

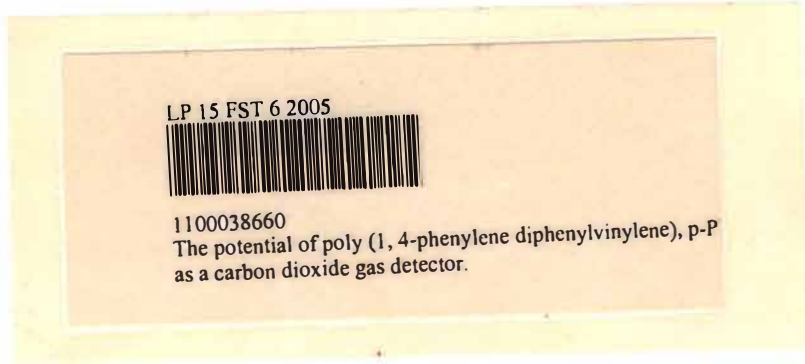
THE DESIGN OF
A PORTABLE, ADAPTIVE, AND ROBUST
ALUMINUM CARBON DIOXIDE GAS DETECTOR

BOON GANNETT

PH.D. THESIS
UNIVERSITY OF CALIFORNIA, SAN DIEGO

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1100038660



PERPUSTAKAAN
KOLEJ UNIVERSITI SAINS & TEKNOLOGI MALAYSIA
21030 KUALA TERENGGANU

1100038660		

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PERPUSTAKAAN KUSTEM

**THE POTENTIAL OF
POLY (1, 4-PHENYLENE DIPHENYLVINYLENE), *p*-PDV
AS A CARBON DIOXIDE GAS DETECTOR**

By

Poon Chi Wei

Research Report submitted in partial fulfillment of
the requirements for the degree of
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Faculty of Science and Technology

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2005**

1100038660



**JABATAN SAINS KIMIA
FAKULTI SAINS DAN TEKNOLOGI
KOLEJ UNIVERSITI SAINS DAN TEKNOLOGI MALAYSIA**

**PENGAKUAN DAN PENGESAHAN LAPORAN
PROJEK PENYELIDIKAN I DAN II**

Adalah ini diakui dan disahkan bahawa laporan penyelidikan bertajuk:

The potential of poly (1, 4-phenylene diphenylvinylene), p-PDV as a carbon dioxide gas detector oleh Poon Chi Wei, No. Matrik UK 6807 telah diperiksa dan semua pembetulan yang disarankan telah dilakukan. Laporan ini dikemukakan kepada Jabatan Sains Kimia sebagai memenuhi sebahagian daripada keperluan memperolehi Ijazah Sarjana Muda Sains (Sains Kimia), Fakulti Sains dan Teknologi, Kolej Universiti Sains dan Teknologi Malaysia.

Disahkan oleh:

Penyelia Utama

Nama: **FAIZATUL SHIMAL MEHAMOD**
Cop Rasmi: Pensyarah
Jabatan Sains Kimia
Fakulti Sains dan Teknologi
(KUSTEM)
Mengabang Telipot
21030 Kuala Terengganu.

Tarikh: 7/4/05

Ketua Jabatan Sains Kimia

Nama: **PROF. MADYA DR. KU HALIM KU BULAT**
Cop Rasmi: Ketua
Jabatan Sains Kimia
Fakulti Sains dan Teknologi
Kolej Universiti Sains dan Teknologi Malaysia
21030 Kuala Terengganu.
Tel: 09-6683257

Tarikh: 7th April 2005

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LIST OF ABBREVIATIONS

Abbreviation/symbol

LEDs	Light-emitting diodes
PAV	Poly (arylene vinylene)
<i>p</i> -PDV	Poly(1,4-phenylene diphenylvinylene)
R & D	Research and development
CO ₂	Carbon dioxide gas
PPV	Poly (phenyl-vinylene)
PT	Poly (thiophenes)
HUMO	Highest occupied molecule orbital
LUMO	Lowest unoccupied molecule orbital
S-PAV	Phenylsubtituted poly(arylene vinylene)
FTIR	Fourier Transform Infrared Spectrometer
FOCS	Fiber-optic chemical sensor
UV-Vis	Ultraviolet-Visible Spectroscopy
TGA	Termogravimetri Analysis
DMF	Dimethylformamide
N ₂	Nitrogen gas
O ₂	Oxygen
NO ₂	Nitrogen dioxide gas
PVC	Polyvinyl chloride

PTFE	Teflon
PAN	Polyacrylonitrile
PE	Polyethylene
Pt	Platinum
S_0	Ground-state energy
S_1	First electronic singlet state
I_0	Absence of quencher
I	Presence of quencher
[Q]	Quencher concentration
[O ₂]	Quencher concentration of oxygen
[CO ₂]	Quencher concentration of carbon dioxide
k_q	bimolecular rate constant
K_{sv}	Stern-Volmer quenching constant
λ_{ex}	Wavelength for excitation
λ_{em}	Wavelength for emission
R.S.D	Relative Standard Deviation
mL	Milliliter
mL/s	Milliliter per second
°C/min	Celsius per minute
KBr	Potassium bromide pellet

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ABSTRACT

Poly (1, 4-phenylene diphenylvinylene), *p*-PDV is a type of conjugated polymer from the poly (arylene vinylene) group. The *p*-PDV has the potential to be used as a sensor to detect carbon dioxide, CO₂ gas. The sensing concept used was fluorescence quenching. The study on *p*-PDV in the form of solution as a sensor was carried out by using the luminescence spectrometer. CO₂ gas was used as an analyte. The properties of polymer were characterized by using the Fluorescence Spectrophotometer, Fourier Transform Infrared Spectrometer (FTIR), Ultraviolet-visible Spectrometer (UV-Vis) and Thermogravimetric Analyzer (TGA). Result obtained from the studied showed that properties of polymer had been successfully recorded. The characteristic of this sensing material include fluorescence spectra, photostability, regenerability, reproducibility and repeatability of sensing reagent towards CO₂ gas, steady-state response towards CO₂ gas and effect of the CO₂ gas concentration were studied. Results obtained showed that the fluorescence intensity decreased upon exposure to CO₂ gas, indicating that the polymer sample was responsive to the presence of the CO₂ gas. The photostability study conducted on solution of *p*-PDV continuously exposed to the xenon lamp was considered stable against visible radiation. The regeneration process of *p*-PDV was fully regenerated. The Relative Standard Deviation (RSD) for reproducibility test on solution of *p*-PDV was 3.19 %, whereas the RSD repeatability was 5.08 % respectively. The study on flow rate was done with 3 different rates which were 1.00 mL/s, 1.43mL/s and 2.22mL/s.

**POTENSI BAGI POLI (1, 4-PENILENA DIFENILVINILENE), *p*-PDV
SEBAGAI BAHAN PENDERIA UNTUK PENDERIAAN
GAS KARBON DIOKSIDA (CO₂)**

ABSTRAK

Poli(1,4-fenilena difenilvinilene), *p*-PDV, ialah polimer berkonjugat dari kumpulan poli(arilena vinilena). *p*-PDV sebagai bahan penderia untuk pengesanan gas karbon dioksida, CO₂ telah dikaji. Konsep penderiaan yang digunakan adalah pelindapan pendarfluor. Kajian penderiaan telah dijalankan ke atas *p*-PDV dalam bentuk larutan dengan menggunakan spektrometer luminesen. Manakala, gas karbon dioksida telah digunakan sebagai analit. Untuk pencirian terhadap polimer, kajian telah dijalankan dengan menggunakan Spektroskopi Infrared Transformasi Fourier (FTIR), Analisis Gravimetri Terma (TGA) dan Spektroskopi Serapan Ultralembayung-Nampak (UV-Vis). Daripada keputusan analisis, pencirian terhadap polimer dapat dijalankan dengan sempurna. Ciri-ciri bahan penderia yang telah dikaji termasuklah spektrum pendarfluor, penjanaaan semula, kestabilanfoto, kebolehulangan dan kebolehasilan semula, masa rangsangan keadaan mantap dan kesan isipadu gas CO₂. Berdasarkan kajian yang dijalankan, keamatan fluoresen berkurang apabila sampel polimer didedahkan kepada gas oksigen. Ini menunjukkan polimer responsif terhadap gas CO₂. Kestabilanfoto bagi larutan *p*-PDV didedahkan kepada cahaya lampu xenon adalah stabil. Manakala, kajian bagi penjanaaan semula oleh CO₂ gas and N₂ gas secara berselang-seli terhadap larutan polymer *p*-PDV telah dijanakan semula sepenuhnya. Bagi nilai sisihan piawai relatif (RSD) bagi kebolehulangan larutan polimer *p*-PDV

adalah 3.19 %, manakala RSD bagi kebolehasilan semula pula adalah 5.08 %. Kajian bagi 3 jenis kadar alir yang berbeza terhadap larutan polimer *p*-PDV adalah 1.00 mL/s, 1.43 mL/s dan 2.22 mL/s.