Vanadium Oxide-based electrochromic devices for display applications

By

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Guide

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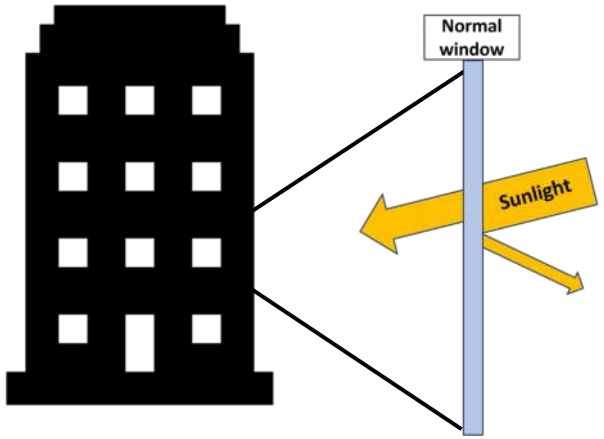
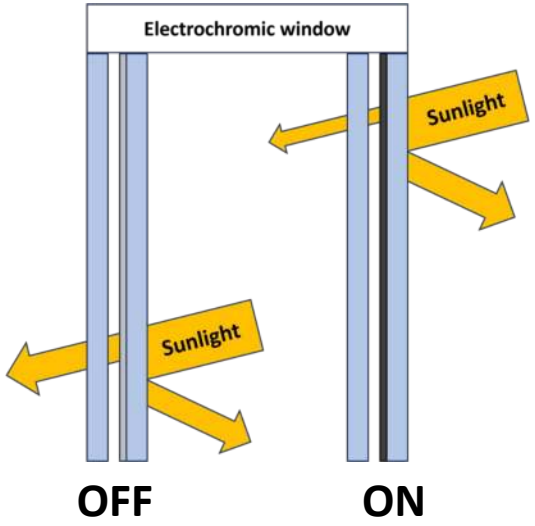
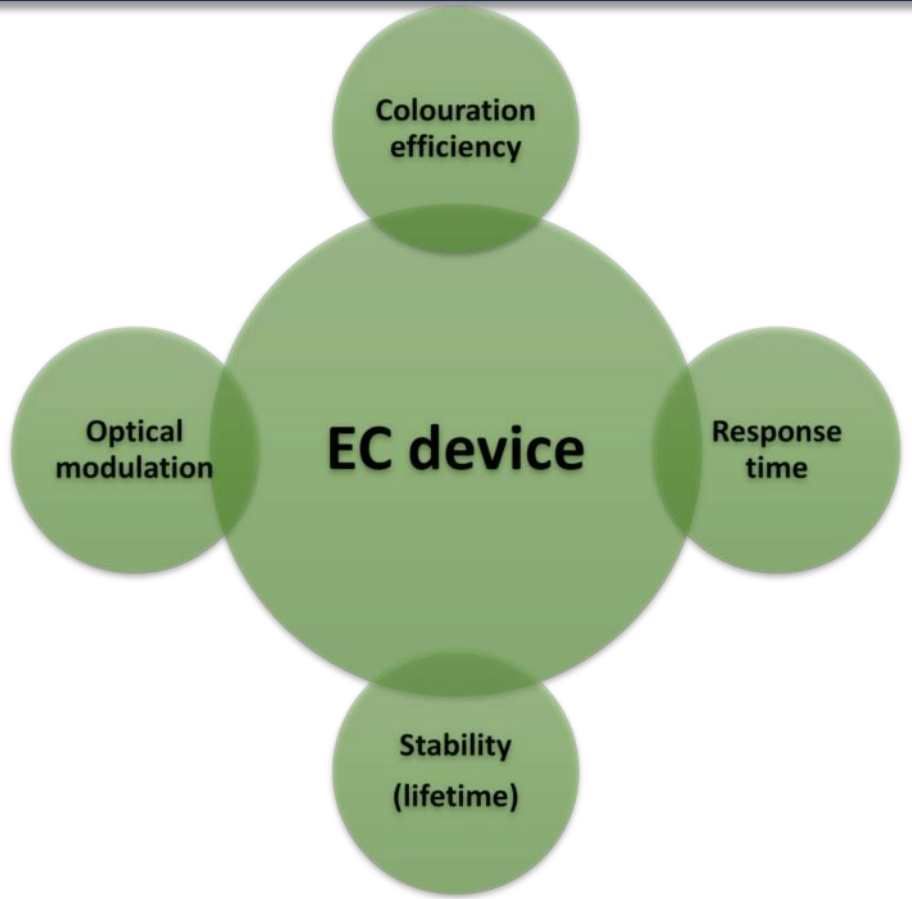
Problem statement

AC – 30% of total energy used

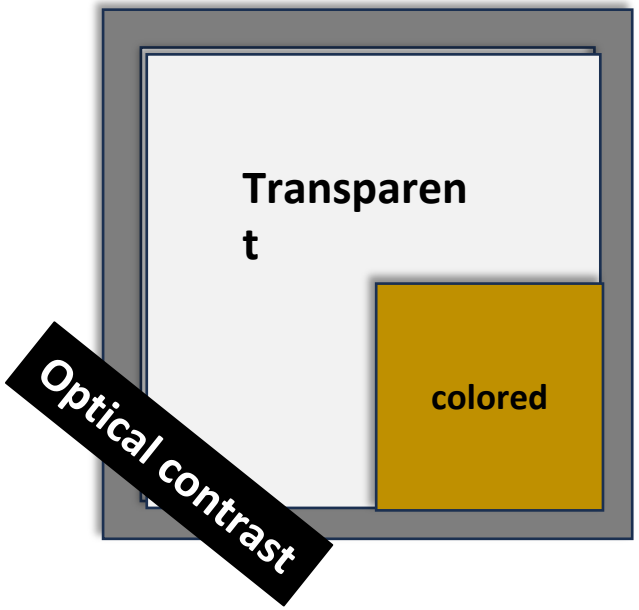


Transmittance is lower

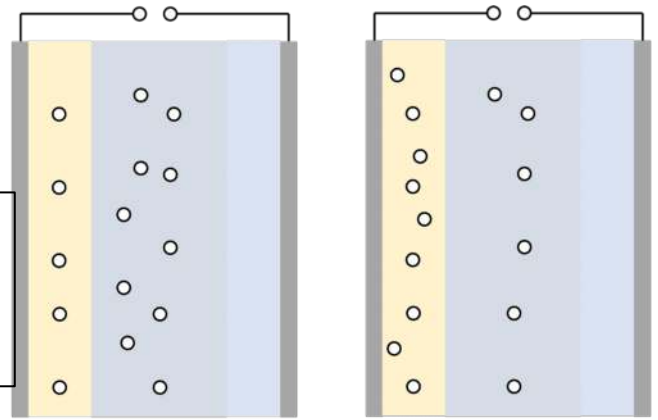




Limited colors



Efficiency is lower But have a hidden advantage



(efficient) Less charge – **same color change** – more charge **(less efficient)**

Methodology

Selection of Electrochromic material

- Various oxidation states +5 +4 +3 +2
- Whether the phases shows electrochromism ? – yes
- Layered structure – more advantageous
- Multiple colour – grey, green, yellow
- Stable oxides
- Good structural integrity - adhesion

Vanadium pentoxide - V_2O_5

Challenges in Lithium

- Hazardous
- Require glove box
- Increasing price
- Environmental impact
- Recycling issues

Alkali metals – a suitable alternative

Structural optimization

- Nanowires, nanosheets, nanorods – which is better?
- Thin films – increases transmittance
- Larger surface area
- Pores for ion intercalation
- Is it feasible to obtain this structures using other methods? – yes, annealing plays a crucial role

Thin Nanosheet films

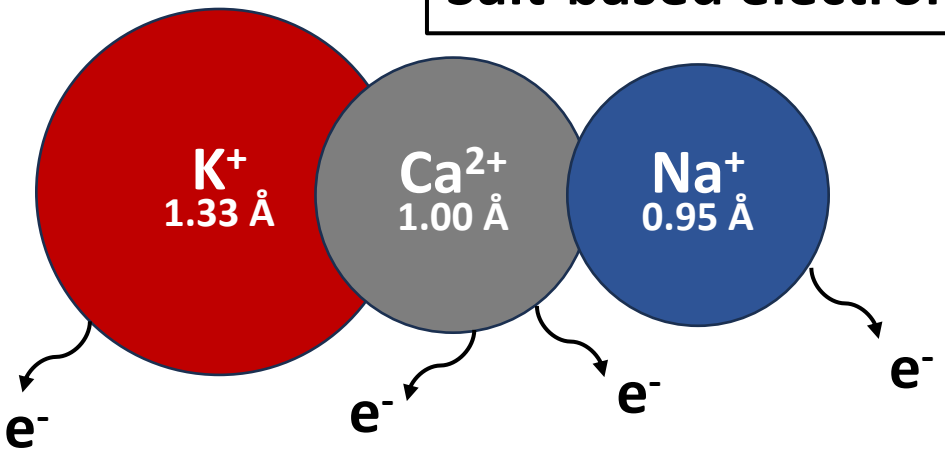
Selection of electrolytes

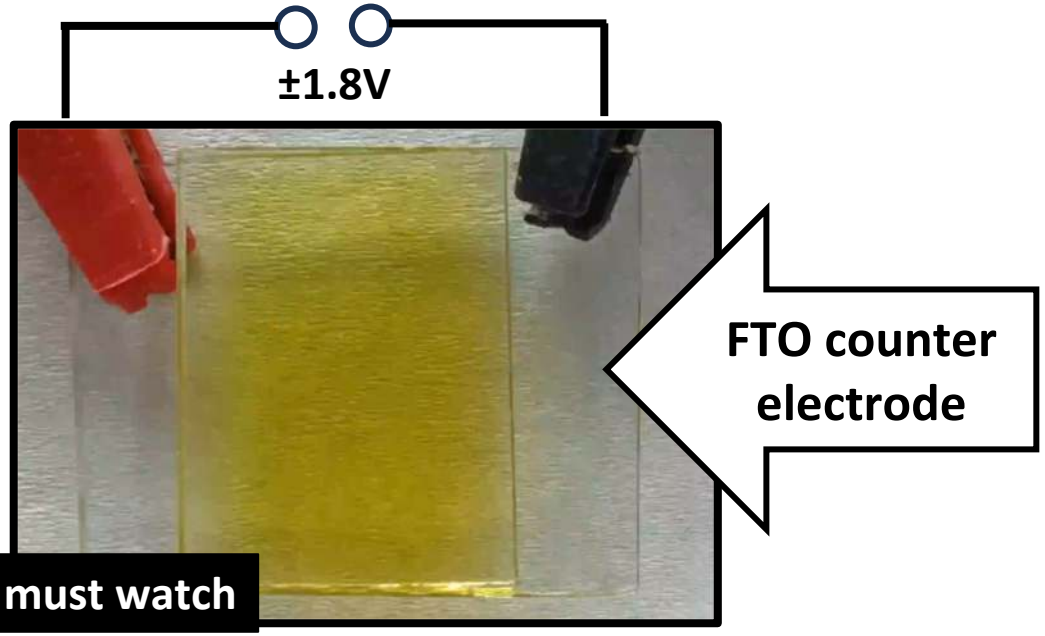
- Optimum ionic sizes – compatibility with structures
- Easily ionized
- Number of electron transfer – high is good
- High theoretical capacity
- Last but nor least – ecofriendly

NaCl, KCl, $CaCl_2$

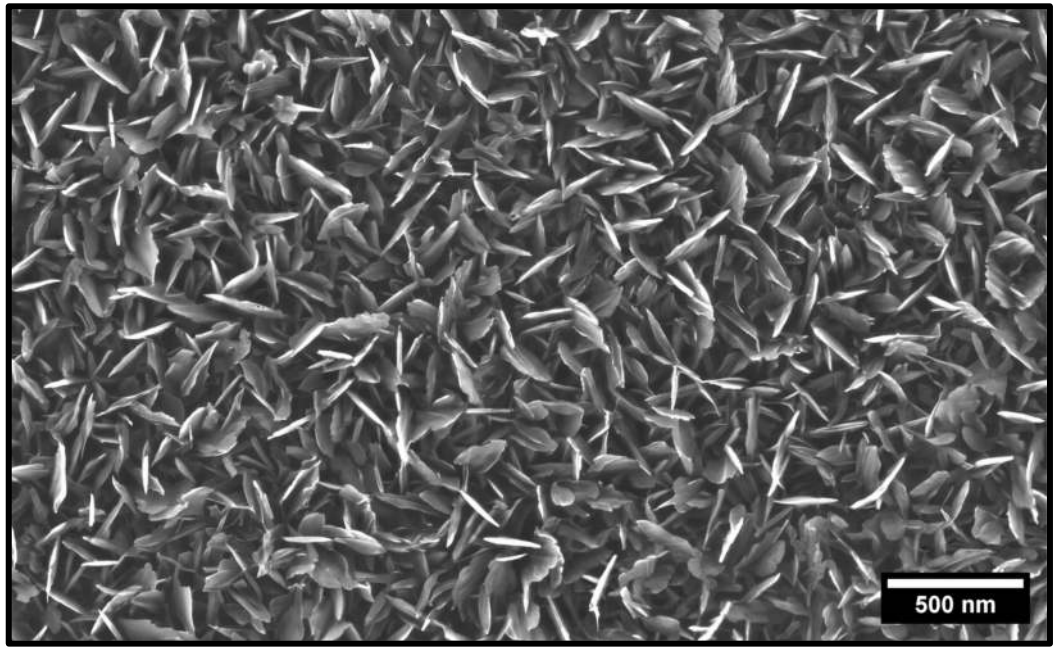
Novelty

Salt-based electrolytes





Video – must watch

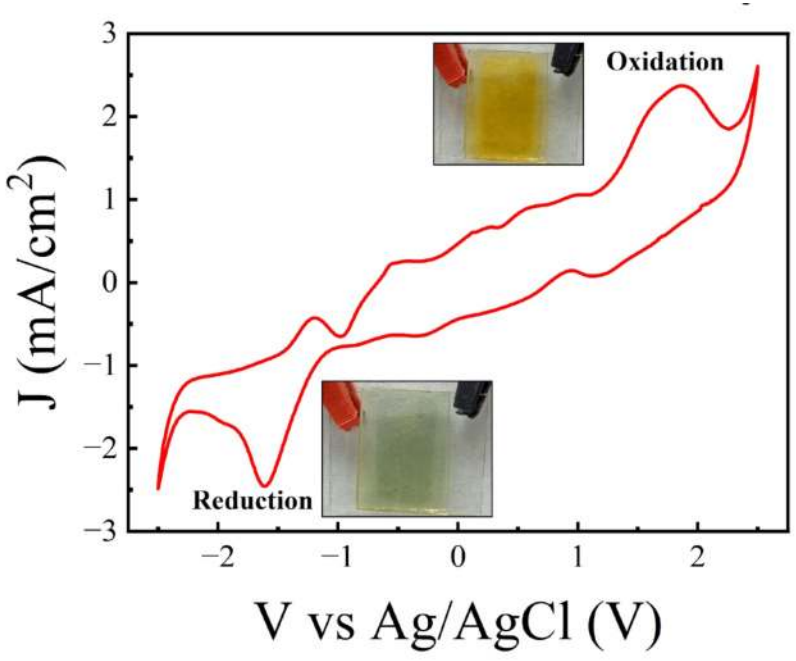


Macroporous nanosheet

- More active surface area
- More electron transfer per site
- No deposition for counter electrode
- Eco-friendly electrolyte

Results

Electrolyte	Q (mC cm^{-2})		ΔT (%)	ΔOD	η (cm^{2}C^{-1})	t_a (s)	R (%)	PI
	Q_{ox}	Q_{red}						
NaCl	32.12	36.05	11.0	0.284	7.88	6.16	89	1.28
KCl	23.36	28.84	24.8	0.527	18.27	11.52	81	1.58
$CaCl_2$	26.80	28.43	36.6	0.715	25.14	6.77	94	3.71



- Achieved comparable EC properties to Lithium
- Lower power usage
- Easy integration with other technology