Optical memory effect in WO₃ and V₂O₅ electrochromic oxide films

B. Faceira*, L. Teule-Gay, I. Mjejiri, M. Maglione, A. Rougier
CNRS, Université de Bordeaux, Bordeaux INP, ICMCB, UMR 5026, 87 avenue du Dr. Albert Schweitzer, 33608 PESSAC Cedex*. brandon.faceira@icmcb.cnrs.fr

Introduction:

Electrochromism is the ability of a material to modify its optical properties under an applied voltage. Applications: electrochromic displays, smart windows.

Focus on two electrochromic oxides:
- WO₃: large optical modulation with a colour switch from transparent to dark blue.
- V₂O₅: multi-electrochromic coloration going from orange to green to blue and gray.

Unusual property: memory effect, corresponding to a colour persistence while no voltage is applied.

This specificity allows ex-situ characterisation in the different colour states.

Origin of memory effect?
- Structural
- Morphology
- Electronic

Radio Frequency Magnetron Sputtering

WO₃, oxide target (3")
Power: 75W
Total pressure: 2Pa
Ar₂O = 49 ± sccm
No heating and 400°C heating.

V₂O₅, metal target (3")
Power: 200W
Total pressure: 2Pa
Ar₂O = 45 ± sccm
No heating.

Free electrons + Ar ions + target atoms = WO₃

No heating and heating: t= 400nm on ITO (7nm/min).

Ex-situ measurements after coloration:

Intercalation/deintercalation mechanism with an increase of disorder during lithiation. Multi-electrochromism with a higher CE in the blue state (9.8 cm²/V).

Conclusion

By using RF-magnetron sputtering with an optimize set of parameters, thin films of V₂O₅ and WO₃, presenting a memory effect were grown. Amorphous WO₃ film presents higher contrast and memory effect than the crystallized one. It is attributed to a more open structure and ion-trapping respectively.

V₂O₅ presents a multi-electrochromism accompanied by an reversible intercalation mechanism and a high memory effect stability in air or in an lithium electrolyte.

Future work:
- Modifying sputtering conditions to tune the memory effect
- Study memory effect property in temperature/humidity controlled environment.

Acknowledgements: the authors acknowledge for their help Eric Lebraud in XRD, Alexandre Fargues in optical measurements and Sonia Buffière in SEM.