700	1.55
0	705	1.60
0	714	1.71

Range: 1.55-1.71 mg/l



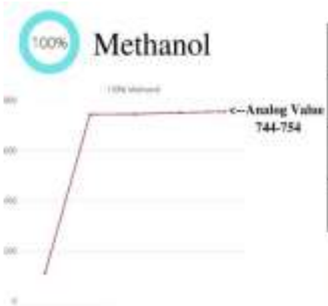
Digital Value	Analog Value	mg/l
0	727	1.75
0	733	1.80
0	735	1.95

Range: 1.75-1.95 mg/l



Digital Value	Analog Value	mg/l
0	738	2.00
0	740	2.15
0	742	2.30

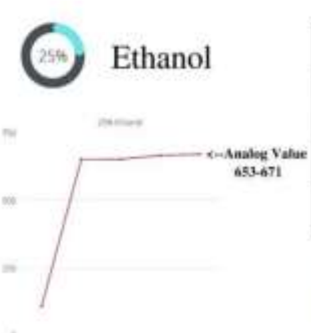
Range: 2.00-2.30 mg/l



Digital Value	Analog Value	mg/l
0	744	2.38
0	754	2.46
0	750	2.40

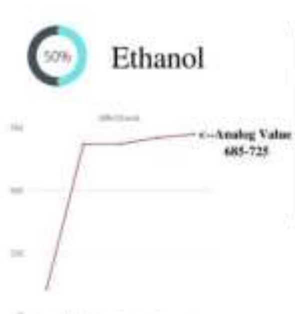
Range: 2.38-2.46 mg/l

B. For Ethanol



Digital Value	Analog Value	mg/l
0	653	1.78
0	667	1.66
0	671	1.65

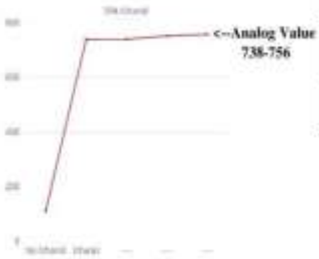
Range: 1.65-1.78 mg/l



Digital Value	Analog Value	mg/l
0	725	2.11
0	710	1.96
0	685	1.89

Range: 1.89-2.11 mg/l

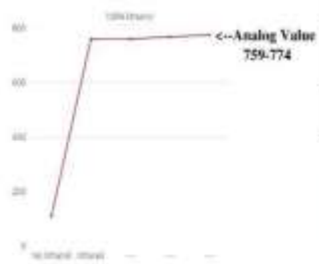
75% Ethanol



Digital Value	Analog Value	mg/l
0	750	2.36
0	756	2.45
0	738	2.38

Range: 2.36-2.45 mg/l

100% Ethanol

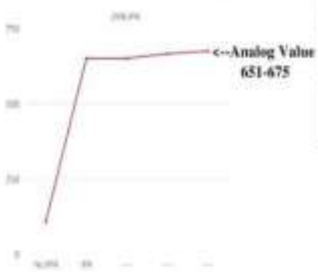


Digital Value	Analog Value	mg/l
0	759	2.50
0	774	2.49
0	766	2.50

Range: 2.49-2.50 mg/l

C. For Iso - Propyl alcohol

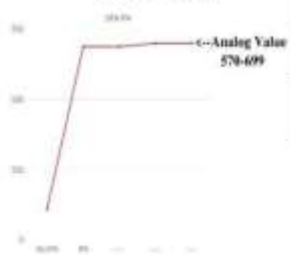
25% Iso Propyl Alcohol



Digital Value	Analog Value	mg/l
0	666	1.31
0	651	1.30
0	675	1.32

Range: 1.30-1.32 mg/l

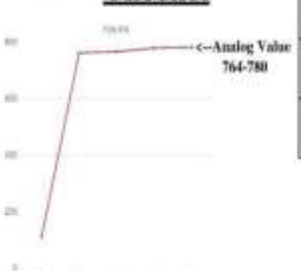
50% Iso Propyl Alcohol



Digital Value	Analog Value	mg/l
0	699	1.58
0	570	1.34
0	688	1.36

Range: 1.34-1.58 mg/l

75% Iso Propyl Alcohol



Digital Value	Analog Value	mg/l
0	764	1.62
0	780	2.10
0	777	1.89

Range: 1.62-2.10 mg/l

100% Iso Propyl Alcohol

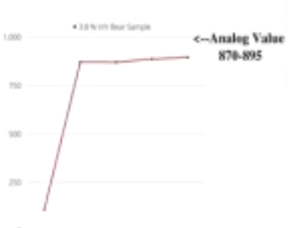
Digital Value	Analog Value	mg/l
0	820	2.18
0	821	2.43
0	820	2.15

Range: 2.15-2.45 mg/l

D .For 15% V/V Wine Sample

E. For 3.8% V/V Bear Sample

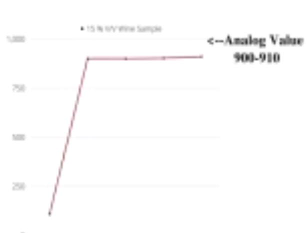
42.8% **Real Alcohol Sample: 3.8%V/V (3.8 ml of alcohol mixed with in 100 ml solvent as Bear.)**



Digital Value	Analog Value	mg/l
0	870	2.60
0	886	2.67
0	895	2.75

Range:2.60-2.75 mg/l

42.8% **Real Alcohol Sample: 15%V/V (15 ml of alcohol mixed with in 100 ml solvent as wine.)**



Digital Value	Analog Value	mg/l
0	900	2.72
0	902	2.80
0	910	2.73

Range:2.72-2.80 mg/l

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F. For 42.8% V/V real Sample Alcohol

42.8% **Real Alcohol Sample: 42.8%V/V (42.8 ml of (ethonol)alcohol mixed with 100 ml of water.)**

Digital Value	Analog Value	mg/l
0	791	2.56
0	787	2.48
0	782	2.38

Range:2.38-2.56 mg/l

G. Sample comparison

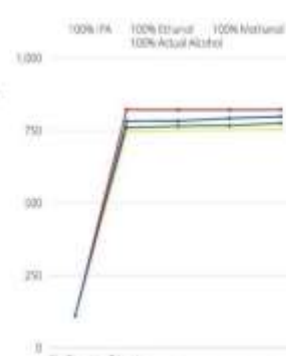
100% Sample Comparison

Methanol (AV: 744-754)

Ethanol (AV: 759-774)

Actual Alcohol (AV: 781-797)

Iso Propyl Alcohol (AV: 820-821)



Comparison table of all tested samples: Table 1

Range of analog values for different alcohol samples:

SAMPLE NAME	ANALOG VALUES	RANGE mg/l
Methanol	**744-754**	**2.38-2.46**
Ethanol	**759-774**	**2.49-2.50**
Iso-propyl Al	**820-821**	**2.15-2.45**
Liquor	**782-791**	**2.38-2.56**
Wine	**900-910**	**2.72-2.80**
Bear	**870-890**	**2.65-2.75**

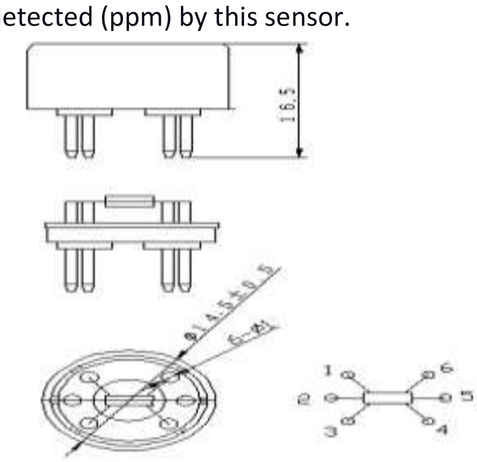
Hardware:

Fig. 6: Real time testing of Alcohol Samples

Sensor study:

The MQ3 sensor is one of the most common among the MQ sensor series. The sensor is a MOS (Metal Oxide Semiconductor). Metal oxide sensors are also known as chemoreceptors since they are based on a change in resistance of the detecting material when exposed to alcohol. A simple voltage divider network has been used to measure alcohol concentrations. The MQ3 alcohol sensor is powered by a 5V DC supply and uses around 800mW. Alcohol concentrations of 25 to 500 parts per million can be detected (ppm) by this sensor.

Model			MQ-3
Sensor Type			Semiconductor
Standard Encapsulation			Plastic cap
Target Gas			Alcohol gas
Detection range			25~500ppm alcohol
Standard Circuit Conditions	Loop Voltage	V_c	≤24V DC
	Heater Voltage	V_H	5.0V±0.1V AC or DC
	Load Resistance	R_L	Adjustable
Sensor character under standard test conditions	Heater Resistance	R_H	29Ω±3Ω (room tem.)
	Heater consumption	P_H	≤900mW
	Sensitivity	S	Ro(in air)/Rs(125ppm C_2H_5OH)≥5
	Output Voltage	Vs	2.5V~4.0V (in 125ppm C_2H_5OH)
	Concentration Slope	α	≤0.6(R_{300ppm}/R_{50ppm} C_2H_5OH)
Standard test conditions	Tem. Humidity		20℃±2℃; 55%±5%RH
	Standard test circuit		Vc:5.0V±0.1V V_H:5.0V±0.1V
	Preheat time		Over 48 hours



The MQ3 sensor produces a significant amount of heat when switched on, which is why it's secured by an anti-explosion network consisting of two layers of small stainless-steel mesh. Since we are sensing combustible gas, the heating element within the sensor will not produce an explosion (alcohol). It also protects the sensor by filtering suspended particles out of the chamber, enabling only gaseous elements to pass through. The star-shaped structure is made up of the sensing element and six connecting legs that protrude beyond the Bakelite base. Two of the six leads (H) are responsible for heating the sensor element and are connected through a Nickel-Chromium coil (a well-known conductive alloy).

Platinum wires are utilized to link the remaining four output signal lines (A and B). These wires are joined to the body of the sensing material and convey tiny changes in the current that flows through it. The tubular sensor element is made of aluminum oxide-based ceramic (AL_2O_3) with a Tin Dioxide coating (SnO_2). Tin dioxide is the most essential chemical that is vulnerable to alcohol. The ceramic substrate, on the other hand, increases heating efficiency and guarantees that the sensor area is always at the correct temperature. When the SnO_2 semiconductor layer's surface is heated to a high temperature, oxygen is adsorbed.Electrons from the valence band of tin dioxide are pulled to oxygen molecules in clean air by producing an electron depletion layer immediately beneath the surface of SnO_2 particles creating a potential barrier. As a result, the SnO_2 layer becomes very resistant, preventing electric current from flowing. When adsorbed oxygen interacts with alcohol, the surface density of the oxygen decreases, lowering the potential barrier. After that, the tin dioxide is blasted with electrons, which allows the current to flow freely through the sensor.Because the MQ3 alcohol sensor is not breadboardcompatible, we provide this handy tiny breakout board. It is simple to use and has two distinct outputs. It provides a binary indicator of the presence of alcohol as well as an analog representation of the concentration of alcohol in the air. The analog output voltage of the sensor (at the AO pin) varies proportionally to the alcohol content. The output voltage rises as the amount of alcohol in the air rises, while it drops as the amount of alcohol in the air falls.

The animation below shows the link between alcohol content and output voltage. An LM393 high precision comparator digitizes the analog signal, which is then available via the Digital Output (DO) pin. A potentiometer is included in the module for adjusting the sensitivity of the digital output. You can use it to establish a threshold so that the module outputs LOW if the alcohol level exceeds the limit;otherwisethe module outputs HIGH.

The efficacy is determined by the light energy generated at the junction and losses due to re-absorption as light tries to escape through the crystal. Because most semiconductors have a high index of refraction, light bounces from the surface into the crystal and is severely attenuated before ultimately departing. The external effectiveness is the efficacy defined in terms of this ultimate measurable visible energy.

4.Conclusion

In this work, we suggested a technique for identifying alcohol in a driver's breath and minimizing the potentially catastrophic effects. The Arduino Uno ATMEGA328 micro-controller and MQ-3 sensor were used to successfully build and implement the system. Using SnO_2-PDDAC (Poly-Diallyl-Dimethyl-Ammonium-Chloride) as the sensitive film, we have shown how to create an ethanol sensor that operates at ambient temperature, is inexpensive, and is adaptable. We discovered that PDDAC not only acted as the binder but also helped to boost the sensor's functionality. At room temperature, the sensor is 10 ppm and has excellent endurance of at least two months. It displays high selectivity to ethanol as well. The suggestion is made due to the advantageous gas sensing characteristics. A potential contender for measuring ethanol at room temperature is the SnO_2 -PDDAC sensor . The system's experimental evaluation revealed that the alcohol sensor could provide a quick reaction when alcohol was detected. The alcohol sensor's ability to work over a long period is also a feature of the suggested system.

5.Future Scope:

Alcohol-related accidents are on the rise in today's society, which is a cause for concern because alcohol is a main factor in many types of injuries. According to the WHO, every year, around 2.3 million people die prematurely as a result of hazardous alcohol usage. In this paper, with a novel idea loaded with alcohol detection sensors, we offered an enhanced alcohol detector project that may be extended to an upgraded version for stopping intoxicated drivers from getting on the road. These new sensors assess a person's breath awareness to determine whether or not they are fit to drive. If they aren't completely sober, a siren will sound, prohibiting them from getting on the road.

- Detection of alcohol (ethanol) at room temperature.
- Detection of minimum percentage of alcohol present in Samples.
- Alcohol (Ethanol) selective detection when other VOC’s (volatile organic compounds) are present.

- INTERDIGITATED ELECTRODE (IDEs) design and fabrication.
- Design an IDE for Sensing of Alcohol (Ethanol) at Room Temperature.
- Testing of other VOCs like Methanol.

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