LC-EEB-01-2019
Integration of energy smart materials in non-residential buildings

Switch2Save

Lightweight switchable smart solutions for energy saving large windows and glass facades

Starting date of the project: 01/10/2019
Duration: 48 months

= Deliverable D2.4 =

Energy efficient EC-device fulfilling D1.1 specification, VLT modulation < 10% to > 70%; g-value modulation <10% to 50% demonstrated on 1500 x 5000 mm²

Due date of deliverable: 31/03/2021
Actual submission date: 31/03/2021

Responsible WP: Alexander Kraft, CMG
Responsible TL: Alexander Kraft, CMG
Revision: V1.1

Dissemination level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869929.

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DOCUMENT CONTROL

Document version	Date	Change
V1.0	29/03/2021	Version ready for revision
V1.1	31/03/2021	Final version ready for submission

VALIDATION

Reviewers		Validation date
Work Package Leader	Alexander Kraft	30/03/2021
Project Manager	Lenka Bajarová	31/03/2021
Exploitation Manager	N/A	N/A
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DOCUMENT DATA

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Delivery date	31/03/2021

DISTRIBUTION LIST

Date	Version	Recipients
31/03/2021	V1.1	EC, partners

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Executive Summary

For the Deliverable D2.4 an EC film demonstrator in the size of 1.500 mm x 5000 mm was produced at CMG. This device is shown in coloured and bleached in figure 1.

Figure 1: Demonstrator of a **WO_3-NiO** (CL70) EC device (5000 x 1500 mm^2) L5528: left side in the dark state, right side: in bleached state

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Abbreviations

Abbreviation	Explanation
EC	Electrochromic
IGU	Insulating glass unit
R_a	Colour rendering index CRI
VLT	Visible light transmittance [%]
YI	Yellowness index
PB	Prussian Blue

1. Introduction

This deliverable **D2.4** is related to task 2.3. ('Full device production process scaling') of WP2. The main objective of WP2 is to create a new (hybrid) electrochromic (EC) device configuration with available, roll-to-roll process-able electrode materials to overcome existing limitations and reduce cost of state-of-the-art EC products. The hybrid EC devices targeted in Switch2Save consist of three active layers: 1) an EC layer, 2) an ion storage layer, and 3) an ion-conducting polymer electrolyte in between both electrodes. With the new device configurations, a high visible light transmittance (VLT) change should be reached, ideally from ≥ 70% in the clear state to ≤ 10% in the dark state.

The main result of task 2.1 of WP2 was the selection of the WO_3-NiO (CL70) cell configuration with the modified polymer electrolyte UV31 for further work in this project. During our research on an improved ion-storage-layer to be paired with the cathodic electrochromic film of WO_3, two good candidates were selected to choose from: Prussian Blue (PB) and a new setpoint nickel oxide (NiO CL70). Although the use of PB resulted in a higher VLT in bleached state with lower YI, NiO CL70 was chosen, because of its great advantages in colored state. The use of PB resulted in an extremely deep blue device in dark state with a very low color rendering index R_a, whereas NiO CL70 provided a comparable low VLT in dark state but with excellent R_a. If we compare the „old" standard NiO CL65 with the new setpoint NiO CL70, we find that the VLT of the device in bleached state and the switching range both increase by about 8% (bleached VLT from 61.2% to 68.8 % and $\Delta\tau_V$ from 42.8 to 51%) with some reduction of the yellowing index (YI) too. This was presented in deliverable **D2.1**. In addition, in task 2.2 the large area magnetron sputter deposition on 1.5 m width with a deposition speed > 1 m/min for WO_3 was established (see deliverable **D2.2**). The deposition speed for NiO CL70 is comparable to that.

In this deliverable **D2.4** it has to be shown, that the device configuration selected in task 2.1 can be produced in large industrial scale (on 1500 x 5000 mm²), fulfilling **D1.1** specification.

2. Results and Discussion

The two films for the large area EC device were produced on 1.65 m wide PET/ITO films (thickness 125 μm each) on rolls by Roll-2-Roll DC magnetron sputtering on the new coater of CMG. In Figure 2, this coating machine is depicted.

The NiO CL70 coating (internal ref. no.: NiO20210210) was performed on 10.02.2021, whereas the WO_3-coating (WO20210318) was performed on 18.3.2021. Lamination of the EC device (L5528) with these two films and UV curing of UV31 electrolyte was done on 22.03.2021. After lamination the electrolyte thickness is 100 μm, resulting in an overall thickness of the EC film of 350 μm.

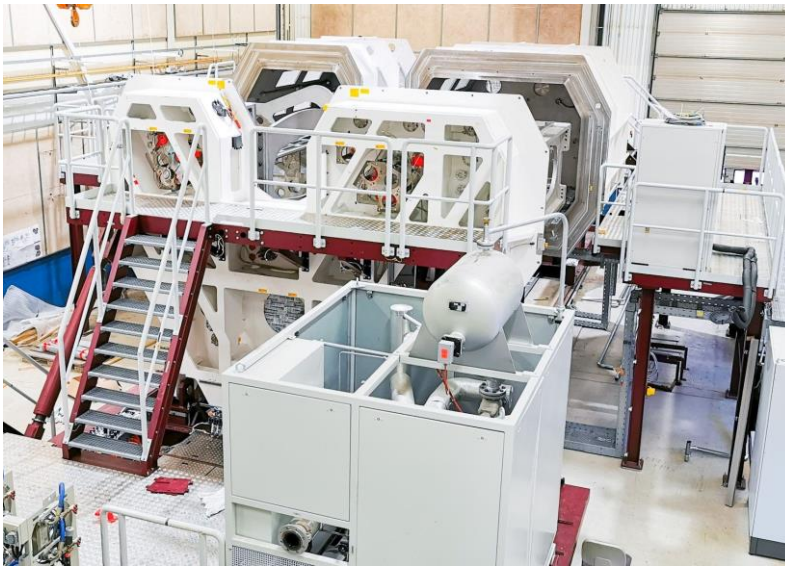

Figure 2: Chromogenics' Roll-to-Roll dc magnetron sputter deposition coater which allows to coat onto PET/ITO substrates with 1.5 m width

Figure 3 shows the EC film after lamination but before cutting and bus bar application.

This cutting to size and contacting was done on 25.3.2021.

The finished EC device was then switched by applying DC voltages between dark and bleached state (coloring: +1.6 V, bleaching -1.4V) using a dc power supply or a CMG proprietary switching controller.

Figure 4 shows the demonstrator in dark and bleached state. Because of its size spectra from this device could not be recorded.

Figure 3: Electrochromic film WO_3/NiO CL70 L5528 1500 mm x 5000 mm after lamination before cutting and bus bar application.

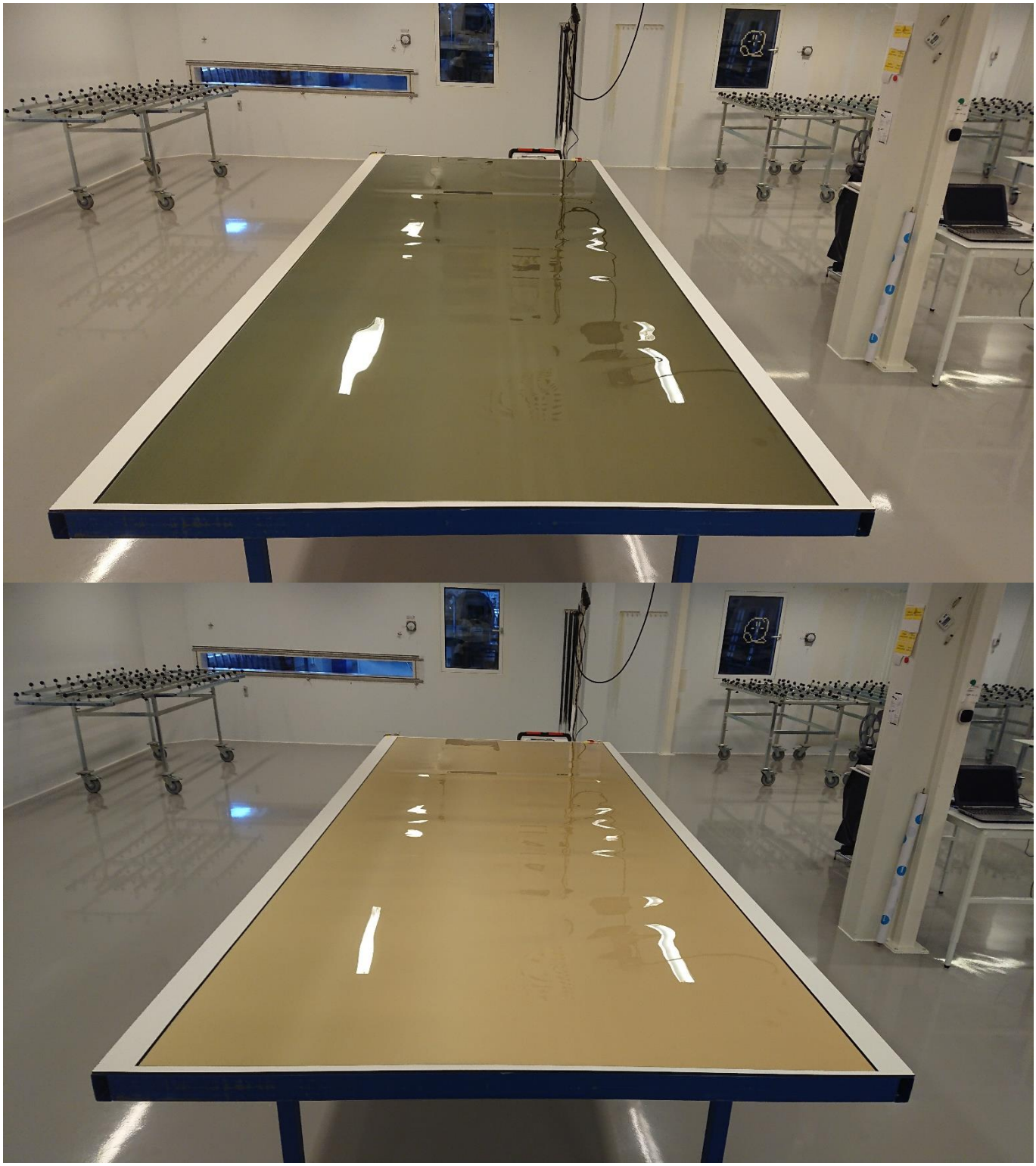

Figure 4: Demonstrator of a **WO_3-NiO** (CL70) EC device (1500 x 5000 mm^2) L5528: picture on top in the dark state; lower picture in bleached state.

Spectral data were recorded on a similar device configuration of the size 250 mm x 250 mm. The corresponding transmittance spectra are displayed in Figure 5. The device switches between 70.1% and 17.8% VLT with a transmittance change of 52.3%. R_a is around 90 in both states. These are comparable data as presented in **D2.1**.

If we compare these data with the goal for WP2, we see, that we just reached a VLT of >70% in bleached state, whereas in dark state, the goal of <10% was not reached for the EC film. It is expected, however, that in a double or triple pane IGU with EC film laminate, this value will be achieved. This will be checked in WP4, which deals with glass lamination and IGU production. This is also true for g-value, which will also be determined for the glass laminate and IGU versions.

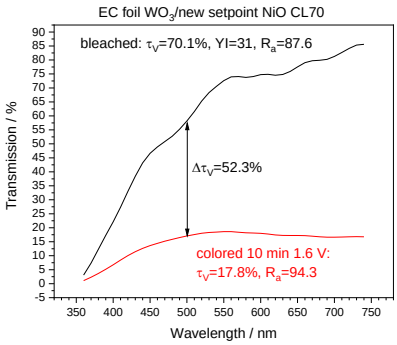

Figure 5: Transmission spectra of a 25 cm x 25 cm EC film device with WO_3, NiO CL70 and UV31 in bleached and dark state

3. Conclusions

At CMG an EC film demonstrator in the size of 1500 mm x 5000 mm using the material combination of **D2.1** was successfully produced. This shows, that the results of WP2 could be translated to the industrial production line of CMG, so that there are good prerequisites to successfully complete the work in WP4 and WP5.

With the production of a fully functional EC prototype and a manufacturing parameter set ready, the results which were requested for Milestone 2.2 could also be reached.

4. Degree of Progress

All task activities reported in the DoA are fulfilled.

5. Dissemination Level

The deliverable D2.4 is public.