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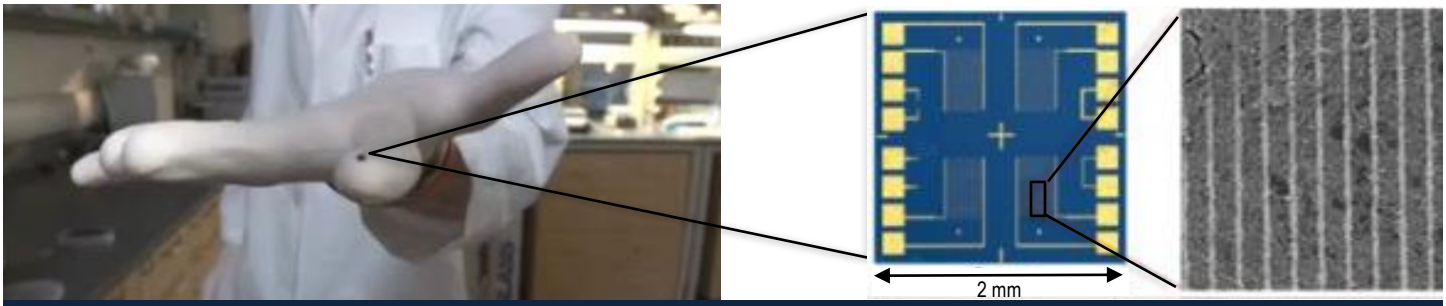


# Sensors Based on Carbon Nanomaterials

ID: 1843, 2285, 2390, 4192

Featured Innovators: Alex Star, PhD, Mike Chido, and Sean Hwang

Manufacturing and maintenance of industrial and medical sensors can be costly. We present a platform for producing cheap, low-power, passive carbon nanomaterial sensors that can be easily integrated into portable devices. This versatile platform has the capacity to detect and quantify myriad chemical substances. We also present a method for safely degrading unused sensor material so that it doesn't present an environmental hazard.

## Technology Description

Carbon nanomaterials are ideal sensor transducers due to their large charge-carrier concentration, high surface area, and single-atom thickness, all of which promote sensitivity to molecular interactions that occur near the material's surface. The nanomaterial is composed of holey reduced graphene oxide, which can be decorated with different receptors that confer selectivity depending on the desired application (e.g., H, $O_2$, or $H_2S$ gas detection). Unlike most commercially-available sensors – which require energy-intensive heating elements or sophisticated lab equipment – our platform can be implemented as simple electronic components that change their resistivity based on chemical interactions.

Despite its advantages, carbon nanomaterials pose a significant health risk to those exposed through environmental contamination or direct handling. To address this concern, we developed an enzymatic method for safely biodegrading carbon nanotubes. When broken down in this way, nanotubes no longer cause lung inflammation in mice.

## Advantages

- Low power
- Room temperature operation
- Solid-state device
- Low cost
- High sensitivity
- CMOS compatible
- Small size (2x2 mm)

## Applications

- Gas leak detectors
- Environmental and occupational safety monitoring
- Auto manufacturing
- Breathalyzers
- Chemical spill kits

## Stage of Development

The basic research supporting most of the sensors has been completed and published. Prototypes exist, and in some cases testing has been done *in vivo*.

## IP Status

Three issued patents (US8,530,227; US8920764; US9,482,638) and multiple applications

## Notable Mentions

- Pitt Clinical Translational Science Institute funding ($100,000)
- Corporate sponsorship ($100,000)
- Innovation Works funding ($35,000)
- Pitt Innovation Institute ($6,000)

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# Innovators

## Alexander Star, PhD

Professor,
Department of Chemistry
Department of Bioengineering
Clinical Translation Science Institute
University of Pittsburgh

A major focus of Dr. Star's research has been materials chemistry and nanoscience. In addition to his academic pursuits, he spent three years as a Senior Scientist and Manager of Applications Development at Nanomix, Inc.-- a nanotechnology startup company – where he worked on development and commercialization of carbon nanotube-based sensors.

Dr. Star has co-authored 105 peer-reviewed publications, four book chapters, and was listed as a co-inventor on nine issued patents and over 20 patent applications. His research was recognized by Intel Award, three University of Pittsburgh Innovator Awards, Chancellors Distinguished Research Award, NSF CAREER Award, and NIEHS Outstanding New Environmental Scientist (ONES) Award.

### Education

PhD in Chemistry, Tel Aviv University
BS in Chemistry, Tel Aviv University

### Publications

- Kuzmych, O.; Allen, B. L.; Star, A. "Carbon Nanotube Sensors for Exhaled Breath Components." *Nanotechnology* **2007**, *18*, 375502.
- Ding, M.; Sorescu, D. C.; Star, A. "Photoinduced Charge Transfer and Acetone Sensitivity of Single-Walled Carbon Nanotube-Titanium Dioxide Hybrids." *J. Am. Chem. Soc.* **2013**, *135*, 9015-9022.
- J. E. Ellis, A. Star* "Carbon Nanotube-based Gas Sensors toward Breath Analysis" *ChemPlusChem* **2016,** *81,* 1248-1265.

## Mike Chido

PhD Student
Department of Chemistry
University of Pittsburgh

Mr. Chido's research focuses on applications of novel hybrid nanomaterials – including polymer-based memory systems – as well as the development of chemical sensors for detection of industrial gases. He is also responsible for the photolithographic patterning and fabrication of the silicon-chip based sensors for the Star Lab projects. In his time at Pitt, he has recieved the Safford Award for Excellence as a graduate student teacher in 2016.

### Education

BA in Chemistry, College of Wooster

## Sean Hwang

PhD Student
Department of Chemistry
University of Pittsburgh

Mr. Hwang worked at the 3M Electronic Solutions Division from 2011 to 2013 as a technician, developing heat dissipating flexible circuits and prototyping LED lighting devices. He is interested in device prototyping and functionalization of carbon nanomaterials with metal oxide and plasmonic nanoparticles for applications in sensors and drug delivery.

### Education

BS in Chemistry and Computer Science, University of Texas at Austin


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