VOC Detection by Visual Inspection of Liquid Crystals

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The Problem

PROBLEM:

There is no effective and simple solution to measure personal exposure to volatile organic compounds (VOCs).

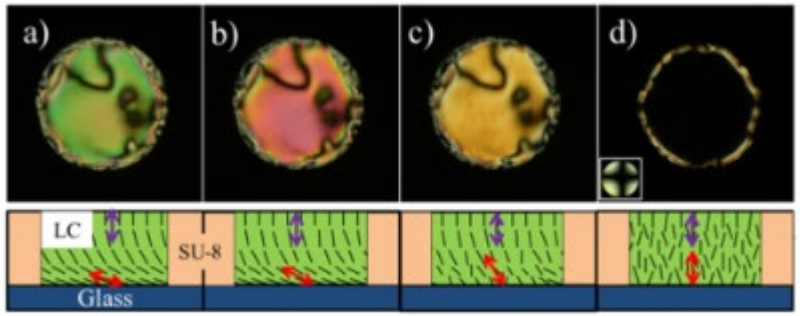
- Indoor air quality is of increasing interest in home, commercial and industrial settings.
- Over two million workers are estimated to face vocational exposure to VOCs.
  - US NOES (National Occupational Exposure Survey)
- “Sources of VOCs in buildings can include wood products, adhesives and glues, preservatives, insulation materials, fabrics, paints, solvents, byproducts of combustion, healthcare products, cleaning products, pesticides, manufacturing processes, mold, and fungi..”
  - BCC Research, “U.S. Indoor Air Quality Market”, Feb 2019

Liquid Crystal Tests for Endotoxin

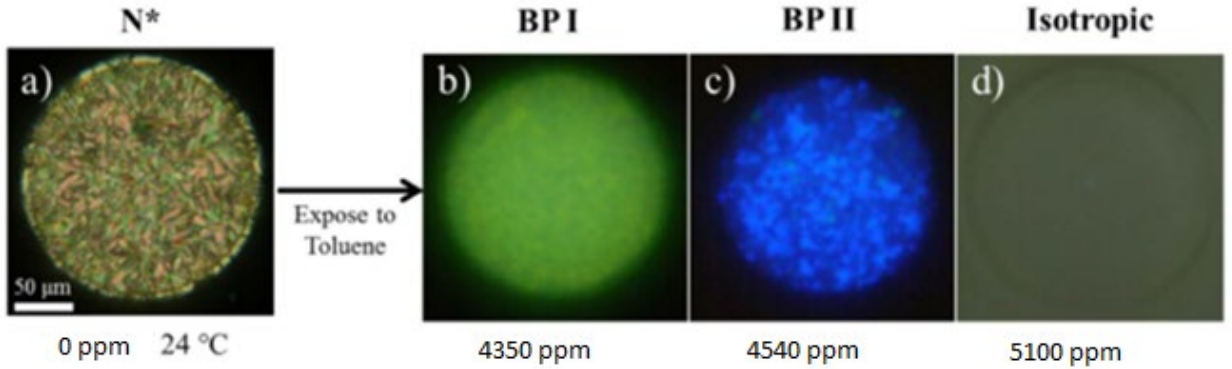
SOLUTION:

Liquid crystal droplets can be used to detect the presence of volatile organic compounds.

- Liquid crystals bind to VOCs in a controllable range starting at 100ppm and change phase and color.
  - This change in color can seen in real time with the unaided eye.

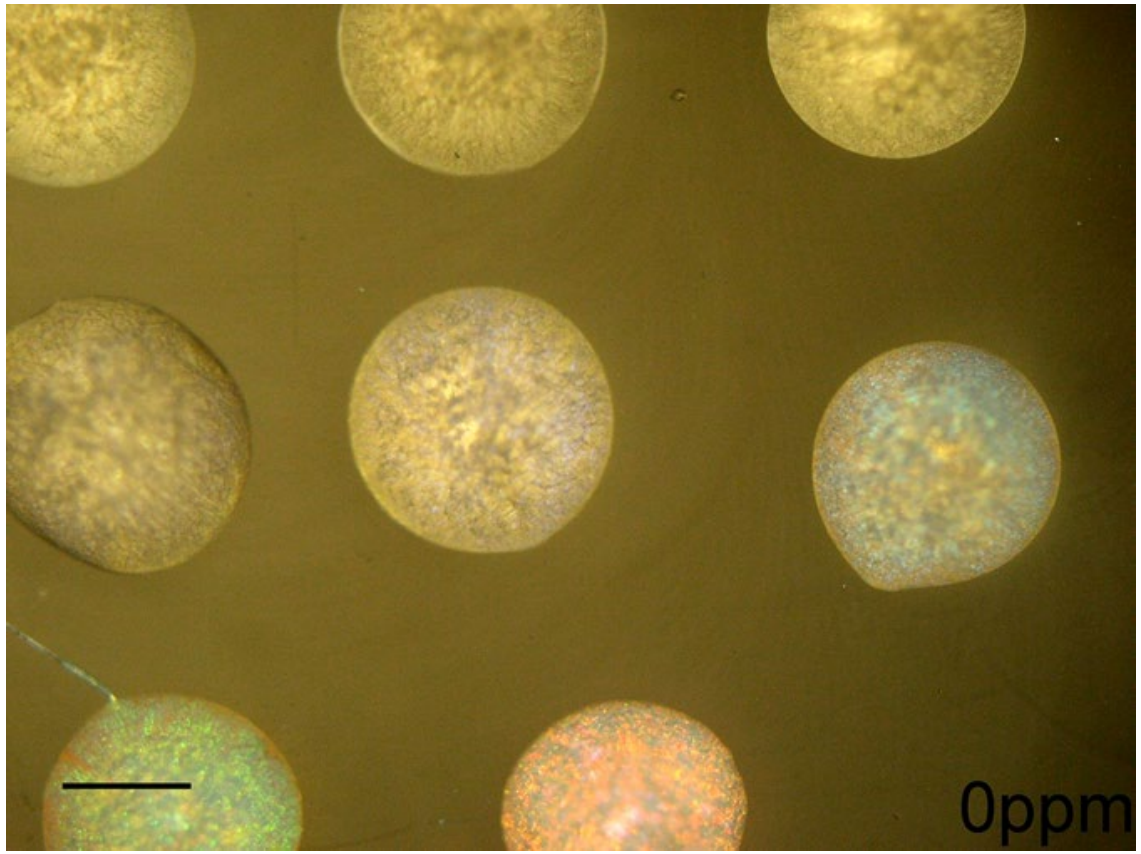


Color Change as exposure from 0 ppm toluene to 2065 ppm toluene



Sample phase and color changes for blue-phase liquid crystals at different toluene concentrations

Scaling bar: 500 µm

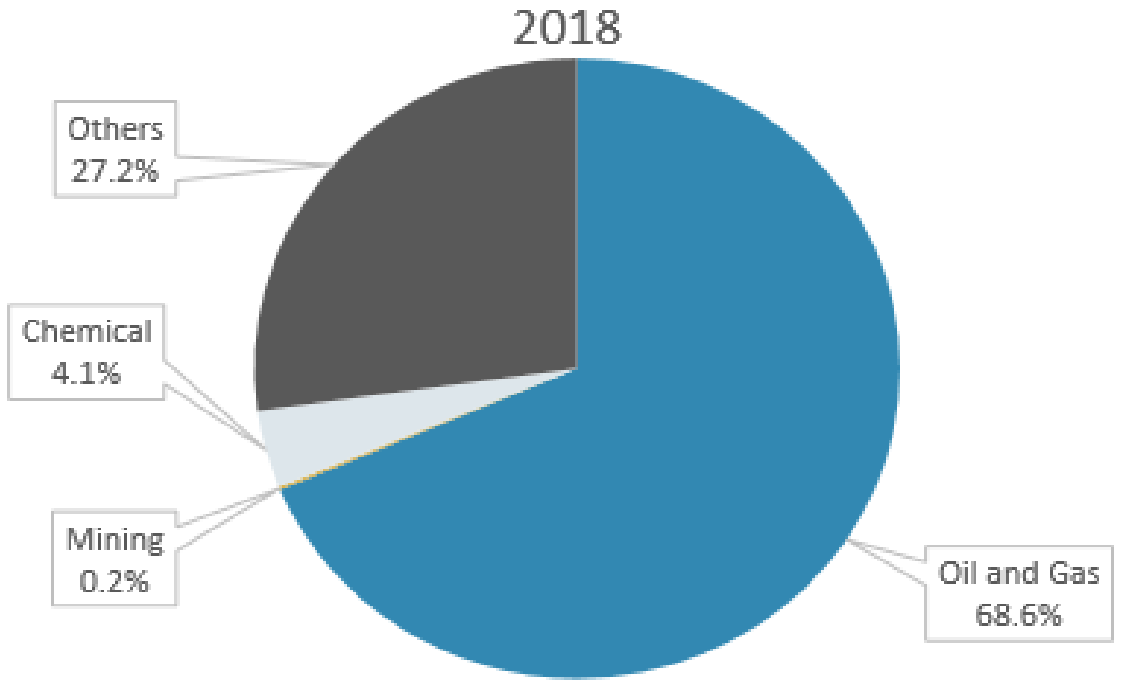


- Microarray with each well calibrated for blue color at a different VOC concertation level

Market

- The market for portable VOC detectors was $64 million in 2018. The market is expect to grow at a CAGR of 3.9%.

(BCC Research, “Portable Gas Detection Systems: Global Markets” Feb 2019)



- Increasing consumer interest in VOCs and home air quality is mostly untapped.

Comparison

Test	Pros	Cons
Liquid Crystal Detection	• Detects many VOCs • Inexpensive • Easy-to-understand color readout • Quantitative response	• Early stage, pre-commerical
Photoionization detectors	• Detects many VOCs • Gives information on personal exposure • Quantitative response	• Expensive
Passive Sampling	• Inexpensive • Detects many VOCs • Gives information on personal exposure • Quantitative response	• Requires laboratory analysis • Long time gap between reading and interrogation
Catalytic metal oxide-based sensors	• Can be integrated into electronics • Quantitative response	• Can be affected by humidity and temperature. • Expensive/complex
Colormetric	• Easy-to-understand color readout • Inexpensive	• Only supports single reading • Slow response (minutes)

Intellectual Property

- P150037 – METHOD OF DETECTION OF VOLATILE ORGANIC COMPOUNDS USING LIQUID CRYSTALS THAT FORM A BLUE PHASE; AND DEVICE FOR STABILIZATION AND THICKNESS CONTROL OF LIQUID CRYSTAL FILMS
  - One issued US patent (US9863923)
  - One pending divisional US patent (US 15/825290)

Research Team

Nicholas L. Abbott

- Currently Tisch University Professor at Cornell University
- Previous professor at University of Wisconsin-Madison and University of California – Davis.
- Founder of Platypus Technologies

Publication

- Bedolla Pantoja, et al., “Surface-Controlled Orientational Transitions in Elastically Strained Films of Liquid Crystal That Are Triggered by Vapors of Toluene”, *ACS Appl. Mater. Interfaces*, 2016, 8 (20), pp 13114–13122

List of Benefits

1. Can immediately detect unsafe levels of VOCs.
2. Detects many VOCs
3. Inexpensive.

Summary

- A new biophysical test has been developed for the detection of VOCs, and can provide immediate feedback upon exposure.
- Proof-of-Concept developed and noticeably changes color upon exposure to VOCs.

Seeking a commercial partner to develop, test and launch product.

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Thank You