Development of Polyaniline Based Gas Sensor

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Outline

- Introduction
- Materials and Methods
- Experimental results and Discussion
- Conclusions

Introduction

- Increasing atmospheric pollution problems → Higher need of effective and low cost monitoring and controlling systems for detection and quantification of pollution sources
- Standard air pollution measurement: Optical spectroscopy, gas chromatography/ spectroscopy
  - **Accurate quantification**
  - **Ability to analyze multiple gas species**
  - **Reproducibility**
  - **Complicated and very expensive**
  - **Massive/Power consumption**
  - **Time consuming**

Introduction

- Semiconductor gas sensor
  - Low cost
  - High sensitivity and fast response
  - Low selectivity
  - High power consumption
- Polymer gas sensor
  - Low power consumption: Room operating temperature
  - Ease of synthesis
  - Diversity
  - Low cost

Introduction

•**Polyaniline:** one of the most promising conducting polymers for gas sensor

- Ease of preparation
- Relatively high electrical conductivity
- Capable of n-type and p-type doping
- Good environmental stability
- Low cost
- Difficult to dissolve and fabricate in thin film form
- Need development for microsensor applications

Materials and Methods

Polyaniline synthesis

Aniline0.08mol+ 1M HCL(91.06ml) Stirring at 3 ^{0}C

↓

Mix89.06ml of 1MHCl with $(NH_4)_2S_2O_{8C}$ Stirred at 3 ^{0}C 3.5 hrs

↓

Green emeradine hydrochloride precipitate

↓

Powder washed first in water and methanol

↓

Powder was immersed in 0.1 M NH_4OH and washed again

↓

Dry in vacuum 12 h at 60^{0}C

Materials and Methods

Preparation of Protonation doped polyaniline

236 g MA added into 1000ml(2M MA)

↓

MA/PANI ratio 425.36ml/0.35g

↓

The mixture was shaken 48 hrs

↓

The doped powder was dried at 60 ^{0}C for 40 hrs

Materials and Methods

Fabrication of polymer gas sensor

Dissolved doped Polyaniline powder in N-Methylpyrrolidone (NMP) 0.5 g: 10 ml with 30 min ultrasonic and 2 hrs stirring

↓

Filter the polymer solution to separate undissolved particle from the solution

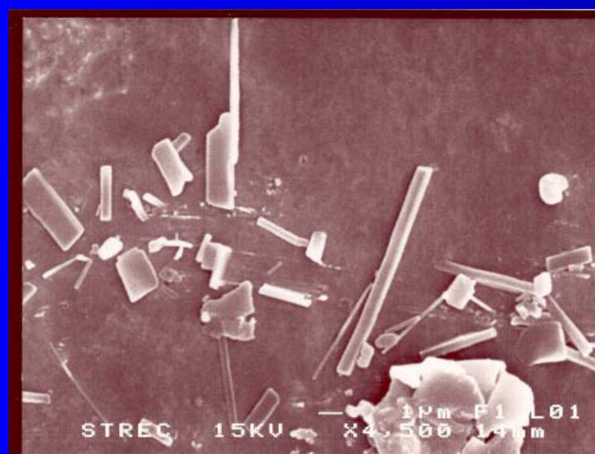
↓

Dropped the solution on an interdigitated Al electrode fabricated on glass slide substrate

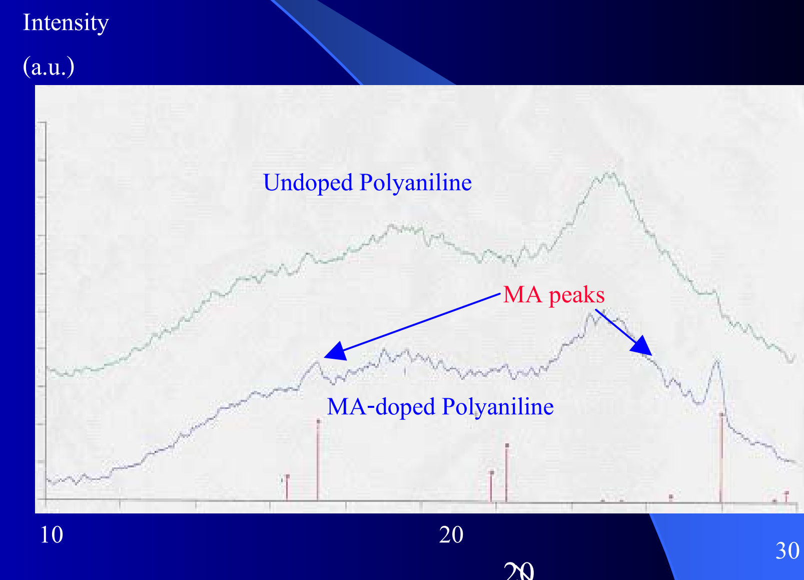
↓

Dry in vacuum oven at 60 °C for 12 hrs

Experimental results and Discussion



(a)

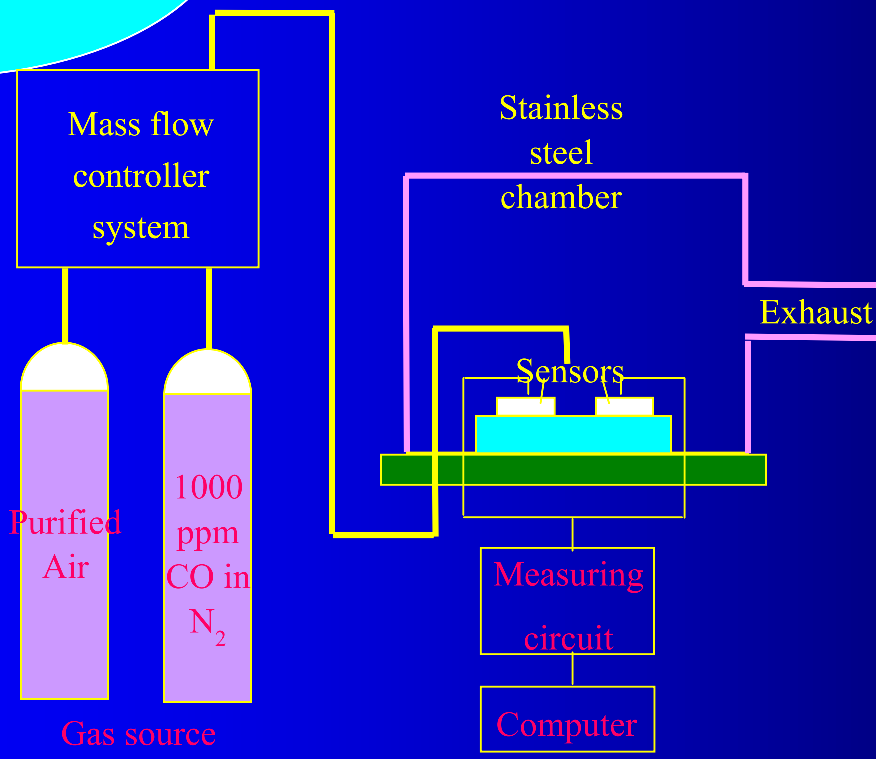


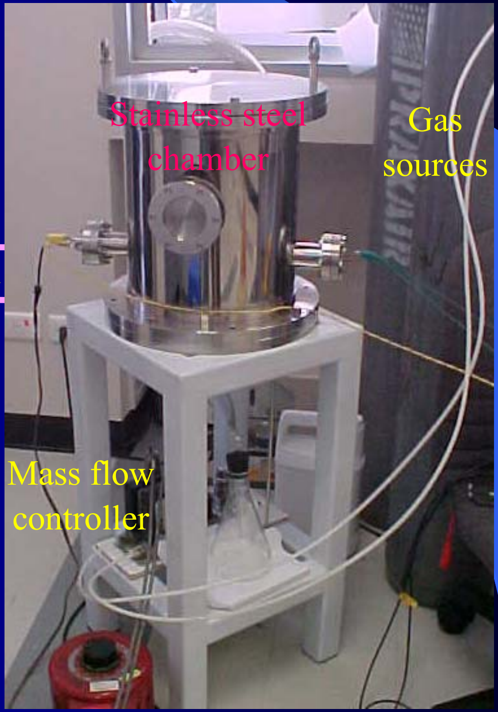
(b)

(a) SEM micrograph (b) X-ray diffraction pattern of polyaniline thin film.

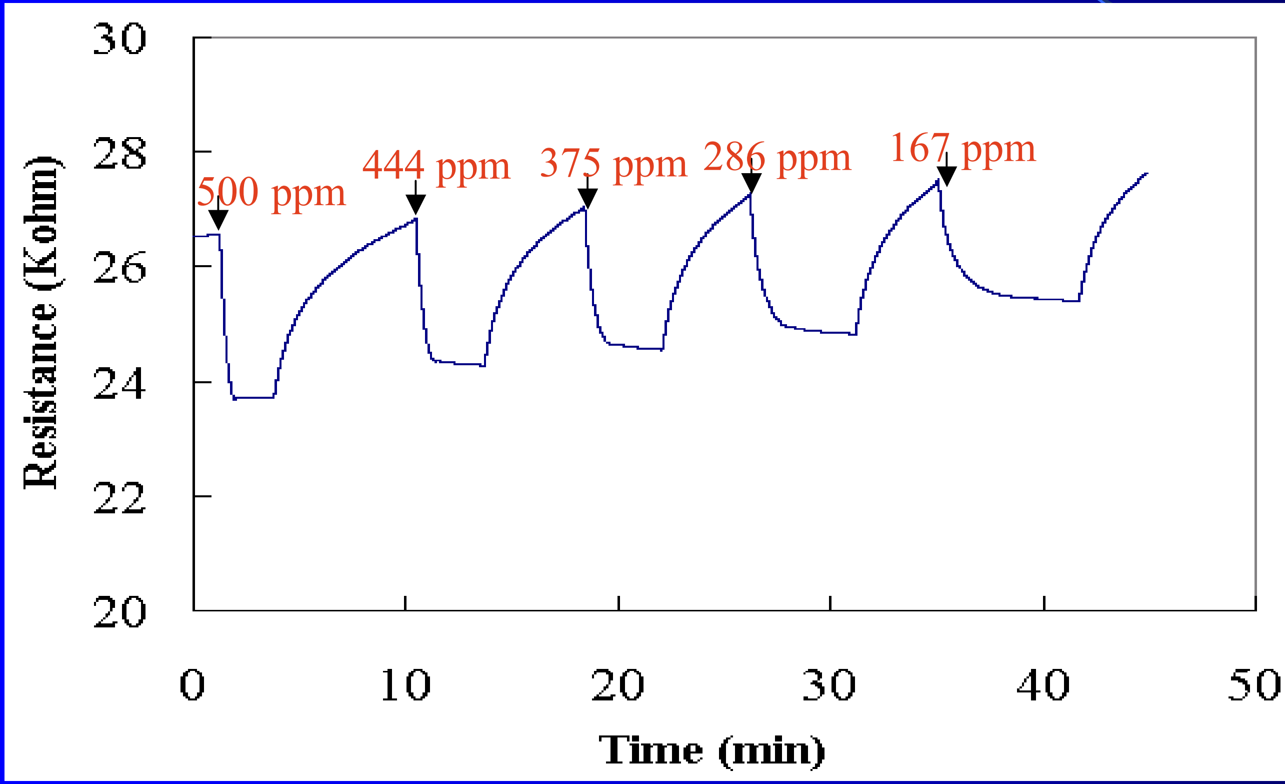
Experimental results and Discussion

Gas Sensing Measurements





Experimental results and Discussion

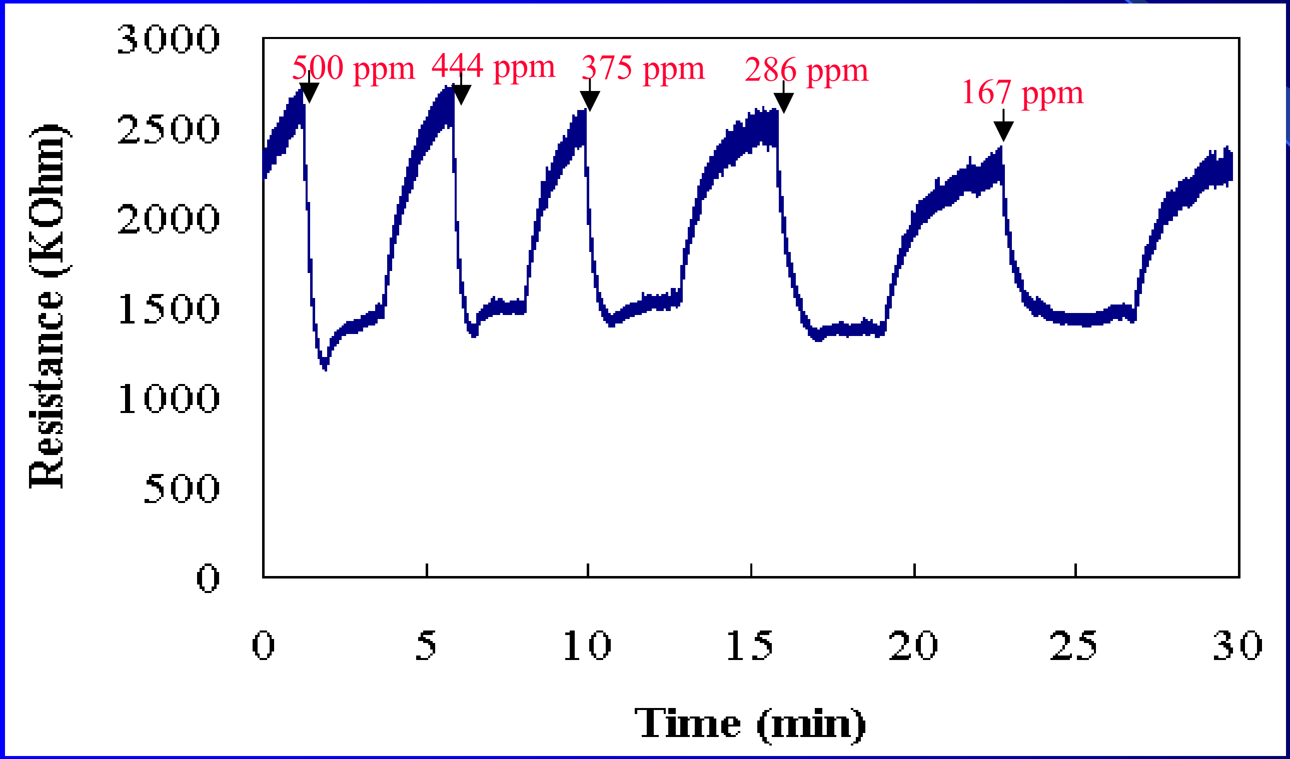


Response time ~ 6 s

Recovery time ~ 6.6 mins

Typical time response to CO of the polyaniline thin film with 24 hours dissolved times in NMP

Experimental results and Discussion

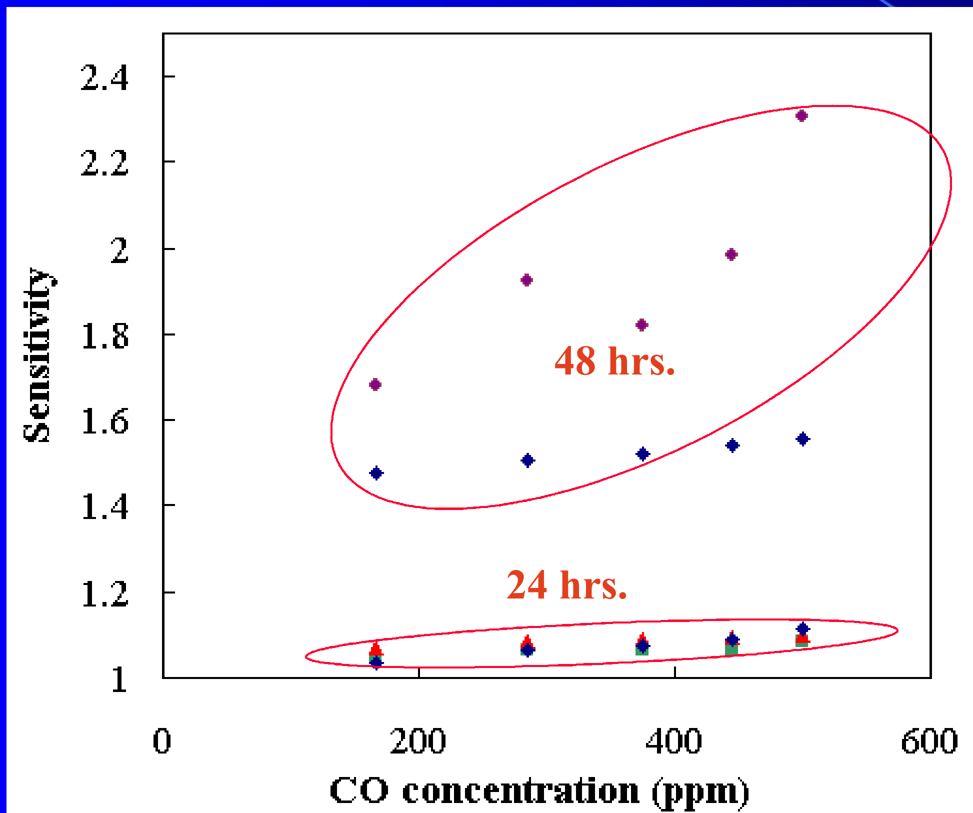


Response time ~ 3 s

Recovery time ~ 2.1 mins

Typical time response to CO of the polyaniline thin film with 48 hours dissolved times in NMP

Experimental results and Discussion



Higher sensitivity with longer dissolved time in NMP

Typical sensitivity to CO of polyaniline thin film with different dissolved times in NMP

Experimental results and Discussion

- Maleic acid doping in polyaniline contributed to CO gas sensing.
- Gas sensing characteristics of polyaniline can be improved by increasing dissolved time in NMP.
- Possible explanation

The longer dissolved times in NMP may lead to higher concentration of MA-doped polyaniline solution before dropping. ⟶ Increase in active adsorption area

Conclusions

- Polyaniline thin film gas sensor has been developed by solvent casting technique on interdigitated electrodes.
- The conductivity of the film reproducibly respond upon CO exposure with concentration in the range of 100-500 ppm.
- The polyaniline sensor has shown fast response time and fair recovery time.
- Gas sensing characteristics of polyaniline can be improved by increasing dissolved time in NMP.
- MA-doped polyaniline is a promising candidate for CO sensor with low-concentration and room-temperature detection capability.

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Thank you for your attention