The background of the slide is a scanning electron micrograph (SEM) showing a highly porous, interconnected network of polymer fibers. The structure consists of numerous small, interconnected clusters and channels, creating a complex, sponge-like morphology. The fibers appear to be randomly oriented and fused together, forming a porous matrix. The overall appearance is that of a highly porous, three-dimensional polymer network.

# Sensor Array for Volatile Organic Compounds based on Doped Poly (2,5-dimethyl aniline) and Poly (o-anisidine)

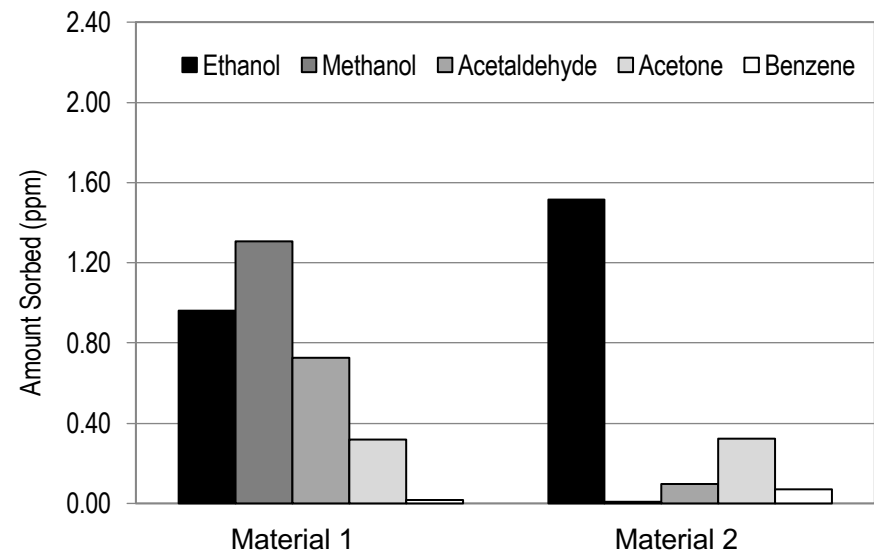
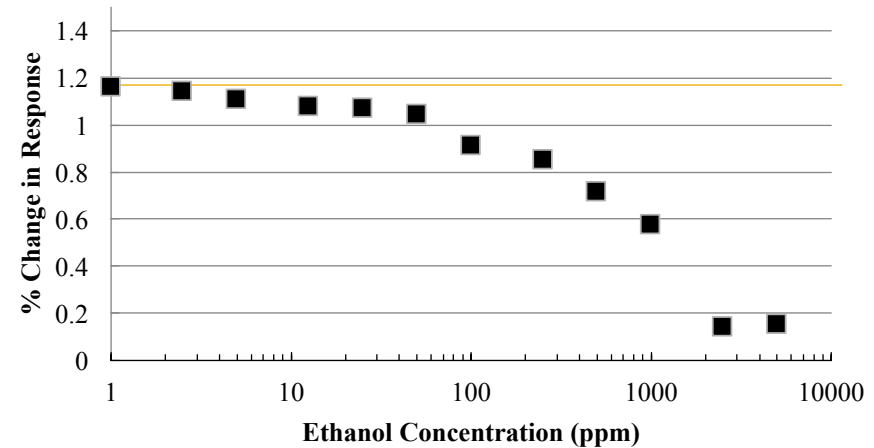
Katherine M. E. Stewart, Alison J. Scott, and Alexander Penlidis  
Institute for Polymer Research (IPR)  
University of Waterloo  
Waterloo, Ontario, Canada

# Motivation: Toxic Gas Analytes

- There are numerous applications in which sensing gas analytes is important
  - Formaldehyde and benzene detection in air
  - Ethanol detection to reduce drinking and driving
  - Acetone detection as a disease indicator
- In any application, many gas analytes are present
  - Target gases and interferent gases
  - May want to identify multiple analytes

# Sensing Characteristics

- Sensitivity
  - Related to the detection limit of a sensor; the lower the detection limit, the more sensitive the sensor.
- Selectivity
  - Ratio between the responses of target analyte to interferent analyte.





# Sensing Materials

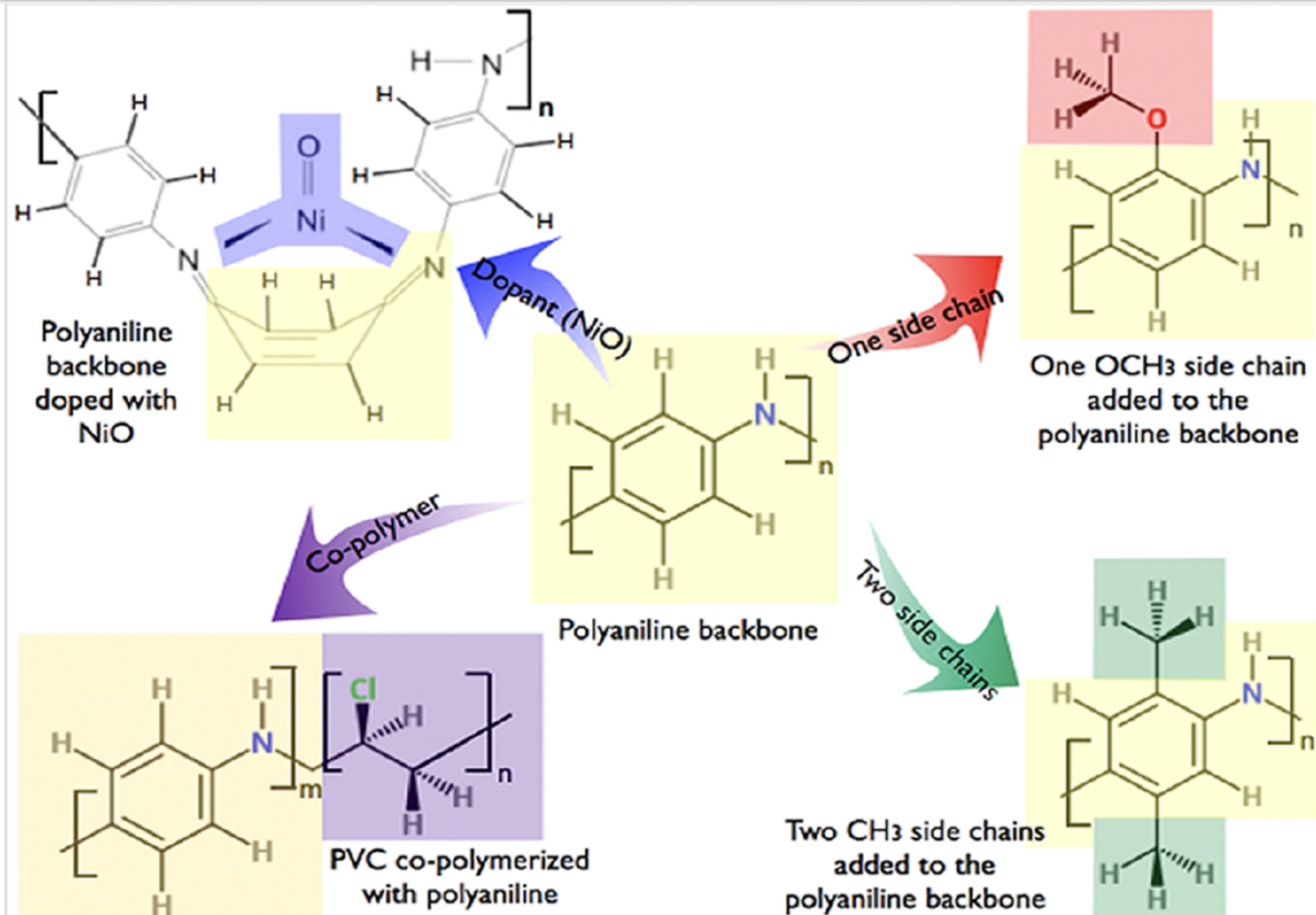
- Sensing Materials are the “heart” of a sensor since they interact with the analytes
- Different types of sensors require different sensing materials
  - Resistive sensor → conductive material
  - Capacitive sensor → material that will swell
  - Mass-based sensor → light weight material
- Polymers are great sensing materials because of their tailorability



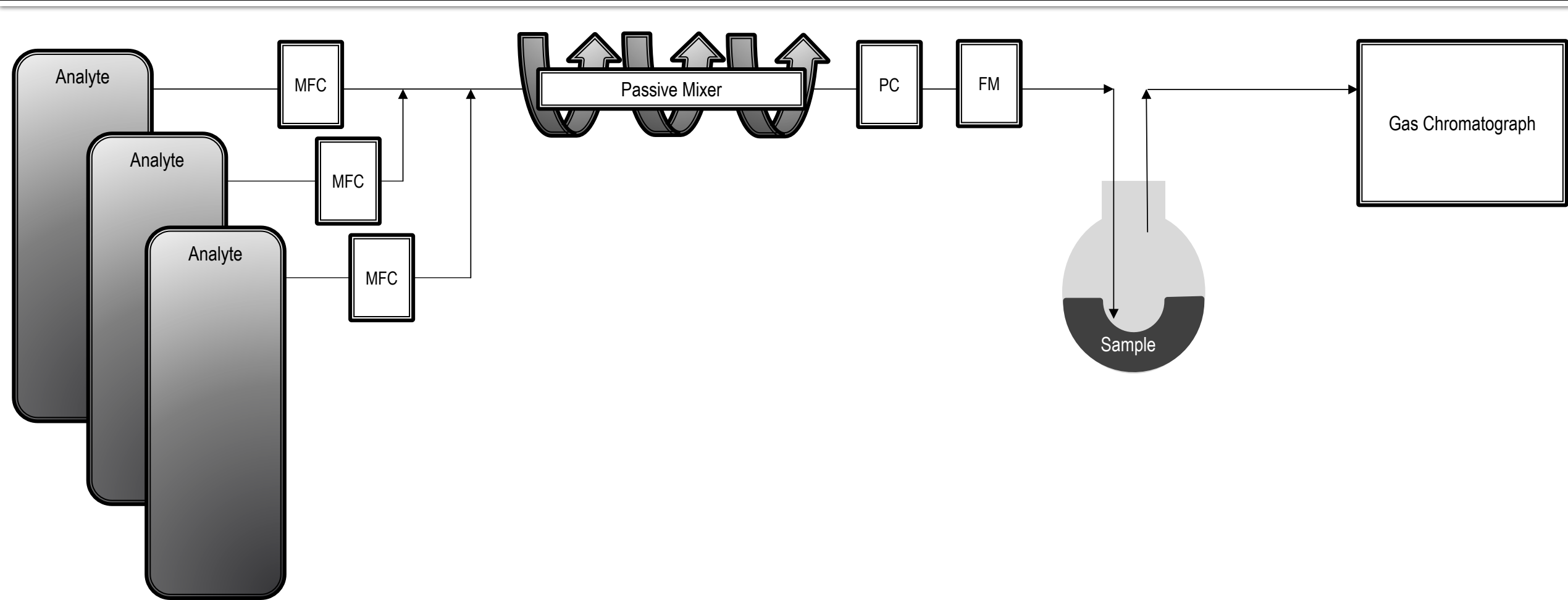
# Tailoring Polymers for Sensing Materials

- Backbones
  - More/less rigid
  - Conductive vs non-conductive
- Functional groups
  - Chosen to selectively attract the target analyte
  - Bulky vs. non-bulky
- Dopants
  - Improve sensitivity and/or selectivity
  - Improve mechanical/electrical properties

# Tailoring Polyaniline



# Experimental Test System

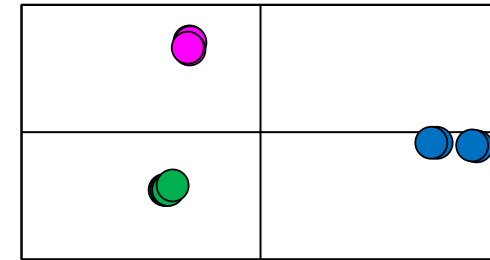
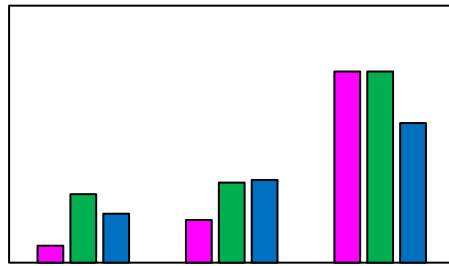


**MFC:** Mass Flow Controller, **PC:** Pressure Controller, **FM:** Flow Meter, **GC:** Gas Chromatograph



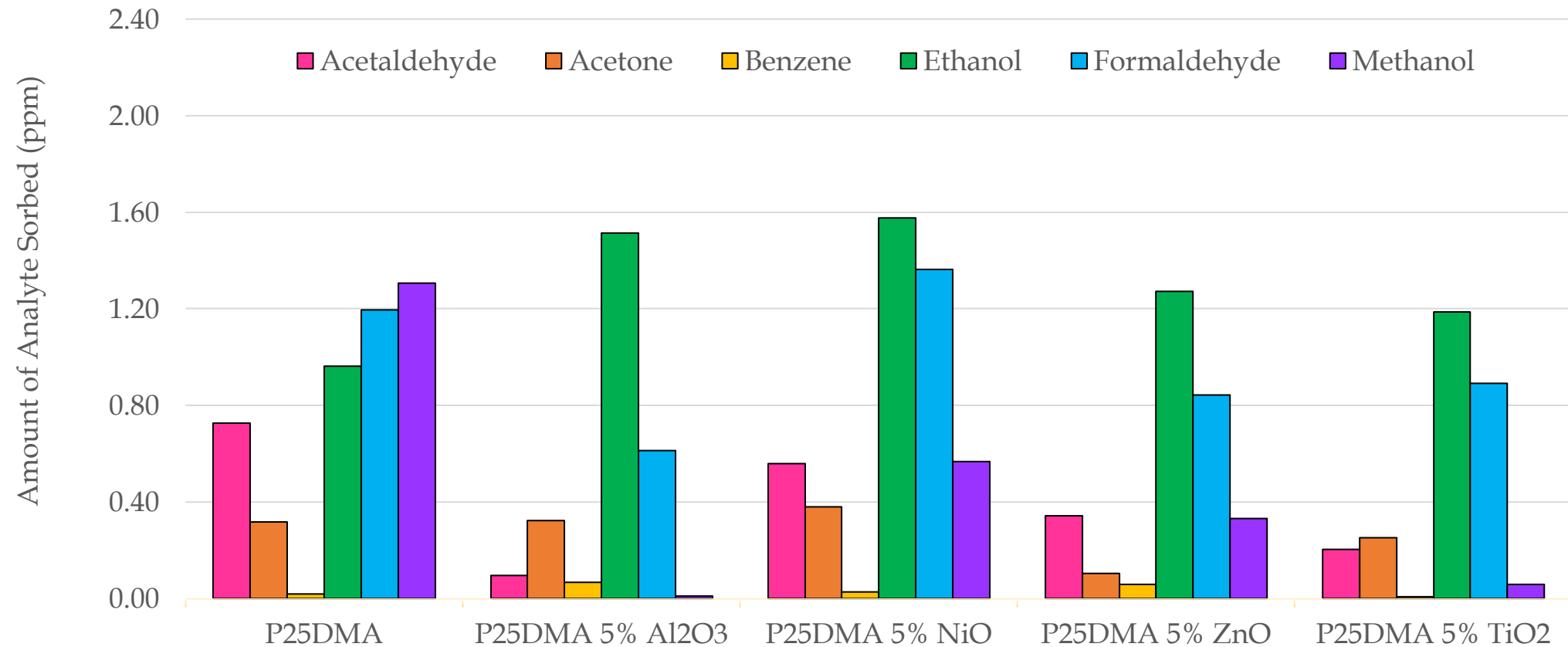
# Sensor Arrays

- Combine the responses of multiple sensing materials

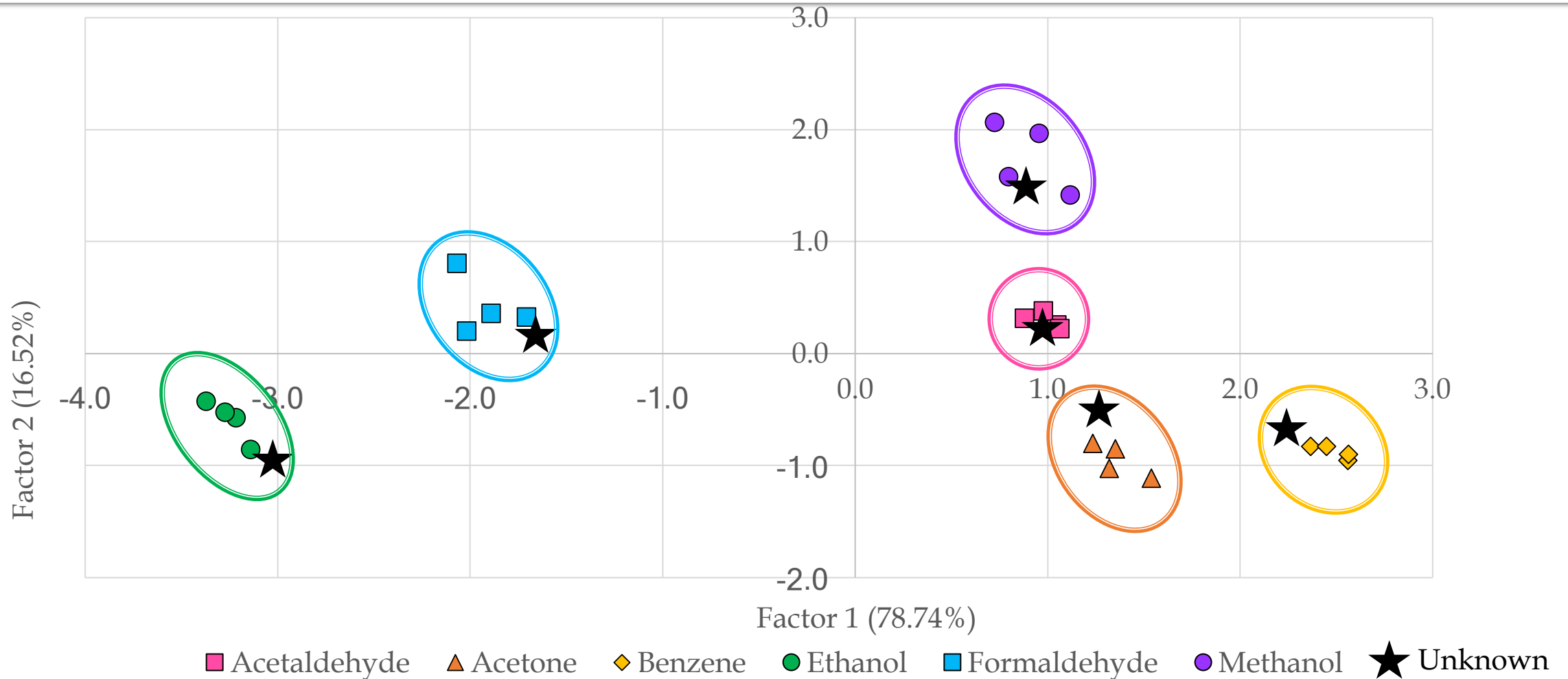


- Use a filtering algorithm
  - Principal Component Analysis (PCA)
- Examples
  - Poly (2,5-dimethyl aniline) P25DMA
  - Poly (o-anisidine) PoANI

# P25DMA Doped with 5% Metal Oxides

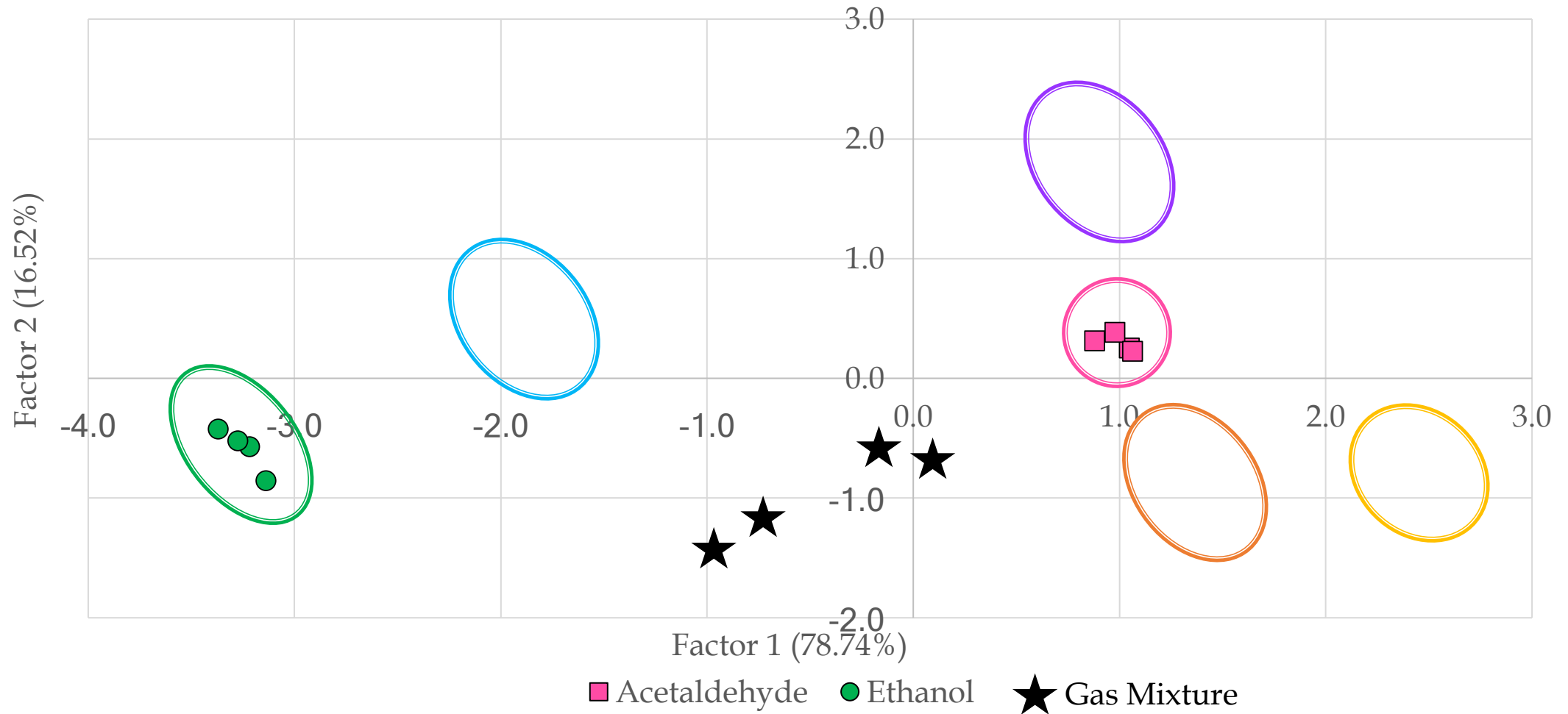


# P25DMA: Sensor Array

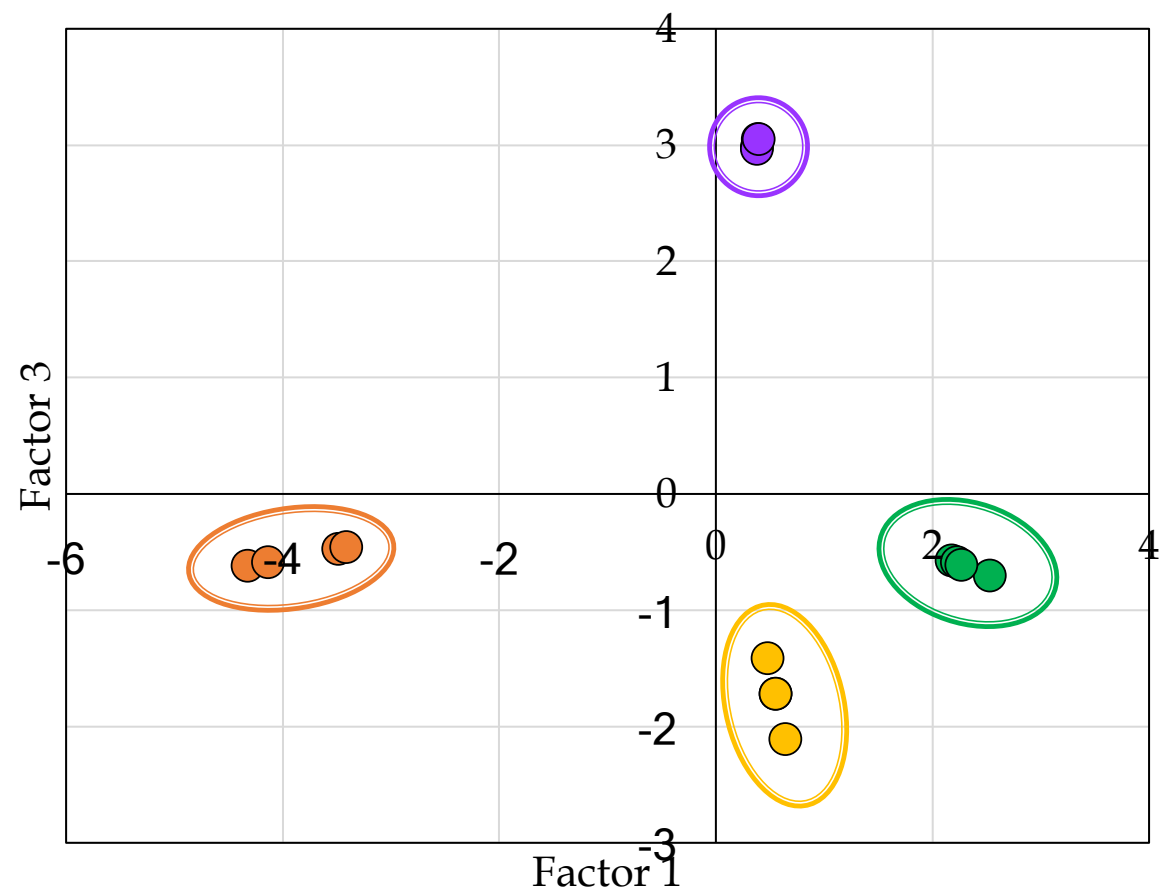
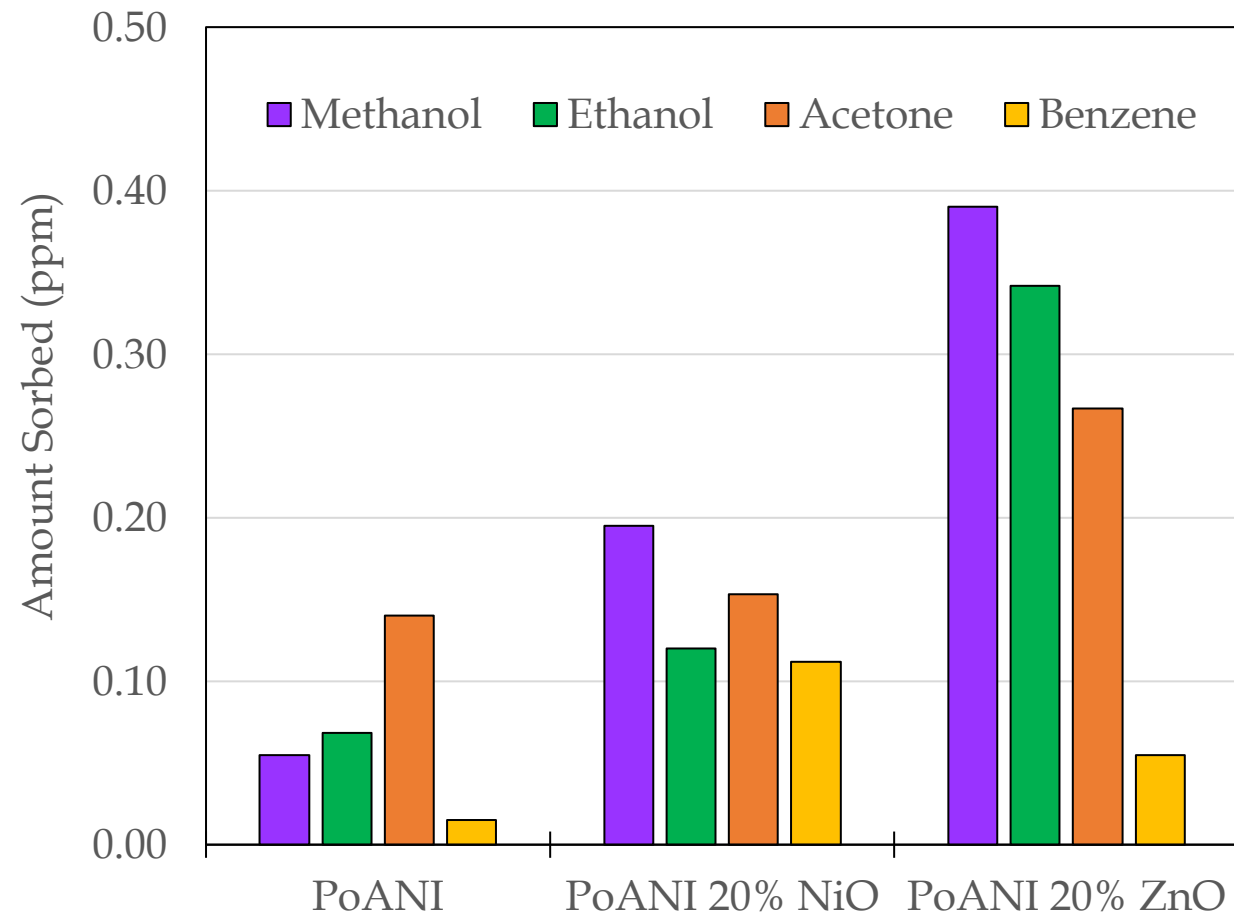




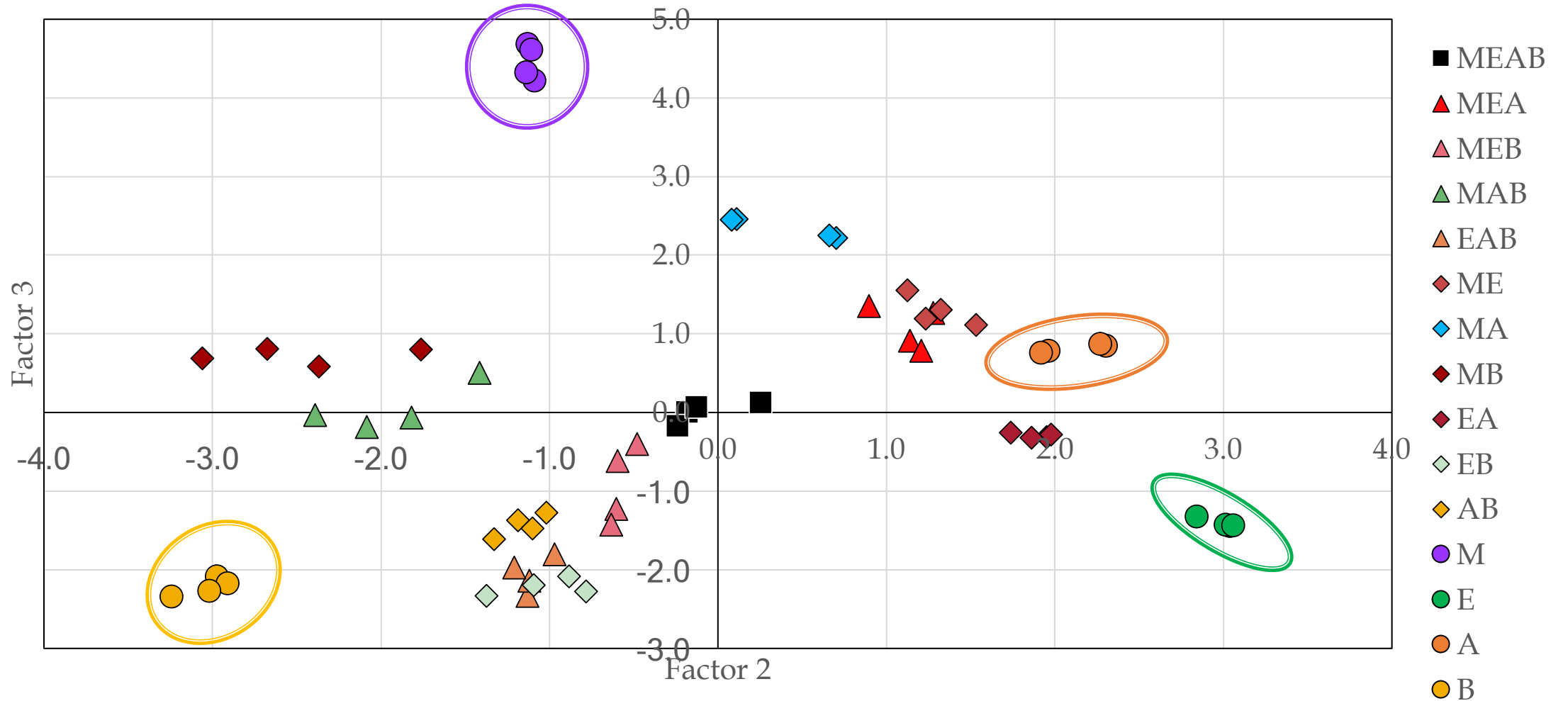
# P25DMA: Sensor Array



# PoANI: Individual Gases

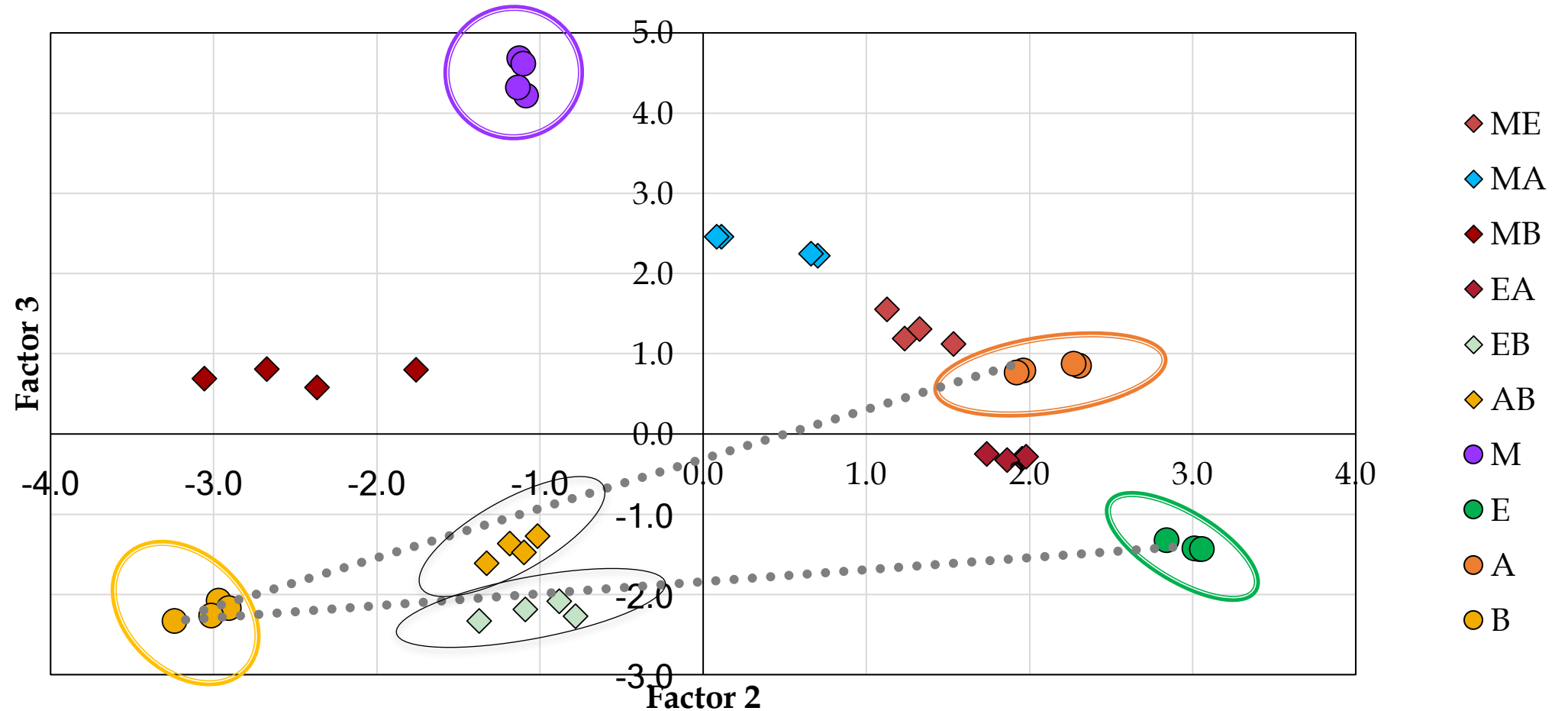


# PoANI: Four-gas Mixture

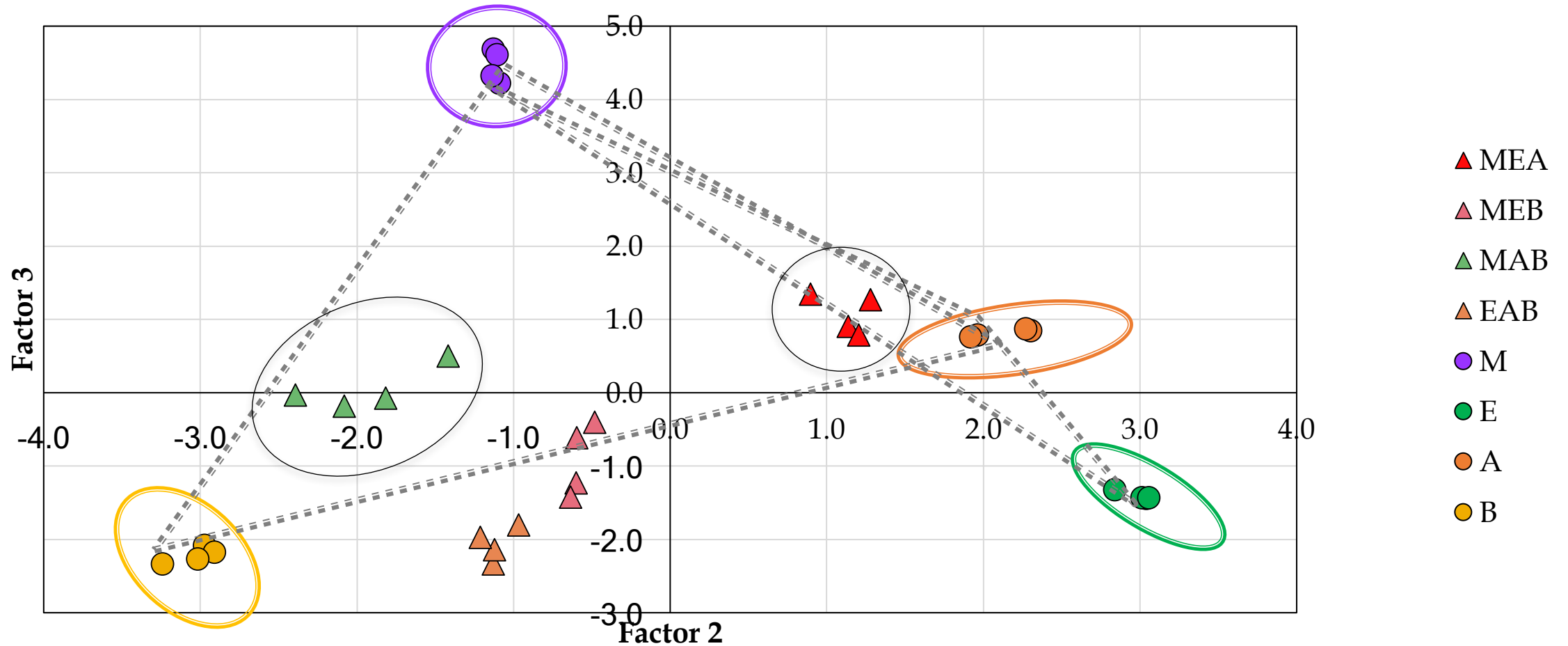




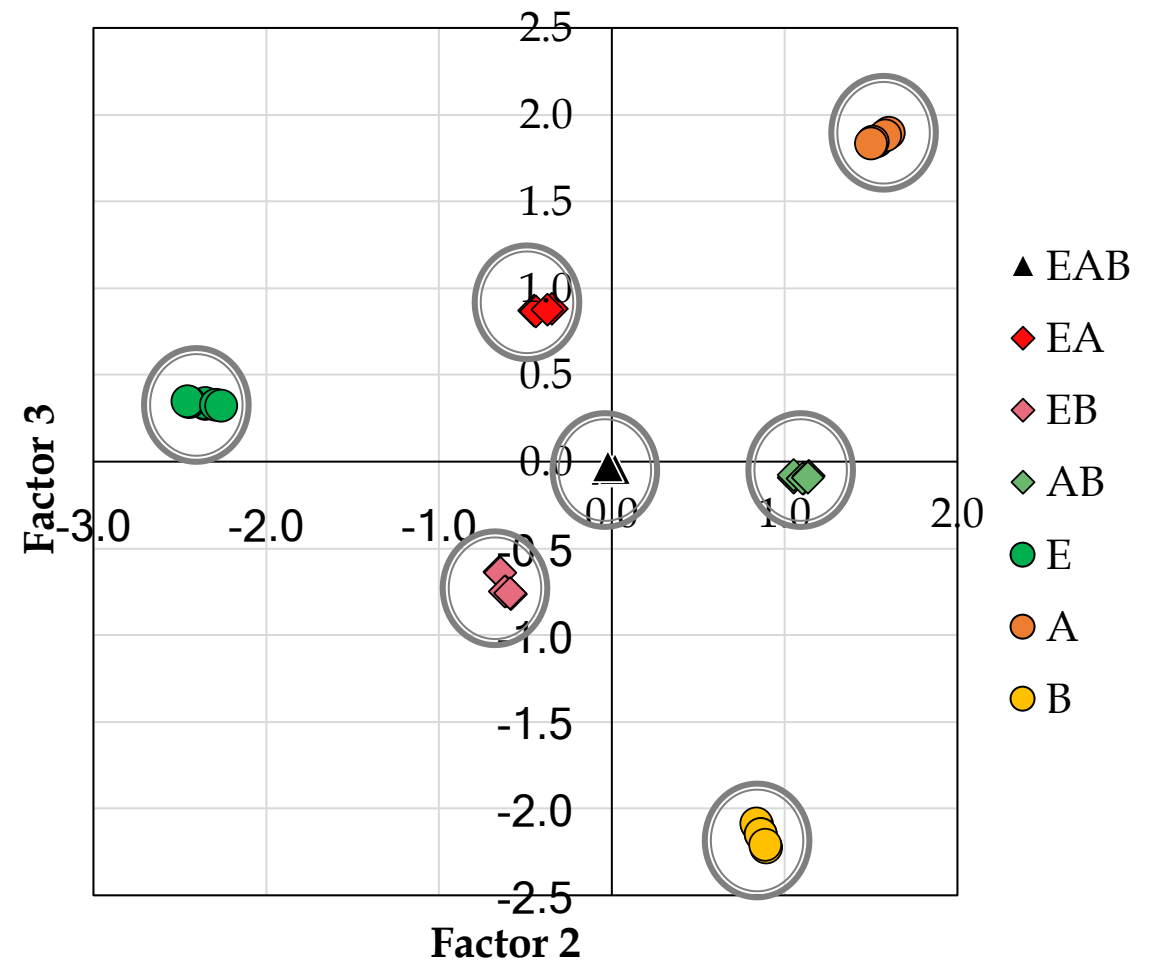
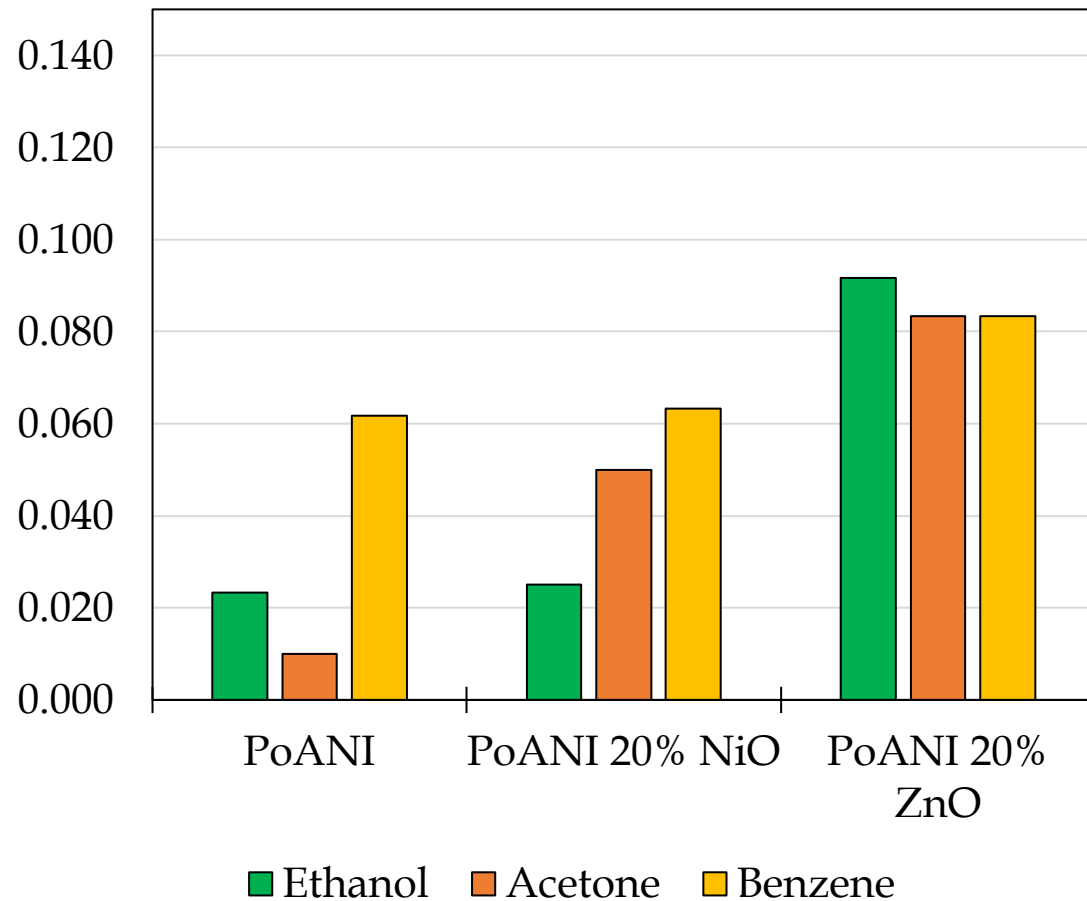
# PoANI: Four-gas Mixture



# PoANI: Four-gas Mixture



# PoANI: Three-gas Mixtures (EAB)



# Concluding Remarks

- Sensor Arrays can be used to improve selectivity to multiple analytes
- Individual Gas Analytes
  - P<sub>25</sub>DMA could distinguish 6 different analytes
  - PoANI could distinguish 4 different analytes
- Gas Mixtures
  - PoANI was able to distinguish 3 analytes, including mixtures of the three analytes

# Thank You

Stewart, K. M. E. and Penlidis. "Designing Polymeric Sensing Materials: What are we doing Wrong?" *Polymers for Advanced Technologies* 132, 42 (2016) doi: 10.1002/pat3893.

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