Comparison on the Performance of Electrochromic Devices according to Voltage Transmission Methods

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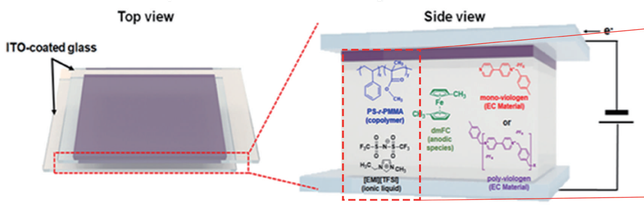
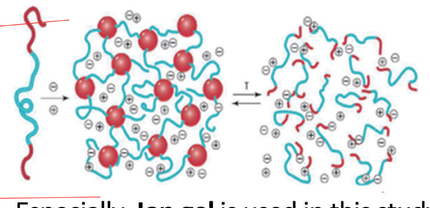
Objectives

1. Comparing the performance of electrochromic devices according to voltage transmission methods
2. Improving stability of ECD by using AC(Alternating Current) instead of DC(Direct Current)
3. Shortening the coloration time and bleaching time by controlling some factors in AC

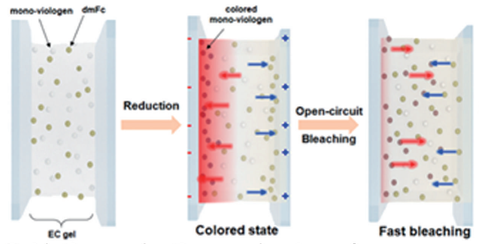
Introduction

Structure of ECD (Electrochromic Devices)



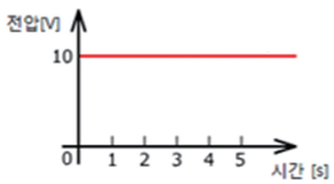


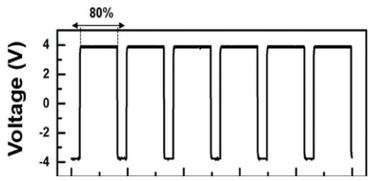
Especially, **Ion gel** is used in this study



Oxidation–reduction mechanism of Anodic and cathodic electrochromic materials

We used both of **AC** and **DC**





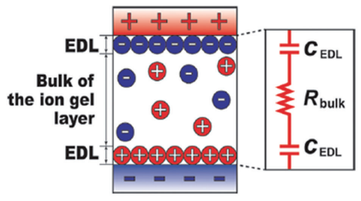
Result & Discussion

DC

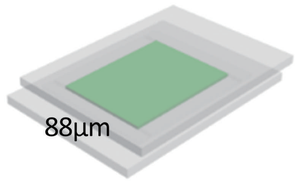
Coloration Time : 17.57s
Bleaching Time : 137.87s

AC

1. Frequency



RC time : The polarization rate or double layer formation time.



In Series

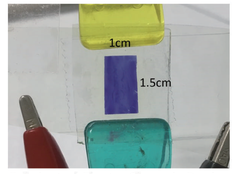
$C'\ (\mu F/cm^2) = \left(\frac{1}{A w_x Z_{im}(45^\circ)}\right)$

In Parallel

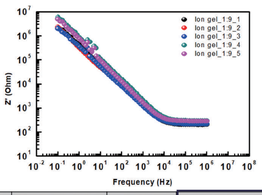
$C'\ (\mu F/cm^2) = \frac{(QR_{ct})^{1/\alpha}}{AR_{ct}}$

But C′ is too small...

$\tau\ (s) = RC = \rho\frac{l}{A} \times \frac{\varepsilon_r\varepsilon_0 A}{d} = \frac{lC'}{\sigma}$



Fabricated ElectroChromic Device



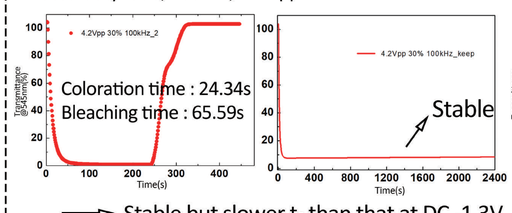
L(μm)	σ (mS/cm)	C' (μF/cm²)	τ (μs)	F (KHz)
88	~6.70	6	7.88	126.894

σ (mS/cm)	C' (μF/cm²)	τ (μs)	F (KHz)_Ref for ion gel	F (KHz)_data for ion gel	F (KHz)_data for EC gel
~6.70	6	7.88	**126.894 (1 Hz)**	**Avg_158.235 (1 Hz)**	**Avg_144.148 (1 Hz)**

Frequency : 100KHz

2. Duty Ratio

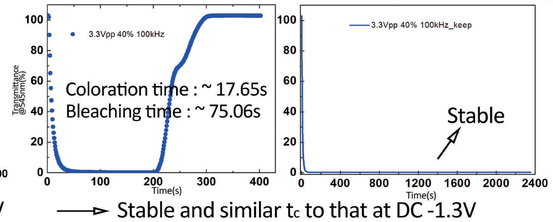
30% duty ratio, 100kHz, 4.2 Vpp



→ Stable but slower t_c than that at DC -1.3V

40% duty ratio, 100kHz, 3.3 Vpp

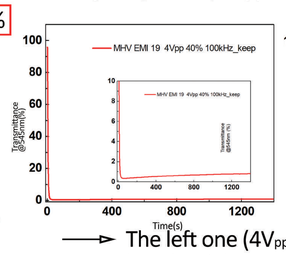
Duty ratio : 40%



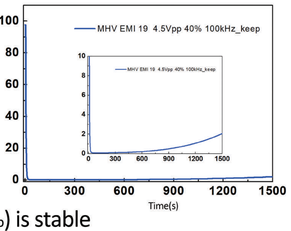
→ Stable and similar t_c to that at DC -1.3V

3. Vpp

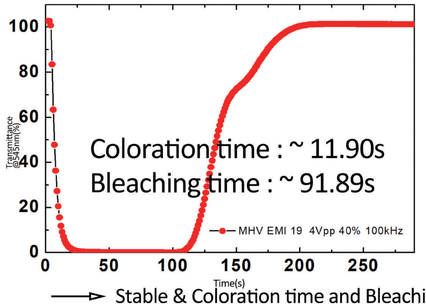
40% duty ratio, 100kHz, 4 Vpp



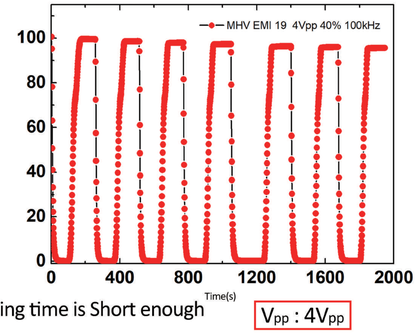
40% duty ratio, 100kHz, 4.5 Vpp



→ The left one ($4V_{pp}$) is stable but the right one ($4.5V_{pp}$) is unstable



→ Stable & Coloration time and Bleaching time is Short enough



Vpp : $4V_{pp}$

Conclusion

AC (at $4V_{PP}$, 40% duty ratio, 100kHz) is stable and faster than DC (at -1.3V)

Summery

1. In this study, we investigated the case where the AC voltage is more stable and faster than when the DC voltage is applied
2. Experiment was conducted by changing the duty ratio and Vpp and frequency that was induced by RC-time was fixed
3. AC (at $4V_{PP}$, 40% duty ratio, 100kHz) is more stable and faster than DC (at -1.3V)