Development of mesoporous tungsten oxide WO_3 thin films for electrochromic applications

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WHAT IS AN ELECTROCHROMIC FILM?

Electrochromism is the ability of some materials to change their optical properties in a reversible and persistent way under the action of a voltage pulse. This phenomenon finds applications in the area of smart windows and subsequently it contributes to building energy savings. The reaction that takes place between the colored (right part) and bleached state (left part) is :

$$WO_3 + xLi^+ + xe^- \rightleftharpoons Li_xWO_3$$

In this project we combine the electrochromic properties of tungsten oxide films and the surface properties of mesoporosity. Large interface between the film and the electrolyte and the formation of small domains which decrease the diffusion length inside the solid, are some of the advantages of mesoporous materials. This will result in the production of sustainable materials with improved kinetics and fast switching time from one state to the other.

EXPERIMENTAL PROCEDURE

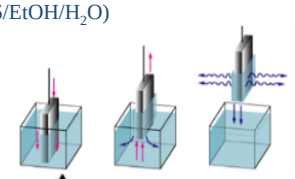
Four steps

1) Preparation of the solution

$([W_{12}O_{42}H_2]^{10-}/EtOH/H_2O)$ + (Brij-56/EtOH/H_2O)

2) *Dip-coating*

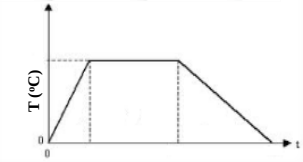
- Controlled RH%
- Controlled deposition speed



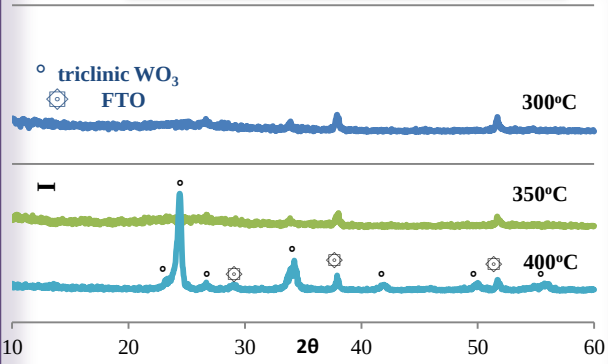
3) Stabilization at 170°C

4) Calcination at high temperatures

- *Elimination of the surfactant*
- *Preservation of mesoporosity*
- *Solidification of the material*

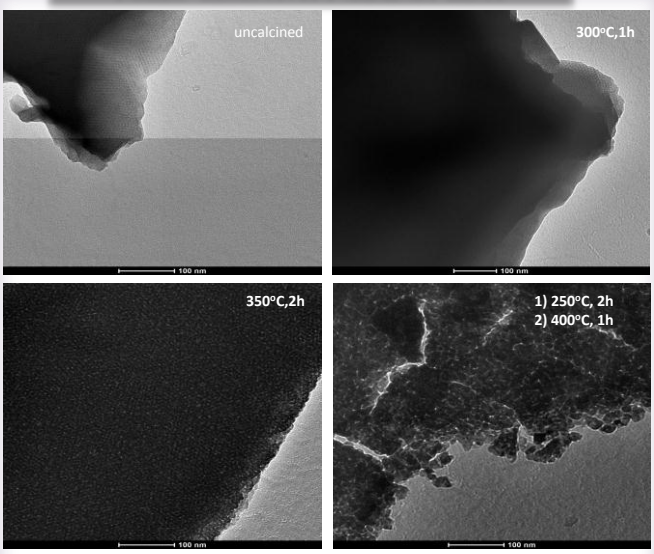


CRYSTALLINITY



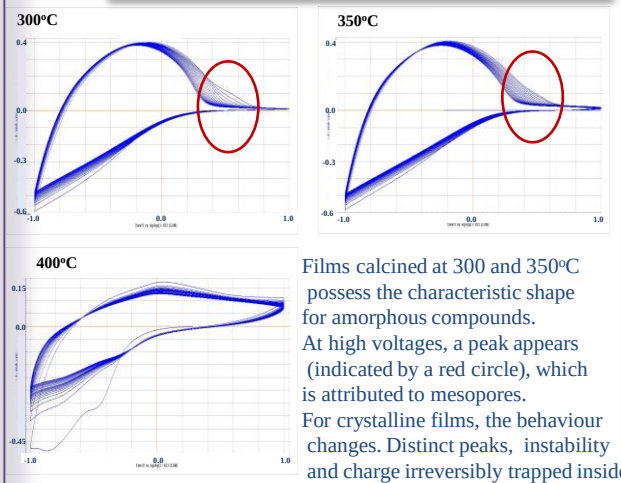
Films become crystalline at temperatures above 400°C. At this temperature, tungsten oxide is converted into the triclinic structure according to the JCPDS no. 01-073-8498.

PORES' RESISTIVITY AGAINST HEAT



Pores' organization is retained until 350°C. After this temperature, crystallization begins. The material is subjected to strains and mass rearrangement which lead to the destruction of mesopores.

CYCLIC VOLTAMMOGRAMS



Films calcined at 300 and 350°C possess the characteristic shape for amorphous compounds.
At high voltages, a peak appears (indicated by a red circle), which is attributed to mesopores.
For crystalline films, the behaviour changes. Distinct peaks, instability and charge irreversibly trapped inside the material, are some impacts of film's crystallization

BIBLIOGRAPHY

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CONCLUSIONS

Mesoporous WO_3 films were successfully prepared. Mesoporosity is well preserved up to 350°C, but when crystallization begins, organisation is collapsed and voids between material's domains prevail. Crystalline materials show less efficient electrochemical performances than their amorphous counterparts.