



ADSA22 Workshop, ALERT Center, Northeastern University, 12/8/2020

Highly Sensitive and Specific Gas Sensors for Instant Detection of Pathogens from the Air

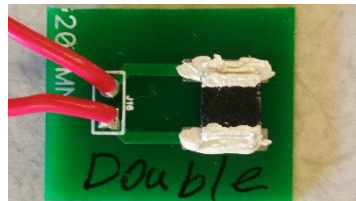
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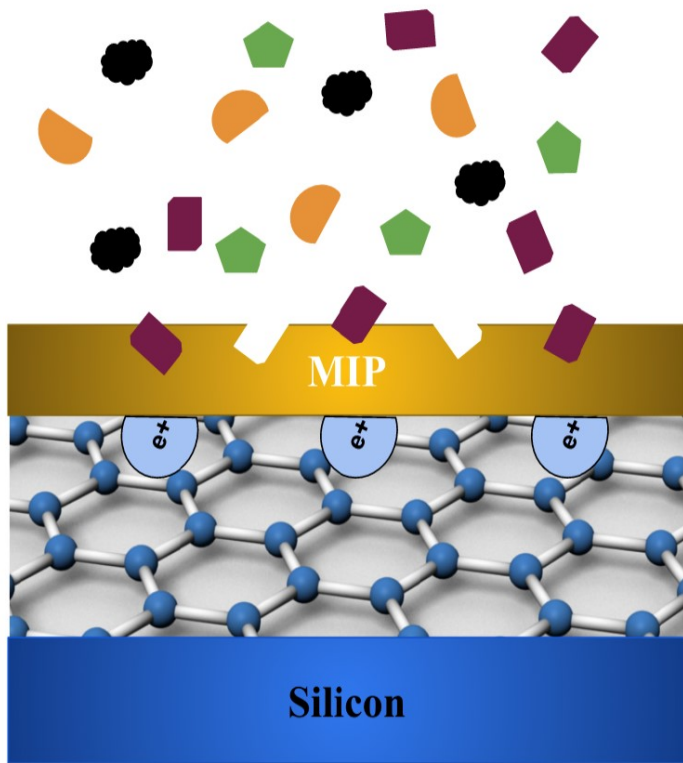
A New Sensor Platform for Instant Detection of Small and Large Molecules in the Air

- **Space:** Instant detection of trace amount of SARS-CoV-2, opioids, etc. readily extended for explosives.
- **Problem:** Instant detection of different molecules in the air has been challenging on achieving high sensitivity and specificity.
- **Solution:** Functionalized molecularly imprinted polymer made with cavities of the targeted molecules.
- **Results:** Oxycodone sensor with 10^{-18} sensitivity, SARS-CoV-2 sensor with limit of detection of 3000 copies/mL and ~100% specificity for instant COVID-19 tests, etc.
- **TRL:** 5~6 for SARS-CoV-2 and Oxycodone; 2~4 weeks for explosive sensors.

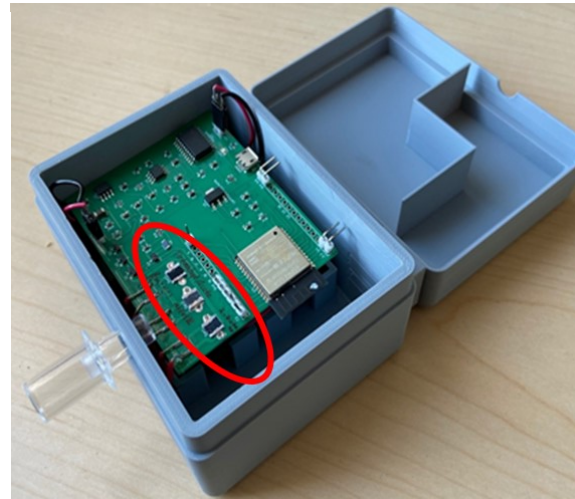


Sensor size: 5x5mm²

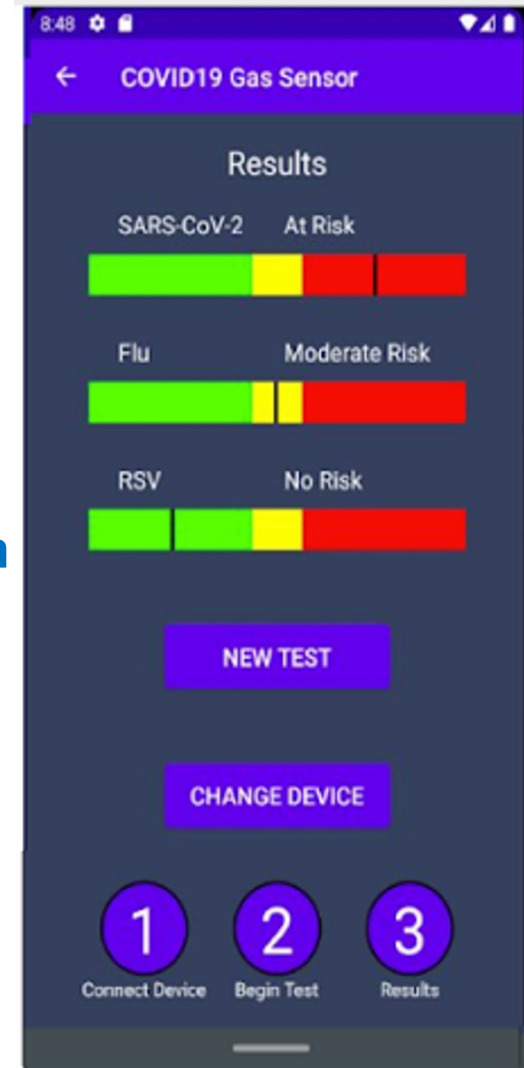
Handheld Gas Sensors System (~2"x3"x4") for Instant SARS-CoV-2 & Oxycodone Sensing in Air



■ Template molecule ● Other molecules in the environment



The sensor is based on functionalized molecularly imprinted polymer (MIP) with a lock-key relation to targeted molecules in air.



Summary of Results for Sensing SARS-CoV-2 and Oxycodone in the Air

SARS-CoV-2 Sensor:

- ❖ Instant COVID-19 tests from the breath or saliva vapor in seconds at a very low cost <0.1\$.
- ❖ Sensor devices in clinical trial now at Massachusetts General Hospital and University of Massachusetts Medical School.

Oxycodone Sensor:

- ❖ LoD: 0.08 parts per quadrillion (10^{-18}), ~1 picogram oxycodone in a cubic meter.
- ❖ 1~2 seconds sensor response and recovery.
- ❖ 6~7 orders of magnitude better than conventional methods and sniffer dogs.

When Will the Sensor Devices be Available

SARS-CoV-2 Sensor:

- ❖ Available now for environmental monitoring of SARS-CoV-2 in small quantities. Mass production in progress.
- ❖ COVID-19 tests available by 01/2021.

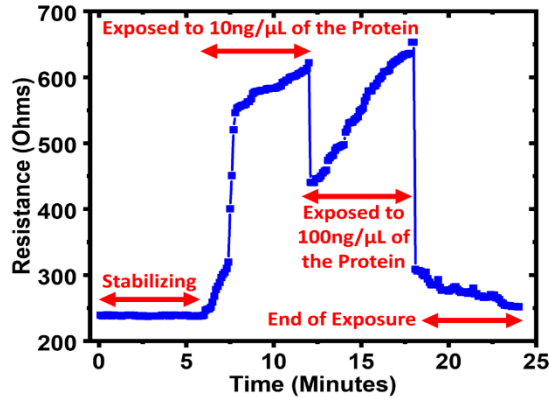
Oxycodone Sensor: Available now.

Sensors for Explosives etc.: Readily extendable to sensors for other molecules in air, e.g. explosives in 2~4 weeks, by switching the sensor chip.

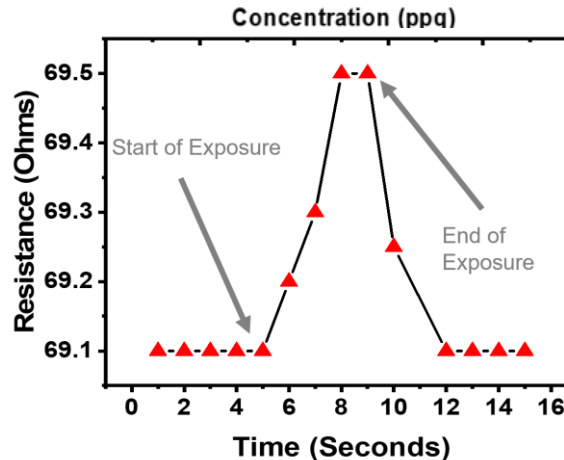
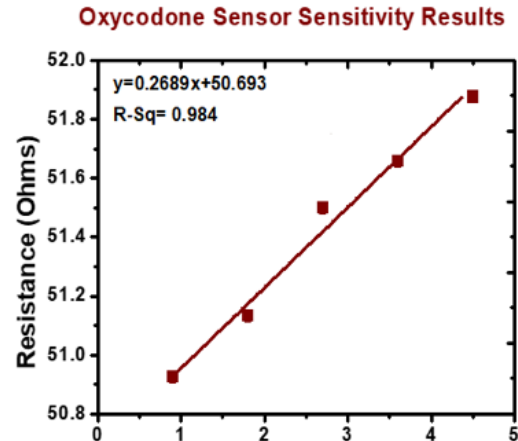
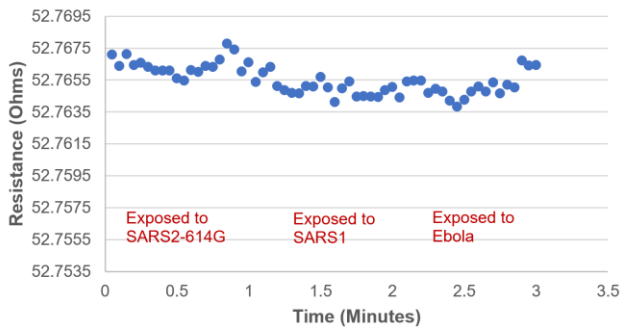
Nian Sun has a financial interest in Winchester Technologies, LLC

Backup Slides

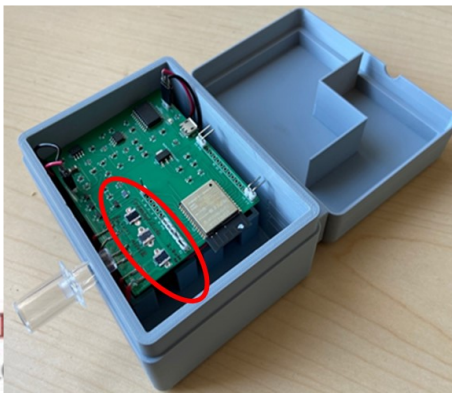
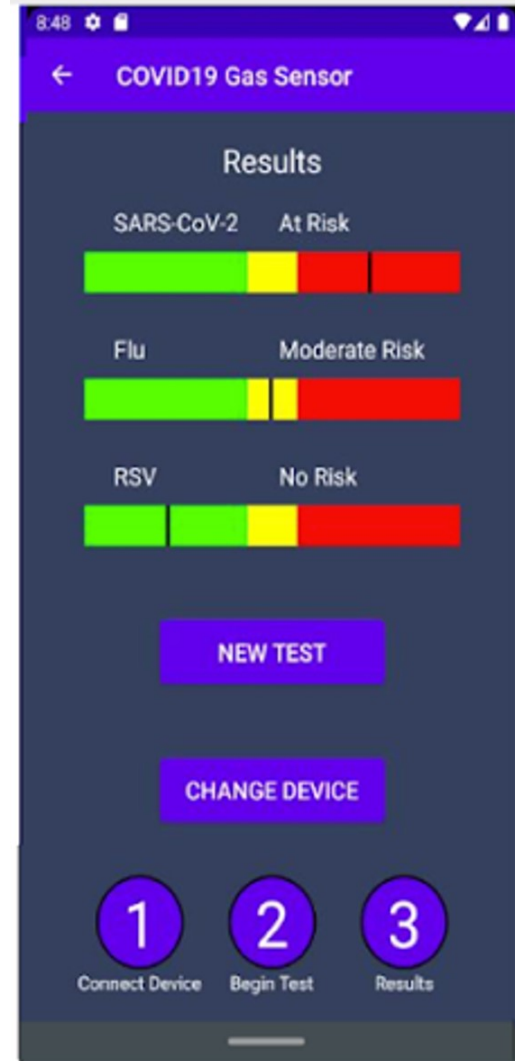
Handheld Gas Sensors System (~2"x3"x4") for Instant SARS-CoV-2 & Oxycodone Sensing in Air



SARS2-614D sensor response to other viruses



Handheld Gas Sensors System and Mobile App.



List of Patent and Publications

Patent:

- **Molecularly-Imprinted Electrochemical Sensors.** Nian-Xiang Sun, Shadi Emam, Adam. K Ekenseair. US Patent App. 16/383,220.
- **New gas sensors for SARS-CoV-2 virus for instant COVID-19 tests,** Nian Sun, Shadi Emam, Mehdi Nasrollahpourmotlaghzanjani, Provisional Patent 5200.2271-000 (INV-21011).

Publications

- **Emam, S. et al. Detection of volatile organic compounds from exhaled breath of APOE4 rats.** Alzheimer's Dement. 12, e12088 (2020).
- **Adams, J.A., Emam, S., Ma, Y., Wang, Q., Shashidhar, R., Sun., N., A Molecularly Imprinted Polymer-Graphene Sensor Antenna Hybrid for Ultra Sensitive Chemical Detection,** IEEE Sensors Journal, vol. 19, no. 16, pp. 6571-6577, 15 Aug.15, 2019.
- **Emam, S., Adedoyin, A., Geng, X., Zaeimbashhi, M., Adams, J., Ekenseair, A., Podlaha-Murphy, E., Sun, N., A Molecularly- Imprinted Electrochemical Gas Sensor to Sense Butylated Hydroxytoluene in Air,** Journal of Sensors, Volume 2018, Article ID 3437149, 1-9.
- **Emam, S., Kulkarni, P., Nasrollahpour, M., Colarusso, B., Ekenseair, A., Ferris, C., Sun, N., An Electrochemical Sensor Array for Detecting Alzheimer's disease Biomarker VOCs,** Society for Neuroscience, Chicago IL, 2019.
- **Emam, S., Sun, N., A Molecularly Imprinted Electrochemical Sensor to Detect VOCs in the Breath Print of Lung Cancer,** Bulletin of the American Physical Society, Boston MA, 2019.
- **Emam, S., Sun, N., Ekenseair, A., A Molecurlly Imprinted Electrochemical Gas Sensor to Sense Chemicals in Air: a Pathway to Diagnosis of Alzheimer's disease from Exhaled Breath,** Alzheimer's Association International Conference, Chicago IL, 2018. (Abstract published: Alzheimer's Dementia: The Journal of the Alzheimer's Association 14 (7), P1549)
- **Zaeimbashi, M., Lin, H., Wang, Z., Chen, H., Emam, S., Gao, Y., Sun, N., NanoNeuroRFID: A Low Loss Brain Implantable Device Based on Magnetolectric Antenna,** 2018 IEEE International Microwave Biomedical Conference (IMBioC), 205-207.
- **Emam, S., Sun, N., Electrochemical Gas Sensor to Diagnose Alzheimer's disease through Exhaled Breath ,** MRS Fall Conference, Boston MA, 2017.
- **Emam, S., Nasrollahpour, M., Allen, P.J., He, Y., Hussein, S., Podlaha, E., Ekenseair, A., Sand, J., Sun, N., A Hand-Held Device to Detect Lung Cancer Biomarkers in the Exhaled Breath,** to be submitted.
- **Emam, S., Iriah, S., Kulkarni, P., Nasrollahpour, M., , Podlaha, E., Ekenseair, A., Heger, N., Magnani, B.J., Ferris, C., Sun, N.X., Part Per Quadrillion-Sensitive Wearable Device to Detect Oxycodone in Exhaled,** to be submitted.