Tailored Nanostructures of WO_3: Unveiling Enhanced Electrochromic Performance through Structural and Morphological Optimization

Group of Research in Energy and Environment from Materials

Virendrakumar G. Deonikar, Florian Gillissen, Gilles Spronck, Rudi Cloots, Pierre Colson, Jennifer Dewalque*

GREEnMat, UR CESAM, Chemistry Department B6a, Allée du 6 août,13 – University of Liège, B-4000 Liège
Presenting author E-mail: vdeonikar@uliege.be

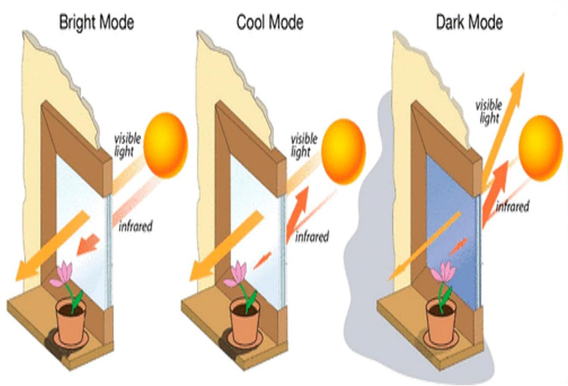
Abstract

Tungsten oxide (WO_3) nanostructures have gained significant attention for their potential applications in electrochromic devices due to their unique structural, morphological, and optoelectronic properties. In this study, we present a comprehensive investigation into the tailored synthesis of WO_3 nanostructures with controlled structural features and morphological properties. The hydrothermal method was used to synthesize WO_3 with different strategies, to engineer the nanostructure growth and morphology of WO_3. Characterization techniques such as scanning electron microscopy (SEM), X-ray diffraction (XRD) are employed to elucidate the structural and morphological properties of the synthesized nanostructures. Moreover, electrochemical analysis is used to evaluate the electrochromic performances of the WO_3 nanostructures to get a deeper understanding of their optical modulation, coloration/bleaching capabilities, etc. Overall, our findings highlight the importance of tuning the structural and morphological properties of WO_3 nanostructures for achieving enhanced electrochromic performance, hence revealing the way for their potential usage in displays, smart windows, printable smart QR codes and other optoelectronic devices.

Introduction

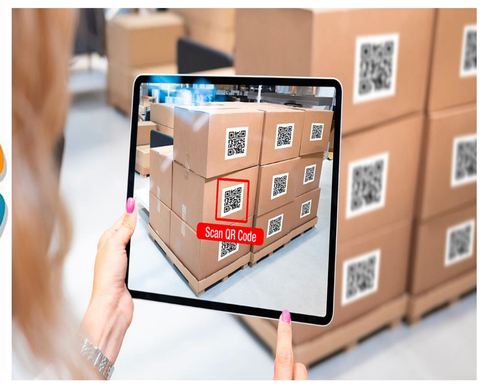
Background

- Electrochromic materials change their optical properties such as colour or transparency in response to an applied electric field.
- The colour change is usually reversible, which makes these materials suitable for applications requiring multiple cycles of coloration and bleaching.



Smart window application

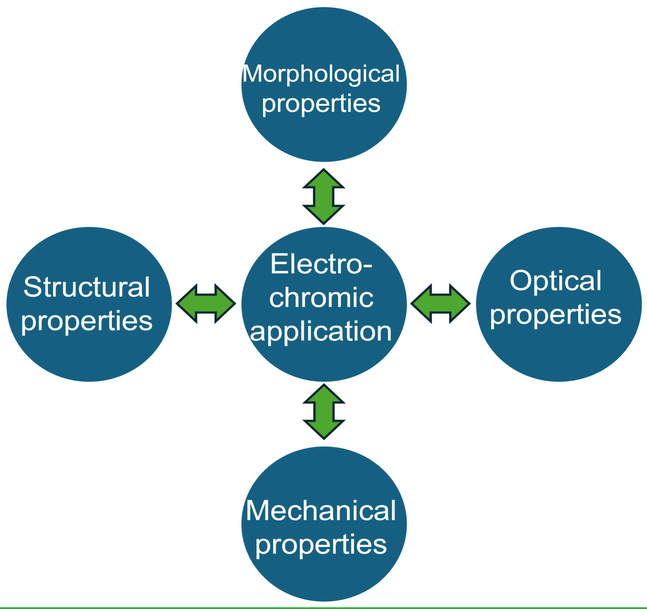
Multiple applications



Smart QR- code application

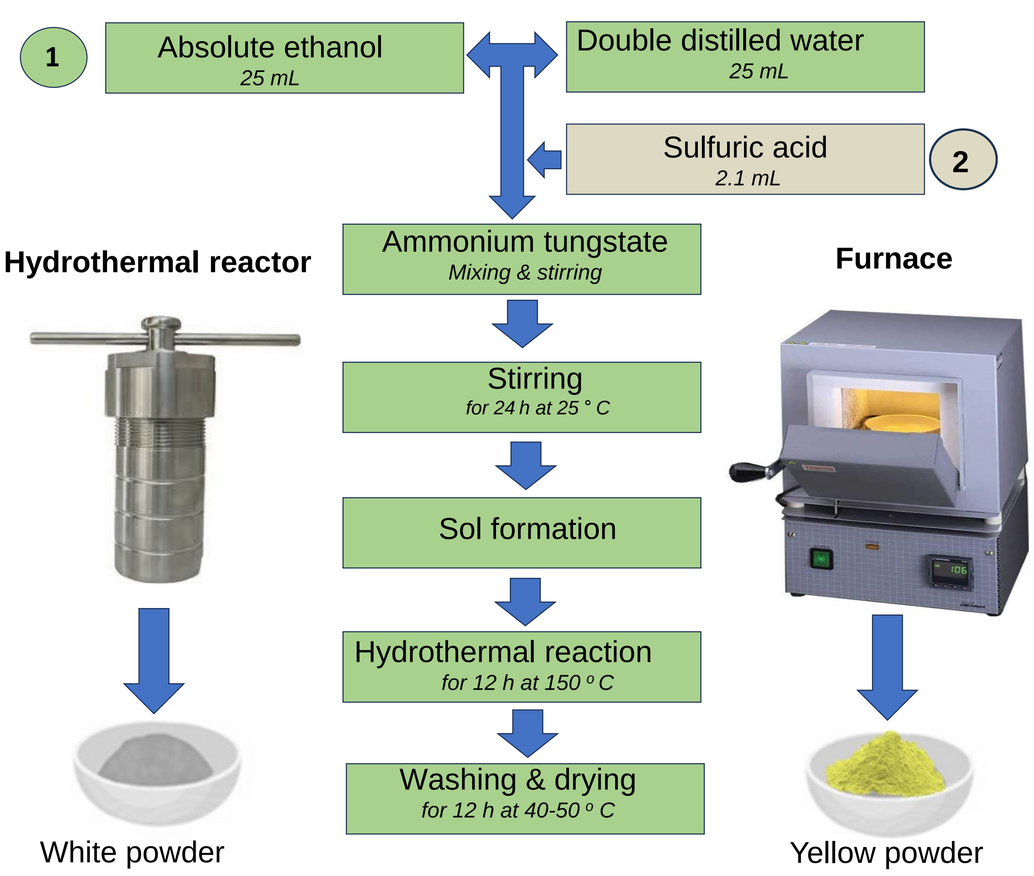
Objectives

- The goal of this study is to develop a variety of techniques for hydrothermal synthesis of WO_3 nanostructures with optimized structural, optical, mechanical, and morphological properties for improved electrochromic applications.



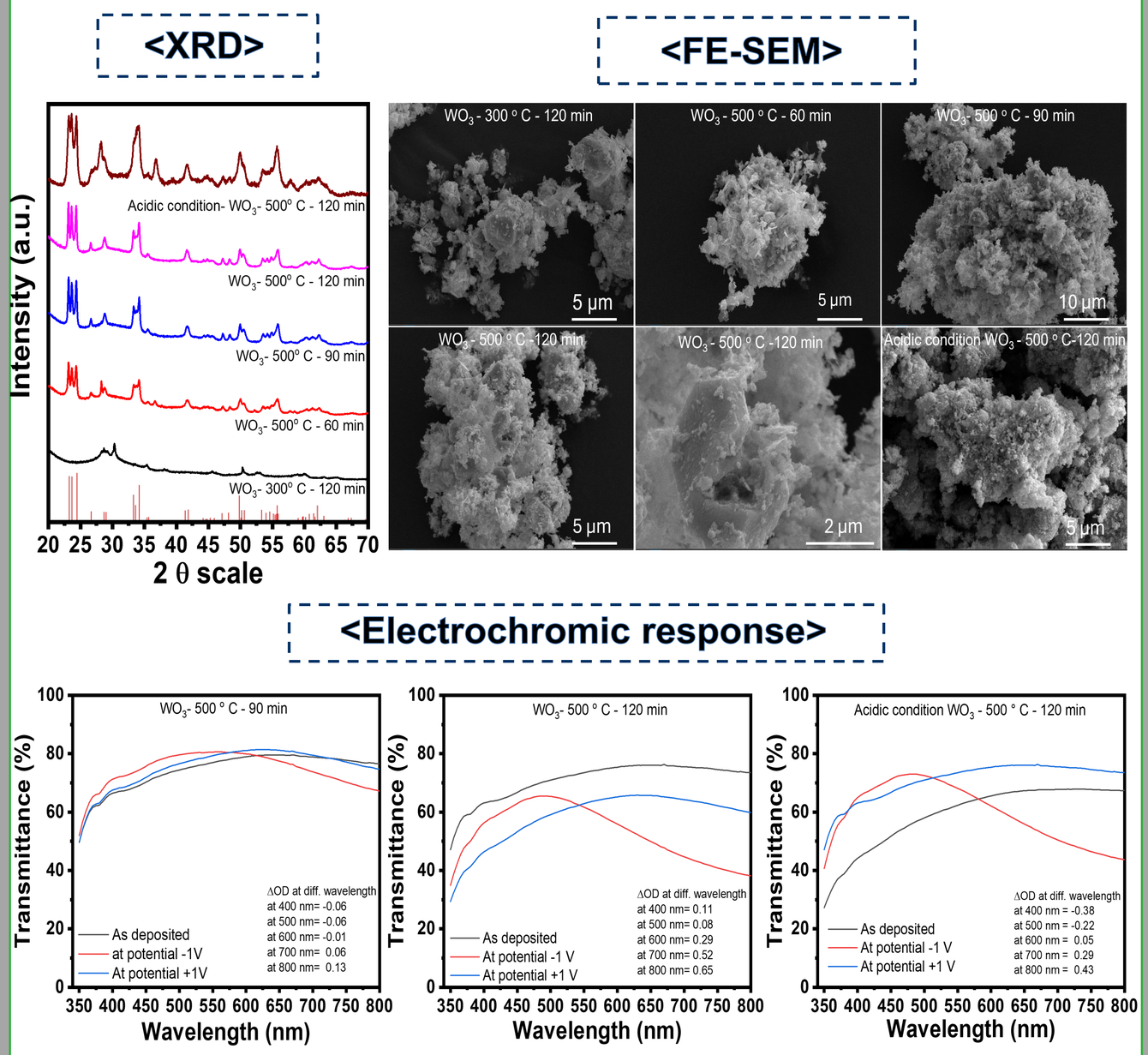
Synthesis strategies

1. Non-acidic condition; 2. Same synthesis strategy with acidic condition



References:
1. Ceramics International 2018, Volume 44, Issue 8, 9364-9371
2. International Journal of Hydrogen Energy, Volume 38, Issue 8, 2013, Pages, 3177-3188

Results & discussion



Acknowledgement

Project PECLABEL was selected in the Joint Transnational Call 2022 of M-ERA.NET 3, which is an EU-funded network of about 49 funding organisations (Horizon 2020 grant agreement No 958174). The project is funded by the :
- Fonds de la Recherche Scientifique – FNRS, Belgium, under Grant n°R8002.23,
- Agence Nationale de la Recherche – ANR, France, under Grant n°ANR-23-MER3-004-01,
- Agencia Estatal Investigación - AEI, Spain, under Grant PCI2023-143366 funded by MCIN/AEI/10.13039/501100011033 and, the European Union NextGenerationEU/PRTR,
- Business Finland, Finland, under grants n°1956/31/2023 & 2888/31/2023.

Conclusions

- The hydrothermal method is effective for tailoring the synthesis of WO_3 nanostructures, allowing precise control over their structural and morphological features.
- FE-SEM and XRD successfully elucidated the structural and morphological properties of the synthesized WO_3 nanostructures.
- Electrochemical analysis revealed that the WO_3 nanostructures (calcined at 500 ºC for 120 min) exhibit excellent electrochromic properties, including optical modulation and coloration/bleaching capabilities
- Tuning the structural and morphological properties of WO_3 nanostructures is crucial for elevating electrochromic performance, and their application in printable smart QR codes.