First year Report of the work done on the Minor Research Project

Optical Properties of Dye doped polymers and their applications as sensors

UGC Reference No.. **F. 47-759/13(WRO) Dated 28 January 2015**

Submitted to

UNIVERSITY GRANTS COMMISSION

UGC (WRO), PUNE – 411007

Principal Investigator

ANSHUL GUPTA

Department of Physics
K J Somaiya College of Science and Commerce Mumbai 400077

Annexure -III

UNIVERSITY GRANTS COMMISSION

UGC (WRO), PUNE – 411007

First year Report of the work done on the Minor Research Project.

1. Project report No.	**First year**
2. UGC Reference No..	**F. 47-759/13(WRO) Dated 28 January 2015**
3. Period of report:	from **April 2016- March 2017**
4. Title of research project	**"Optical Properties of Dye doped polymers and their applications as sensors"**
5. (a) Name of the Principal Investigator	**ANSHUL GUPTA**
(b) Department	**Department of Physics**
(c) College where work has progressed	**K J Somaiya College of Science and Commerce Mumbai 400077**

6. Effective date of starting of the project – 10 04 2016

7. Grant approved and expenditure incurred during the period of the report:

a. Total amount approved Rs. /- 152500

b. Total expenditure Rs. /-

c. Report of the work done: (Please attach a separate sheet)

Please see attachment Annexure I

i. Brief objective of the project

ii. Work done so far and results achieved and publications, if any, resulting from the work:

(Give details of the papers and names of the journals in which it has been published or accepted for publication **– One Publication-**

Papers Published in International Journals:

Acceptance received

(UGC approved journal)-10061

Synthesis and analysis of planer optical waveguides as pH sensors, Recent Innovations in Chemical Engineering, Bentham Science Publishers B.V.,

iii. Has the progress been according to original plan of work and towards achieving the objective **Yes**

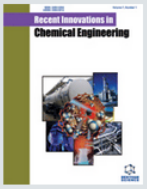
iv. Please enclose a summary of the findings of the study. Two bound copy of the final report of work done may also be sent to the concerned Regional Office of the UGC.

v. Any other information- NIL

PRINCIPAL INVESTIGATOR **PRINCIPAL**

(Seal)

Publication details- **(Acceptance received)**



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Synthesis and Analysis of Planar Optical Waveguides as pH Sensors

(E-pub Ahead of Print)

Author(s): S S Gaur, Pramod K Singh, Anshul Gupta, Rahul Singh*, Y. Kumar.

Journal Name: Recent Innovations in Chemical Engineering

Volume 11 , 2018 **DOI** : 10.2174/2405520411666180306155326

Journal Home

Journal in UGC list- (UGC Approved List of Journals)

	Journal No	Title	Publisher	ISSN	E-ISSN
View	10061	Recent Innovations in Chemical Engineering	Bentham Science Publishers B.V.	24055204	24055212

PROJECT COMPLETION REPORT (PCR)

1. Name of the Principal Investigator: **ANSHUL GUPTA**

2. Title of research project **"Optical Properties of Dye doped polymers and their applications as sensors"**

3. UGC Reference No.F. **No. F. 47-759/13(WRO) Dated 28 January 2015**

4. Period of report**: From**

5. College where work has progressed: **K J Somaiya College of Science and Commerce Mumbai**

Final Report on Project:

The project has been completed. The work done has been published in the International Journal (01 Publication).

(i)Brief objective of the project

Annexure -I

(ii) Papers Published in International Journals:

Acceptance received

(UGC approved journal)-10061

Synthesis and analysis of planer optical waveguides as pH sensors, Recent Innovations in Chemical Engineering, Bentham Science Publishers B.V.,

(iii) Research findings have been presented in the following National level conference.

NIL

PRINCIPAL INVESTIGATOR **PRINCIPAL**

(Seal)

Annexure-I

Optical Properties of Dye doped polymers and their applications as sensors

Introduction

The polymers have come a long way and are now extensively used in various photonic devices such as optical switches, modulators, LEDs, sensors etc. Various kind of sensors have been fabricated like gas sensors, biosensors, chemical sensors and pH sensors.

pH sensors are very useful for monitoring boiler, water or turbid, fouling environments. They can also be used to monitor deterioration in civil infrastructure materials as this involves the chemical reactions, which cause degradation of the physical properties of the materials.

Polymers are doped with dyes or indicators to sense the changes in pH because of their pH sensitive properties. When a light wave interferes with a particle or molecule, it either gets scattered or absorbed. When the energy of the photon corresponds to the difference between the energy levels in that molecule, absorption occurs. The molecule which absorbs the light is called chromophore. Most of the dyes are pH sensitive chromophores.

We report here a planar dye-doped pH sensor. We have fabricated dye-doped planar waveguides and have studied the effect of different pH solutions on the output intensity and absorption spectra of the waveguides. Two dyes, Methyl Red (MR) and Bromocresol Purple (BCP) were used for doping. Methyl Red dye was doped in polystyrene (PS) (chlorobenzene solvent) solution and BCP dye was doped in styrene acrylonitrile (SAN) (dioxane solvent) solution. These dye doped waveguides can be used as pH sensors in various applications such as boilers, monitoring deterioration in civil infrastructures etc.

Polymers are doped with dyes or indicators to sense the changes in pH because of their pH sensitive properties. When a light wave interferes with a particle or molecule, it either gets scattered or absorbed. When the energy of the photon corresponds to the difference

Dyes are used as pH sensors in various applications. We here report study of effect of pH solutions on Methyl Red doped polystyrene and BCP doped SAN waveguides. The effect of pH solutions was observed on the absorption spectra and output intensity of the waveguides. It was observed that for pH solutions to which the dye is sensitive output intensity decreased and it was clearly seen in absorption spectra too. MR doped polystyrene waveguides showed sensitivity for pH range 5-6 and BCP doped SAN waveguides showed sensitivity for p range 5-9. These dye-doped polymer waveguides can be used as pH sensors.

Experimental Details

The planar waveguides were fabricated using MR doped polystyrene and BCP doped SAN using dip coating technique. PS was dissolved in chlorobenzene (10% wt./vol) and concentration of MR was kept to 0.3 % in the solution. SAN was dissolved in dioxane (10% wt/vol) and BCP concentration was kept to be 0.03 % in the solution. The waveguides were fabricated using dip coating technique.

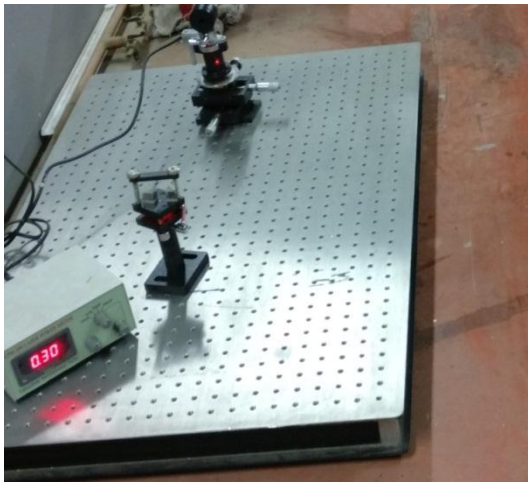


Photo-1 : Prism coupling preparation

The characterization of the waveguides was done using prism coupling technique . The light source used was He-Ne laser (0.6328 μm). He–Ne laser (0.6328 μm) light was coupled into these guides by input coupling prism (SF-16). The output coupling prism was kept at a distance of 1 cm from input coupling prism. The output intensity is measured using the photodetector. The pH solution was applied on the surface with the help of a soft brush and then the output intensity was again measured.

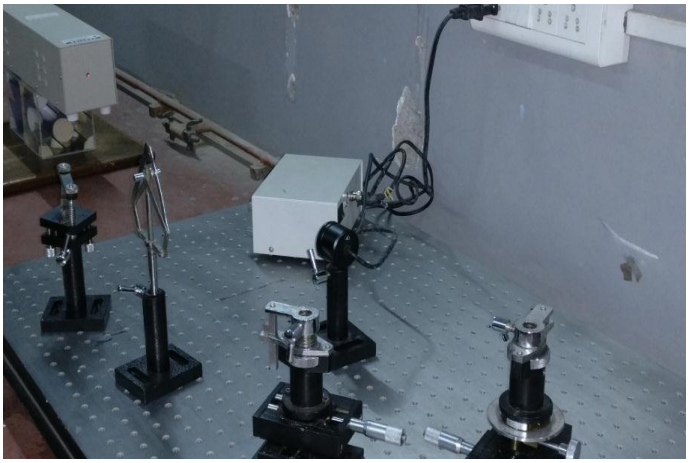


Photo-2 : Set up on bread board

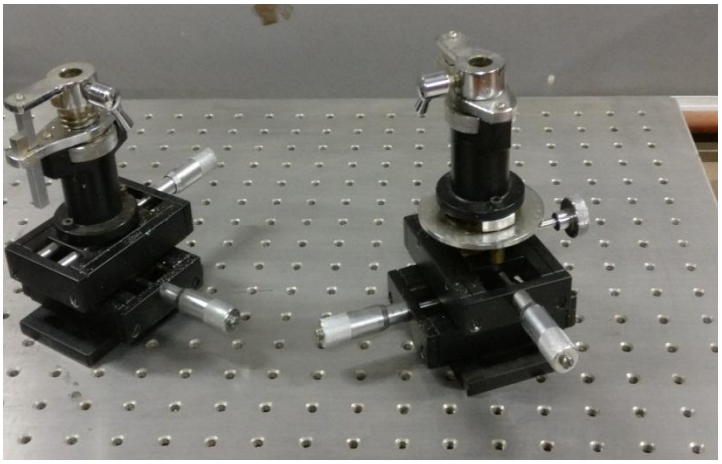
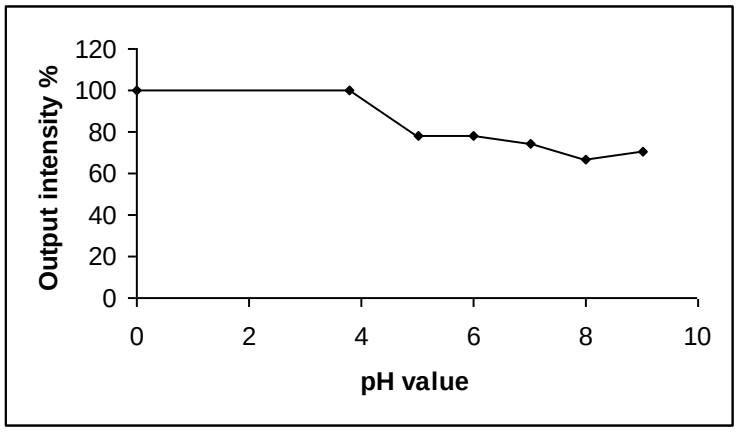


Photo-3: XYZ and XYZθ Micropositioners

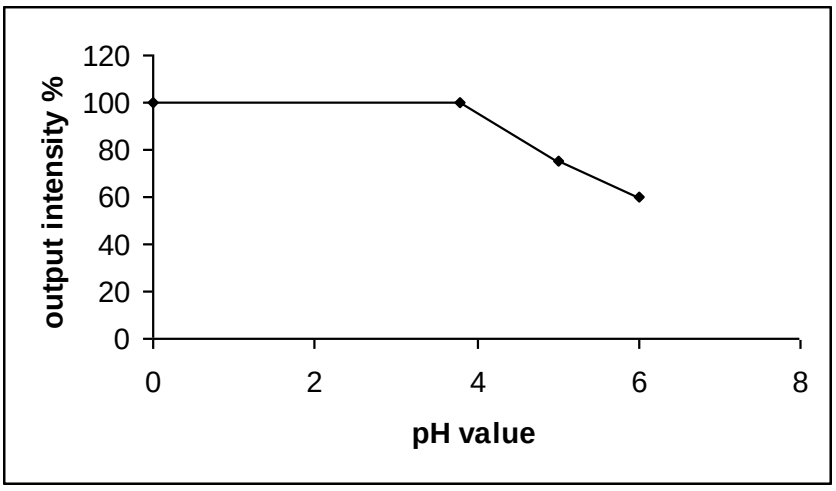
Outcomes and results

The effect of pH solutions on the absorption spectra and output intensity was observed on MR doped polystyrene and BCP doped SAN waveguides. It was observed that MR doped waveguide showed sensitivity to pH solutions in the range of 5 - 6. BCP doped SAN waveguides show sensitivity in the pH range of 5 - 9. These dye doped waveguides can be used as pH sensors in various applications such as measuring pH, monitor deterioration of civil infrastructure materials, in boilers etc. Other dyes which are sensitive for pH ranges, other than that of Methyl Red and Bromocresol Purple, can be used collectively to cover a wide range of pH for detection.

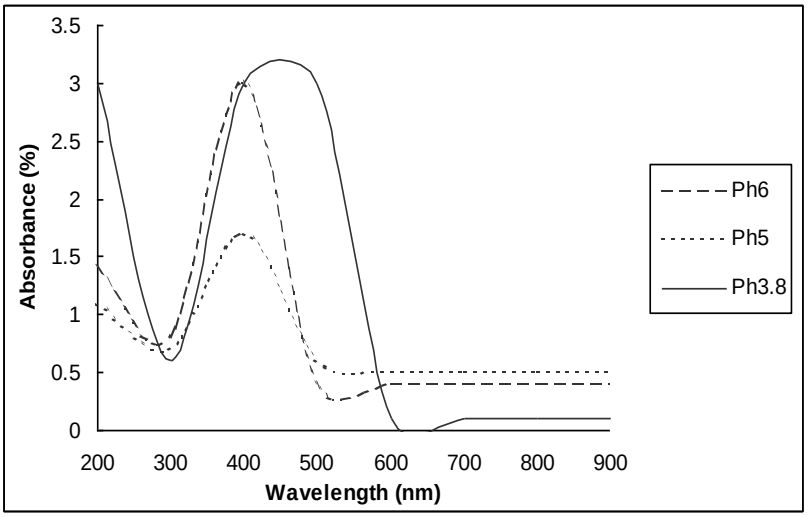
Plot between output intensity% and pH value for MR doped polystyrene waveguides.



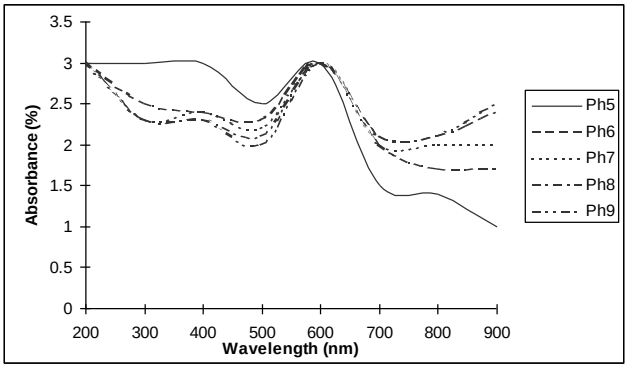
Plot between output intensity% and pH value for BCP doped SAN waveguides.



Absorption Spectra for Methyl Red doped Polystyrene waveguides



Absorption Spectra for BCP doped SAN waveguides



Acknowledgements and Credits

A due credit is paid to University Grant Commission INDIA, for sanction of minor research project titled "Optical properties of dye doped polymers and their applications as sensors" No. F. 47-759 /13 (WRO).

A thank is due to Dr. Shiv Shankar Gaur, Shivaji College Delhi and his group for experimental supports. Some part of this work has been done in his lab at Delhi.

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