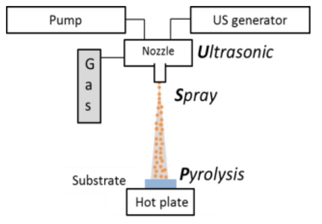
A Technology Opportunity of the University of Liège & INISMa

New wet deposition method to make electrochromic devices

In the last years, University of Liège has developed a unique expertise on Ultrasonic Spray Pyrolysis (USP) technology. USP is used in a variety of applications from nanoparticle formation to thin film deposition in energy and environment fields. In partnership with INISMa, ULiège-GREEnMat researchers have developed specific conditions to obtain a stack of electrochromic and electrolytic layers exploiting this technology. The layers and devices can be used for smart windows applications such as glazing material for energy-efficient buildings.

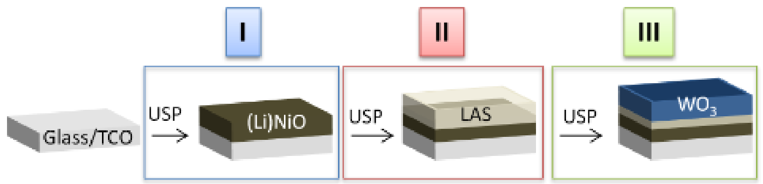
Description

USP is a wet deposition technique in which a precursor solution or suspension is sprayed onto a heated substrate (e.g. glass) to generate a thin functional coating (**Scheme 1**).
Within the spray nozzle, ultrasounds are used to atomize the precursor solution/suspension, allowing for a good control over the droplets size and size distribution resulting in homogeneous and smooth deposits with limited defects.



Scheme 1: principle of USP

USP has been exploited here to form an "all solid" electrochromic device made by the progressive stacking (**Scheme 2**) of an electrochromic layer made of (Li)NiO (I), a LAS electrolytic layer (II) and a WO_3 complementary electrochromic layer (III). Reverse stacking sense, from WO_3 to (Li)NiO, is also conceivable. Individual layers show good electrochromic (or electrolytic) properties without any further post-treatment steps. The whole device leads to high optical contrasts with fast coloration/discoloration kinetics and proves to maintain its electrochromic performances after 1 year aging.



Scheme 2: progressive stacking of electrochromic (I & III) and electrolytic (II) layers obtained through USP deposition process. *TCO = Transparent Conductive Oxide layer; (Li)NiO = lithium-doped nickel oxide; LAS = lithium aluminosilicate; WO_3 = tungsten oxide*

Advantages

- Deposition at atmospheric pressure
- Deposition at moderate temperature (300-400° C)
- Wet process enabling aqueous deposition
- High coating homogeneity and less defects than with other deposition techniques
- Compatible with continuous, roll-to-roll deposition processes
- Easy upscaling

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Applications

The patented technology consists in an effective way to produce electrochromic or electrolytic layers via USP. Electrochromic layers are notably used for smart windows applications where a control over the optical properties of the glass is desired. Another typical example of electrochromic technology are the rear-view mirrors in cars that can automatically adjust light reflection in order to prevent glaring.

Electrolytic layers are essential elements of electrochromic device as they ensure the transport of electricity through ionic conductivity. Other applications of these layers are typically found in energy production & storage devices such as photovoltaic cells or batteries.

Scientific literature

• "*Improved coloration contrast and electrochromic efficiency of tungsten oxide films thanks to a surfactant-assisted ultrasonic spray pyrolysis process* " by J. Denayer, P. Aubry, G. Bister, G. Spronck, P. Colson, B. Vertruyen, V. Lardot, F. Cambier, C. Henrist and R. Cloots. Solar Energy Materials and Solar Cells 130, 2014, 623-628.

• "*Surfactant-assisted ultrasonic spray pyrolysis of nickel oxide and lithium-doped nickel oxide thin films, toward electrochromic applications* " by J. Denayer, G. Bister, P. Simonis, P. Colson, A. Maho, P. Aubry, B. Vertruyen, C. Henrist, V. Lardot, F. Cambier and R. Cloots. Applied Surface Science 321, 2014, 61-69.

Patent Status

WO2016/113050 A1 (Patent application pending)

Research Team

***GREEnMat** group from University of Liège* is a research laboratory directed by Prof. Rudi Cloots, Vice-Rector of Research, specializing in the development and characterization of inorganic materials. We develop powders, bulk materials or coatings for applications related to energy, environment, health or protective coatings. In most projects, we pay special attention to the control of microstructure, porosity and interfaces in order to optimize the material properties.

***INISMa** from Belgian Ceramic Research Center in Mons*, directed by Dr. Jacques Rennotte, is a research, tests and analysis laboratory specialised in materials (research and development, analysis, certification, expertises), soils (geotechnics and sampling), and environment (sampling and analysis).

Opportunities

Research services, research collaboration & license agreement

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