Phosphonium Dicyanamide Ionogel Incorporating Bromophenol Blue Dye as a Versatile Platform for Monitoring pH in Solution

Vincenzo F. Curto, R. Byrne, K. J. Fraser, D. Diamond, F. Benito-Lopez

[1]*CLARITY: Centre for Sensor Web Technologies, Dublin City University, Dublin 9, Ireland*

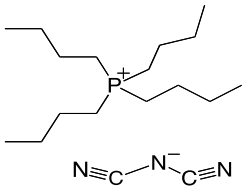
vincenzo.curto2@mail.dcu.ie

Introduction

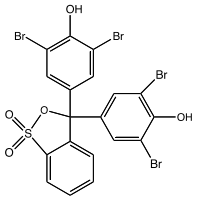
Online monitoring of pH levels in different environments such as bio-engineering and chemistry is vital for an effective control of many critical industrial processes.[1] An increasing interest has been reported in the fabrication of robust, cheap and versatile pH sensing materials that can be easily integrated within existing industrial technologies.[2]

In our laboratories we have previously demonstrated that ionogels integrating pH sensitive dyes are solid, flexible and easy to pattern materials that can perform continuous measuring of pH during chemical or biological processes.[3]

Materials

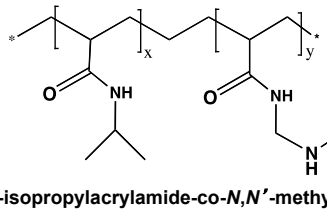


[P_{4444}] [dca]



Bromophenol Blue (BPB)

3.0 | 4.6 | pK_a= 4.00



poly(*N*-isopropylacrylamide-co-*N,N'*-methylenebisacrylamide)

- monomer molar ratio 100:5

- UV photopolymerisation: 15 minutes

Experimental

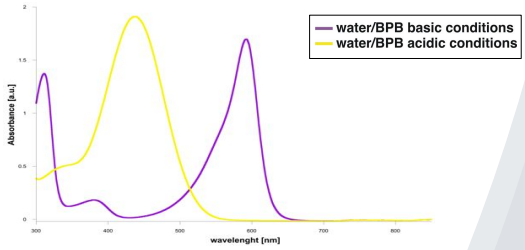


Figure 1: UV-Vis spectra of BPB in water at acidic and basic conditions, C_{BPB}=10^{-4} M.

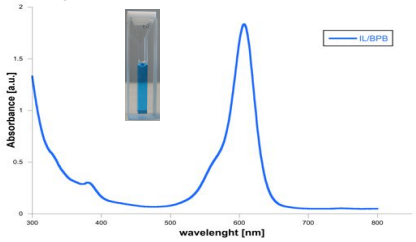


Figure 2: UV-Vis spectra of BPB in [P_{4444}] [dca], C_{BPB}=1.25×10^{-5} M.

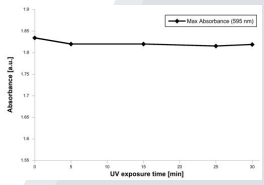


Figure 3: Stability test of BPB dye in IL under UV irradiation (λ_{ir}=365 nm).

Results

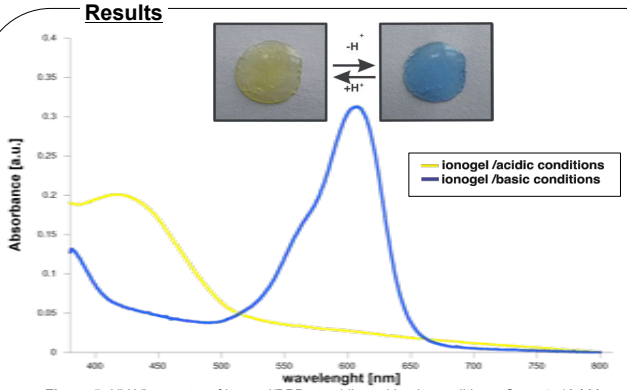
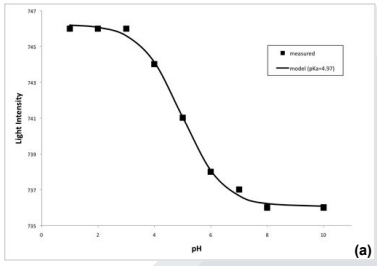
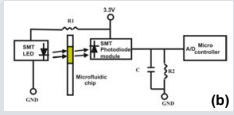


Figure 5: UV-Vis spectra of ionogel/BPB at acidic and basic conditions, C_{BPB}=4×10^{-4} M.





(c)

$$I = \left[\frac{a}{1 + e^{b(pH - z)}}\right] * c + d$$

I = light Intensity
a = peak height
b = slope coefficient
z = point of inflection
c =symmetry parameter for the sigmoid
d = accounts for baseline offset

Figure 6: (a) Calibration curve showing pH *vs.* light intensity of BPB measured using a surface mounted Light Emitting Diode system. **(b)** Circuit diagram of the detection system. **(c)** Mathematical model that correlates light Intensity and pH.

Conclusions

In this work a hybrid ionogel of poly(NIPAAm-co-BIS)/[P_{4444}] [dca] incorporating Bromophenol Blue photoresponsive dye has been synthesised.

The main achievements of this hybrid material are:

- **BPB dye in the ionogel matrix shows variation in colour at different pH's and that process is reversible. In the other hand, the mixture IL/BPB is not sensitive to changes in pH.**
- **The polymer matrix prevents leaching of the dye from the ionogel into the sample solution.**
- **The photo-polymerisation process during the material synthesis does not decrease the dye sensitivity to pH in the ionogel.**

REFERENCES

[1] M. Blumentritt, *et al., Sens.Actuators B*,131(2008), 504-508.

[2] S. Capel-Cuevas, et al., Analytica Chimica Acta 681(2010), 71-81.

[3] F. Benito-Lopez, *et al., BSN-2010,26-28 June,(2010),Singapore, 291-296.*

ACKNOWLEDGMENT

This work was supported by Science Foundation Ireland under grant 07/CE/I1147 and the Research Career Start Programme 2010 fellowship form Dublin City University.