



2018 ACCES23-CMBEC41

Joint Conference
Charlottetown PEI
May 8-11, 2018

DEVELOPMENT OF A LOW-COST PORTABLE SENSOR FOR DETECTION OF TETRAHYDROCANNABINOL (THC) IN SALIVA

Mason Boertien, Robert Smith, Bryce Stewart, Walid Mazyan, Nadja Bressan, and Ali Ahmadi*

School of Sustainable Design Engineering, University of Prince Edward Island

**aahmadi@upe.ca*

ABSTRACT

The design of a swab-based detector was developed for the detection of tetrahydrocannabinol (THC) in saliva. A gas sensor was used to differentiate among different concentrations of THC in water. The results show the initial proof of concept in detecting the presence of the THC. Further development is required to differentiate THC from other volatile organic compounds (VOC). Recommendations moving forward include integrating a microchannel and VOC filtering systems into the design to obtain a more selective device.

Keywords: Tetrahydrocannabinol; saliva-based detection; gas sensor

INTRODUCTION

With the impending legalization of marijuana by the Government of Canada in July 2018, onsite testing devices for determining the impairment from tetrahydrocannabinol (THC) are needed. THC is the active ingredient in marijuana that causes impairment, euphoria, and anxiety [1]. The impairment from THC must be monitored by law enforcement to keep the public safe from reckless driving. Current THC level testing methods consist of blood sampling which requires a user to be taken to a lab [2, 3] and THC breathalyzers [4] which are undergoing extensive research and development.

A possible solution for determining THC impairment includes a measuring device, which analyzes saliva to determine the user's THC

level of toxicity using mouth swabs. The THC concentration of the sample taken from the user is evaluated by determining the cannabinoid vapor pressure [4]. If the vapor pressure exceeds the legal level set by the Canadian government, the individual would be considered as impaired.

In this work, a low cost portable system was developed for detection of THC in Saliva. The gas sensing device is used to determine the concentration of THC present in saliva.

METHODOLOGY

The device utilizes a gas sensor to measure the concentration of THC in the vapor emitted from a saliva sample that is collected using a cotton swab. The sensing element uses a metal oxide semiconductor layer formed on an alumina substrate of a sensing chip with an integrated heater for the detection of solvent vapors. As the sensor is exposed to THC, the resistance of the sensor decreases based on the THC concentration (see Figure 1).

As gas passes through the sensor, the resistivity of the sensor changes. This change creates a variation in the current passing through the circuit; and hence, the voltage across the load resistor R_L is measured and determines the concentration of THC present [4]. The legal limit of THC concentration can be set on the sensing device to determine the impairment of the individual [5, 6].

Figure 2 shows the CAD design of the detector prototype. The components used within the case are a gas sensor (Figaro, TGS2620), an Arduino Uno REV 3 SMD

microcontroller and LCD screen, 12-V battery, breadboard-friendly SPDT slide switch, Piezo buzzer, three LED's (green, blue and red), and a 3D printed polycarbonate enclosure with the testing channel attached to the bottom section of the device. The testing utilized a Δ^9 -Tetrahydrocannabinol solution at 1.0 mg/mL in methanol (Sigma Aldrich) to simulate saliva containing THC. The total cost of the prototype was \$70.98 (see Table 1).

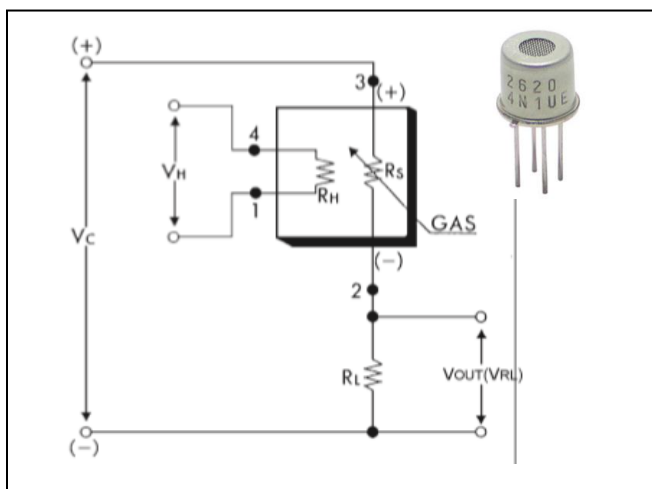


Figure 1: THC sensor electric circuit schematic [7].

Table 1: The price list of all the parts.

Part	Price
ARDUINO UNO REV3 SMD	\$20.90
ARDUINO LCD SCREEN	\$20.90
9V battery clip with 5.5mm/2.1mm plug	\$2.95
Potentiometer Knob - Soft Touch T18 - Red	\$0.50
Piezo Buzzer - PS1240	\$1.50
Breadboard-friendly SPDT Slide Switch	\$0.95
Gas Sensor	\$15
LED	\$8.28
Total	\$70.98

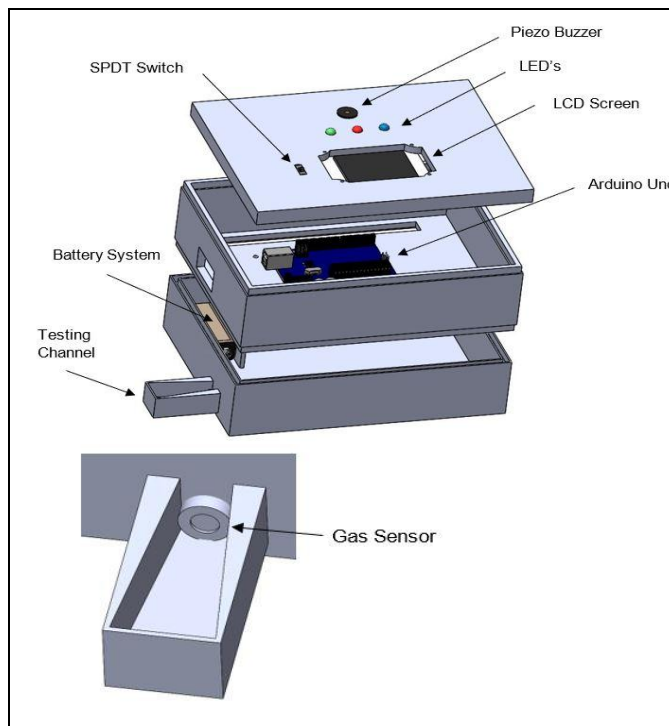


Figure 2: The CAD design of THC detector components.

RESULTS AND DISCUSSION

THC concentration testing was carried out using a swab. The loaded swab was present 5 mm from the sensor in the testing channel (see Figure 3). The swab was held at the inlet and then removed. Different concentrations of ethanol and THC dissolved in water were tested. Baseline trials were carried out to show the effect of sensor readings when a dry swab and a wet swab soaked in pure water approached the sensor. Next, the THC trials were performed for different concentrations of THC: i) 100% w/v THC, ii) 2% w/v THC, iii) 4% w/v THC and 8% w/v THC. Ethanol trial was carried out with rubbing ethanol at 10% w/v concentration.

Figure 4 shows that the prototype successfully differentiates among THC, ethanol, wet and dry swab. For this test, the swab was removed from the inlet after 40 s. Figure 5 shows that the detector can differentiate among different concentrations of THC. Further testing is required to securely identify the relationships between THC concentrations and

solutions. For this test, the swab was removed from the inlet after 100 s.

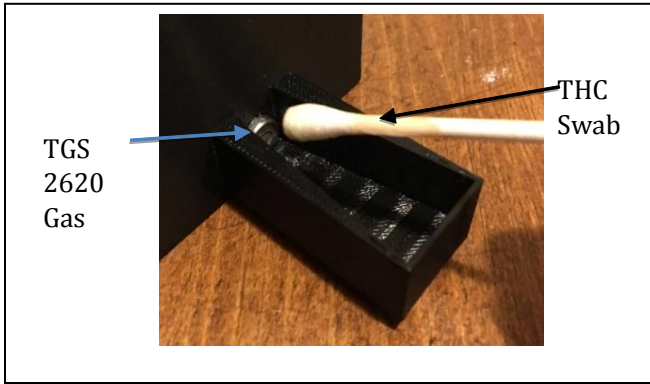


Figure 3: THC swab sampling process.

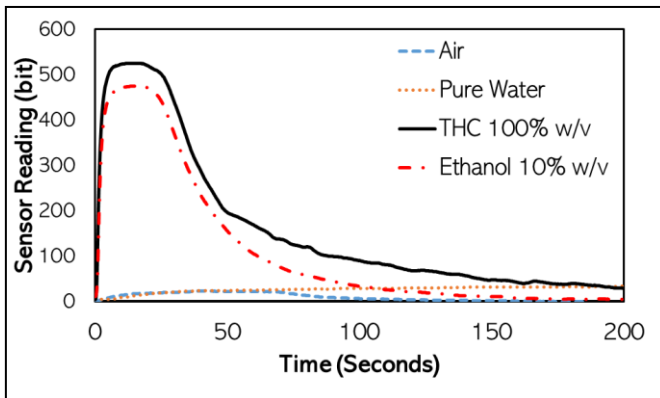


Figure 4: Sensor response to THC, ethanol, water and air.

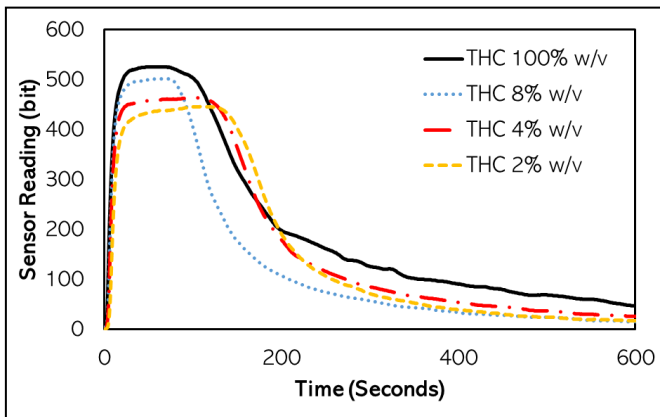


Figure 5: Sensor response to various concentrations of THC.

CONCLUSION

The current design demonstrates the ability to detect various volatile compounds through swab/saliva testing using the proposed

prototype. At this stage, the device is unable to differentiate the compounds that are being detected but can determine the concentration of the gas at low concentrations.

Moving forward, the team will optimize the device capabilities to differentiate between different particles and fumes (ethanol and THC). Further analysis will be conducted on integrating microfluidic channels and THC filters in order to enhance the selectivity.

REFERENCES

- [1] N. Comeau; S. Stewart; P. Loba. "The relations of trait anxiety, anxiety sensitivity, and sensation seeking to adolescents' motivations for alcohol, cigarette, and marijuana use". *Addictive Behaviors*. Vol. 26, pp. 803-825, 2001.
- [2] A. Hayley; L. Downey; G. Hansen; A. Dowell; C. Stough. "Detection of delta-9-tetrahydrocannabinol (THC) in oral fluid, blood and urine following oral consumption of low-content THC hemp oil". *Forensic Science International*. Vol. 284, pp. 101-106, 2018.
- [3] R. Goodwin; W. Darwin; C. Chiang; M. Shih; S. Li; M. Huestis. "Urinary elimination of 11-nor-9-carboxy-tetrahydrocannabinol in cannabis users during continuously monitored abstinence". *Journal of Analytical Toxicology*. Vol. 32, pp. 562-569, 2008.
- [4] M. Paknahad, A. Ahmadi, M. Hoorfar (2016). Diffusion-based microfluidic breath analyzer for detection of cannabis use. The 20th International Conference on Miniaturized Systems for Chemistry and Life Sciences (MicroTAS16), Dublin, Ireland.
- [5] Independent Drug Monitoring Unit - Drug Testing - Cannabis "Blood & Urine Drug Testing for Cannabinoids" Matthew J Atha BSc MSc LLB <http://www.idmu.co.uk/pdfs/drugtest.pdf>
- [6] Health Canada. "Backgrounder: Changes to Impaired Driving Laws". Government of Canada. Retrieved on February 2018 from: https://www.canada.ca/en/health-canada/news/2017/04/backgrounder_changestoimpaireddrivinglaws.html
- [7] Figaro "TGS 2620 - for the detection of Solvent Vapors", Figaro USA, Inc. Retrieved on February 2018 from: <http://www.figarosensor.com/products/entry/tgs2620.html>