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Fabrication of octahedral tantalum cluster film by electrophoretic deposition

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ELECTROPHORETIC DEPOSITION: FUNDAMENTALS AND APPLICATIONS

Fabrication of Octahedral Tantalum Cluster Film by Electrophoretic Deposition



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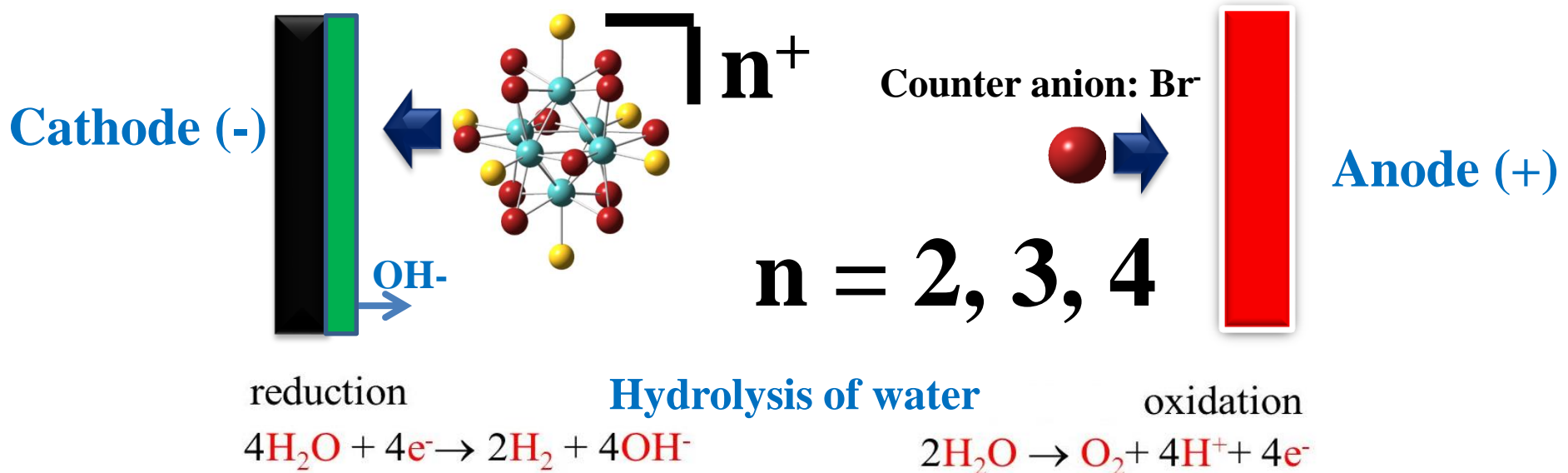
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Electrophoretic Deposition

Precursor: $[\text{Ta}_6\text{Br}^{i}_{12}(\text{H}_2\text{O})^a_6]\text{Br}_2$

Synthesized by Prof. Stephane Cordier, Univ. Rennes 1, France

**Strong absorption
of UV and NIR**



Key parameters effecting to EPD process

Solution parameter

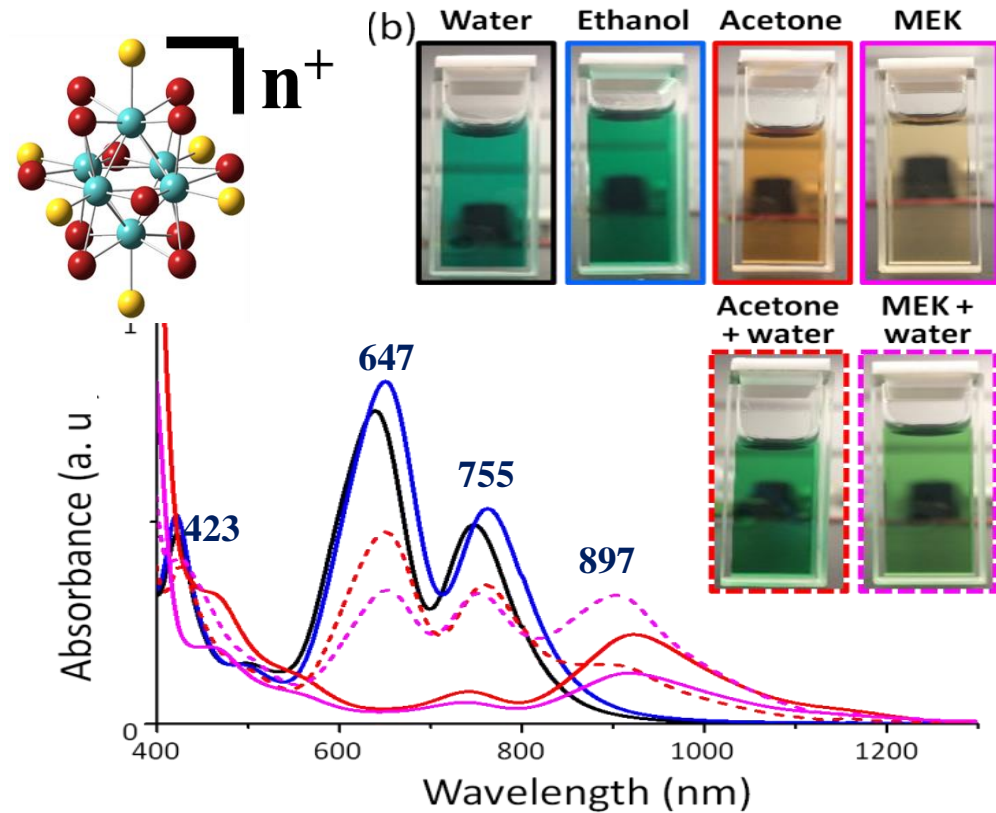
1. Concentration
2. pH
3. Solvent
4. Zeta potential

EPD parameters

1. Deposited time
2. Deposited applied voltage
3. The distance of electrodes

[Ta₆Br₁₂(H₂O)^a]₆ Film Prepared by EPD process

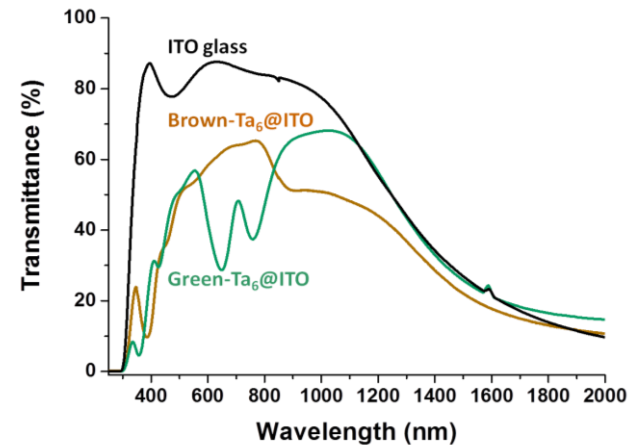
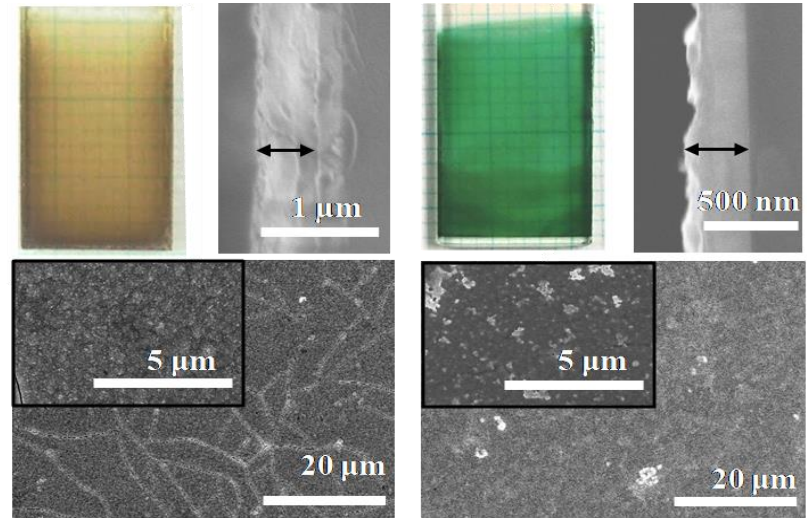
Selection of the solvent



Brown color: [Ta₆Br₁₂(H₂O)^a]₆^{3+/4+}
Green color: [Ta₆Br₁₂(H₂O)^a]₆²⁺

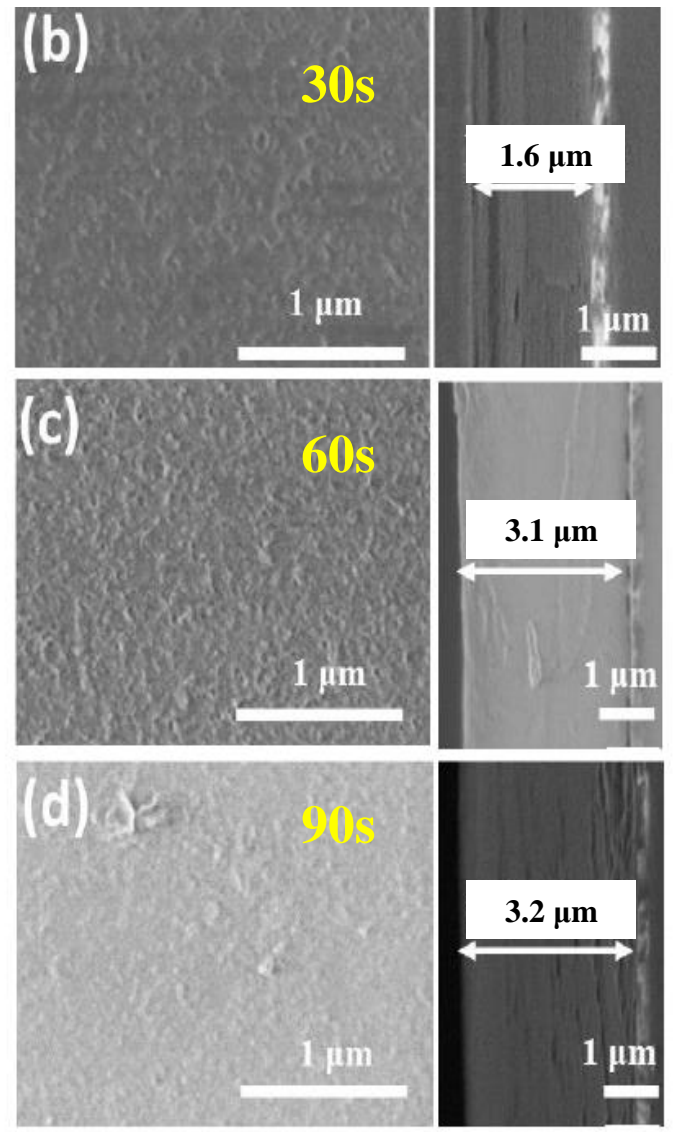
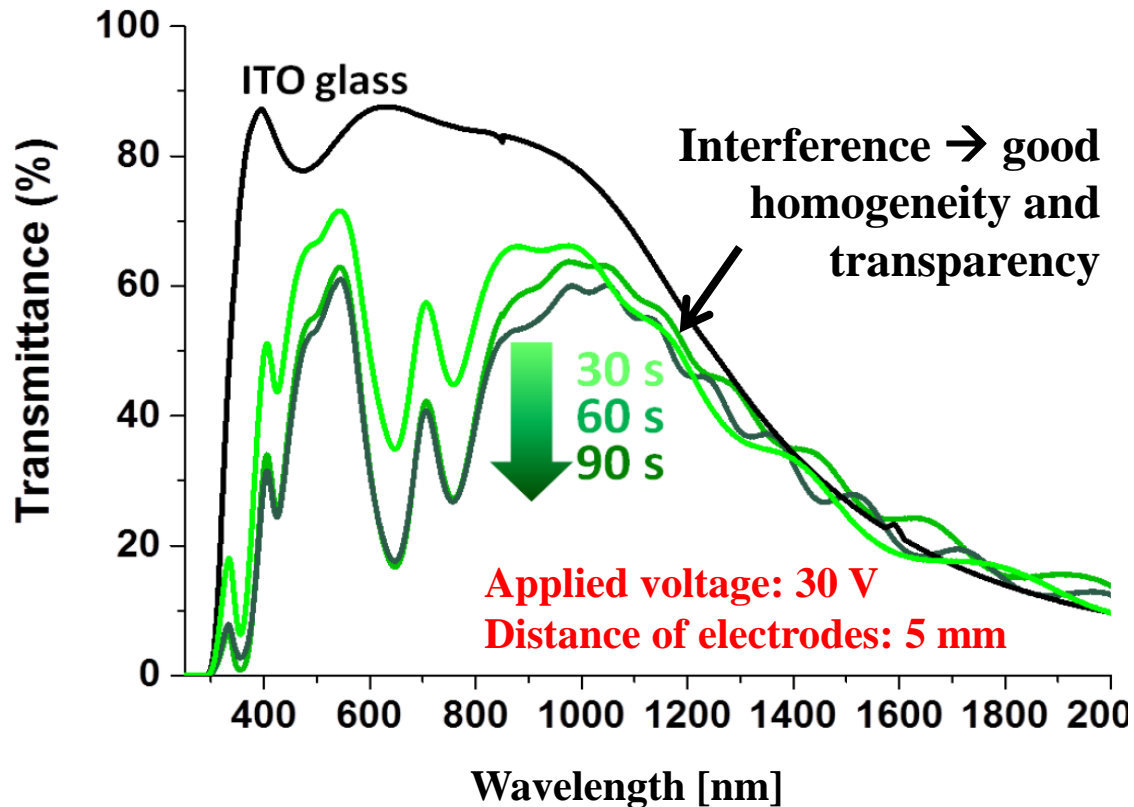
Acetone

Acetone+H₂O



Strong redox activity and UV-NIR absorption properties of [Ta₆Br₁₂(H₂O)^a]₆ⁿ⁺ are potential characteristics for electrochromic window.

Stabilization of the $[\text{Ta}_6\text{Br}_{12}(\text{H}_2\text{O})_6]^{2+}$ film by organic binder $[\text{Ta}_6\text{Br}_{12}(\text{H}_2\text{O})_6]@\text{Poly Vinyl Pyrrolidone (PVP)}$ film



3. Summary

The optimized parameters:

- Solvent: **acetone + H₂O** (~ 100:2)
- Concentration of **[Ta₆Br₁₂(H₂O)₆]²⁺** : 0.2-0.5 g/l
- Organic binder: **poly vinyl pyrrolidone (PVP)**
- Process: **EPD + sonication on ITO glass**
- EPD parameter: **15~30 V, 30~90 s**
- Optical property: **Transparency > 60%**, strong absorption in UV, NIR range, and visible range at 647 nm and 755 nm.

- i) **Octahedral Tantalum clusters are new promising UV-NIR blocking pigments.**
- ii) **EPD is a useful technique to fabricate homogeneous film of the Ta₆ cluster.**

Goal

Challenges for applying the film on window



- **Mechanical property?**
- **Hydrophobic surface?**
- **Thermal resistance?**
- **Oxidation stability?**



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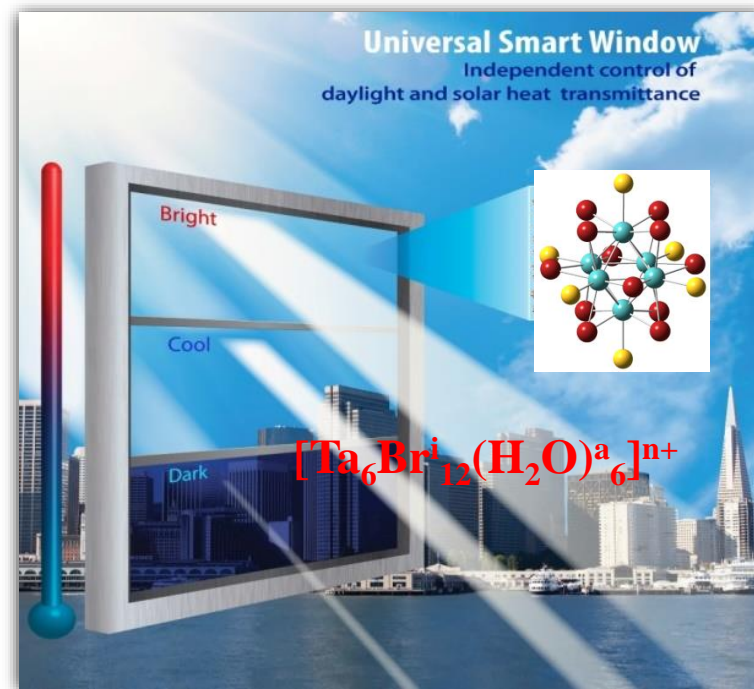
New ultra-violet and near-infrared blocking filters for saving energy applications: Fabrication of tantalum metal atom cluster-based nanocomposite thin films by electrophoretic deposition



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UV and NIR absorber film on window



<https://phys.org/news/2013-08-iq-smart-windows.html>