An Electrochromic Ionic Liquid: Device optoelectronic properties as a function of current flow.

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INTRODUCTION

- Electrochromic devices (ECD's) undergo a change in their optical properties in response to an applied voltage [1].
- Viologens are attractive materials for ECD's as they can switch between complete transparent and coloured states reversibly [2].
- ECD's are fabricated by placing the redox sensitive material between two electrodes, in the presence of an electrolyte [3].
- Ionic liquids (ILs) / ionogels have evolved as a new type of device platform for ECD's, mainly due to the ionic conductivity endowed on the polymer by the IL in the solid state [4].

AIMS

- To synthesise an IL capable of acting as the electrolyte and the optically active redox salt to form a functioning ECD.
- Characterise the optical output of the novel IL as part of the ECD.

MATERIAL SYNTHESIS

- The electrochromic IL was prepared via two individual quaternisation reactions:

1) Trioctylphosphine was allowed to undergo a thermally controlled S_N2 addition reaction with a dihaloalkane, producing the precursor IL capable of undergoing further addition reactions (Fig. 1 (a)).
2) The precursor IL was then allowed to react with a mono-alkylated viologen precursor to produce the electrochromic IL (Fig. 1 (b)).

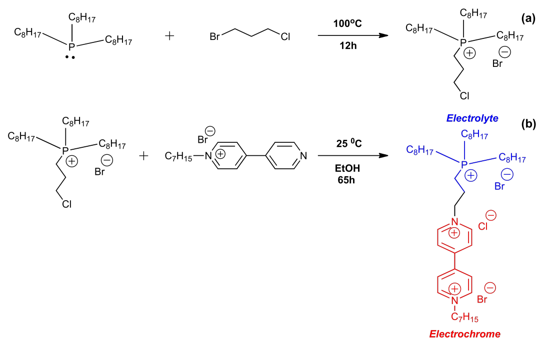

Figure 1: The synthetic route used to produce an IL with inherent electrochromic properties.

DEVICE FABRICATION

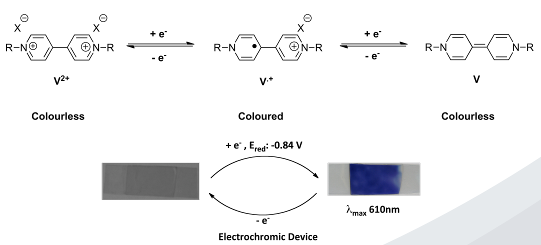

Figure 2: (Top) The redox governed equilibria of the viologen chromophore.
(Bottom) Fabricated ionogel device exhibiting transparent and darkened states.

- An ionogel containing the synthesised electrochromic IL functioned as an ECD when photopolymerised between two electrodes.
- The ECD exhibited the transparent (V^{2+},oxidised) and coloured ($V^{\cdot +}$ reduced) states (Figure 2, bottom).

SPECTROELECTROCHEMISTRY

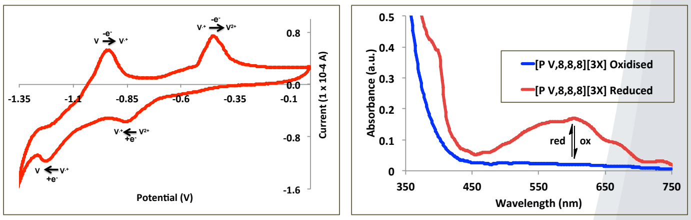

Figure 3: (Left) The cyclic voltammogram obtained for the ECD and **(Right)** The absorption spectra of the transparent and coloured states of the ECD.

- The classical CV of viologen materials was obtained for the ECD containing the Electrochromic IL. Similarly, the expected optical features in the visible region was obtained [2].

DEVICE OUTPUT

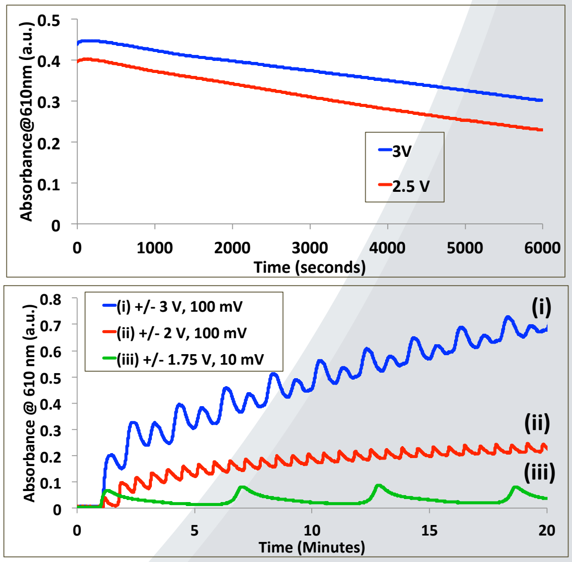

Figure 4: Kinetic profile of the reduced state of various ECD's under differing current conditions. **(Top) D.C., open circuit (Bottom) A.C., Two electrode cell.**

- The optical output of the ECD was found to differ under various electrochemical conditions.
- By pumping D.C into the device, it was found to maintain 60% of its coloured state after 100 minutes, under open circuit.
- Figure 4 (bottom) shows the steps taken to optimise the colouration reversibility of the ECD.

CONCLUSIONS

- Although a highly viscous wax, the synthesised material proved capable of acting as the electrolyte *and* the electrochrome as part of an ECD.
- The ECD proved capable of differing optical outputs as a function of the nature of the current being passed through the device.

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