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Lithium-doped nickel oxide and nanostructured tungsten oxide thin films made by USP, toward improved electrochromic performances

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In the last few years, there has been increasing interest in electrochromic glass (also known as smart glass or electronically switchable glass) due to its potential use as an energy-saving component for buildings, as it could reduce considerably their CO_2 emission by decreasing their energy consumption up to 30%.

The crucial issues of such devices are the coloration efficiency as well as the reversibility upon coloration and bleaching of the electrochromic layers. The combination of NiO and WO_3 films (separately as working and counter electrodes) affords a good coloration contrast between the colored and the bleached state of the device (Figure 1), since tungsten oxide colors upon ions and electrons insertions while nickel oxide gets colored after their extractions.

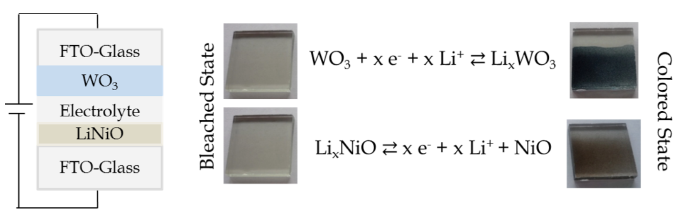

Figure 1: Representation of coloration and bleaching processes in electrochromic glass

In order to improve the performances of those electrochromic films, we have investigated nanostructuration of the WO_3 layer and the addition of lithium dopant in the NiO layer.

All films have been deposited on FTO substrates by ultrasonic spray pyrolysis (USP), which is a low-cost alternative to industrial vacuum processes for manufacturing high quality thin films. The resulting films have been characterized by cyclic voltammetry coupled with UV-visible, by chronoamperometry, as well as SEM, XRD and Dektak profilometer.

The addition of lithium ions in nickel oxide films has shown improved reversibility (97%) and coloration efficiency (32 cm²/C) compared to the undoped films (80% and 28 cm²/C respectively). The higher active surface of nanostructured tungsten oxide films has also led to higher reversibility (68% against 43% without nanostructuration) and coloration efficiency.