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TEXACOV

Cellulose nanocrystals/titanium dioxide hybrids for volatile organic compounds degradation

Gertrude Kignelman and Wim Thielemans

June 23rd, 2017

Overview

Titanium dioxide: pigment grade vs nanomaterial

Cellulose nanocrystals (CNC)

CNC/TiO₂ hybrids and photodegradation

Outlook



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200 nm

Titanium dioxide (TiO_2)

Pigment grade



*Titanium dioxide stewardship council,
About titanium dioxide*

UV absorption

Brightness

Photocatalyst



Architen Landrell, TiO_2 : Exciting new environmental fabric



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Titanium dioxide (TiO_2)

Nanomaterial

$D < 100 \text{ nm}$

High surface area

Transparency



*Titanium dioxide stewardship council,
About titanium dioxide*



<http://nutritiouslife.com/edible-sunscreen-you-need-to-know-about/>



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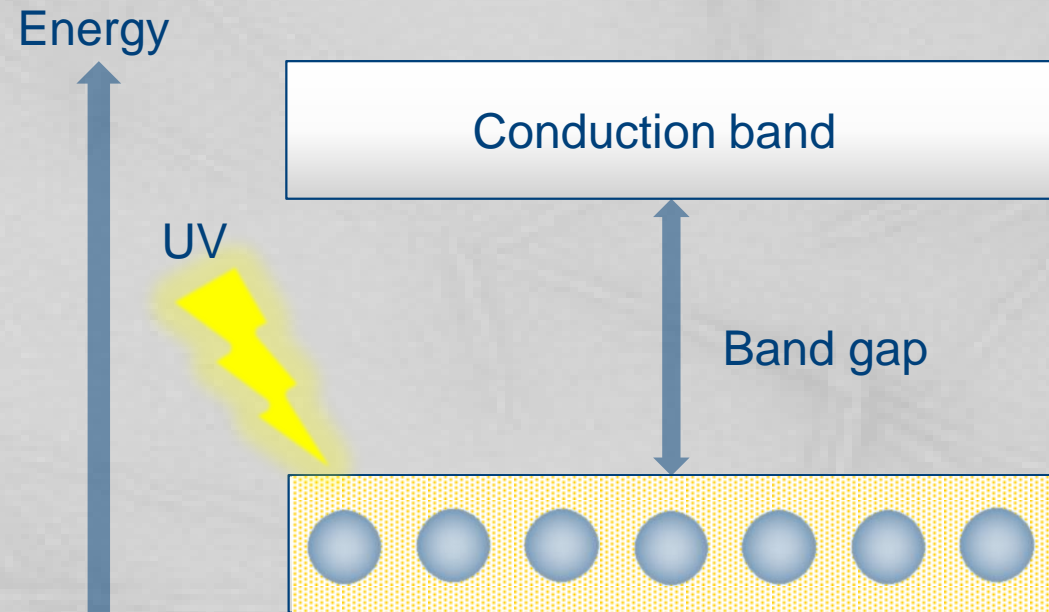
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200 nm

TiO₂ = photocatalyst



Band gap TiO₂: $\sim 3.2 \text{ eV} \cong 390 \text{ nm}$

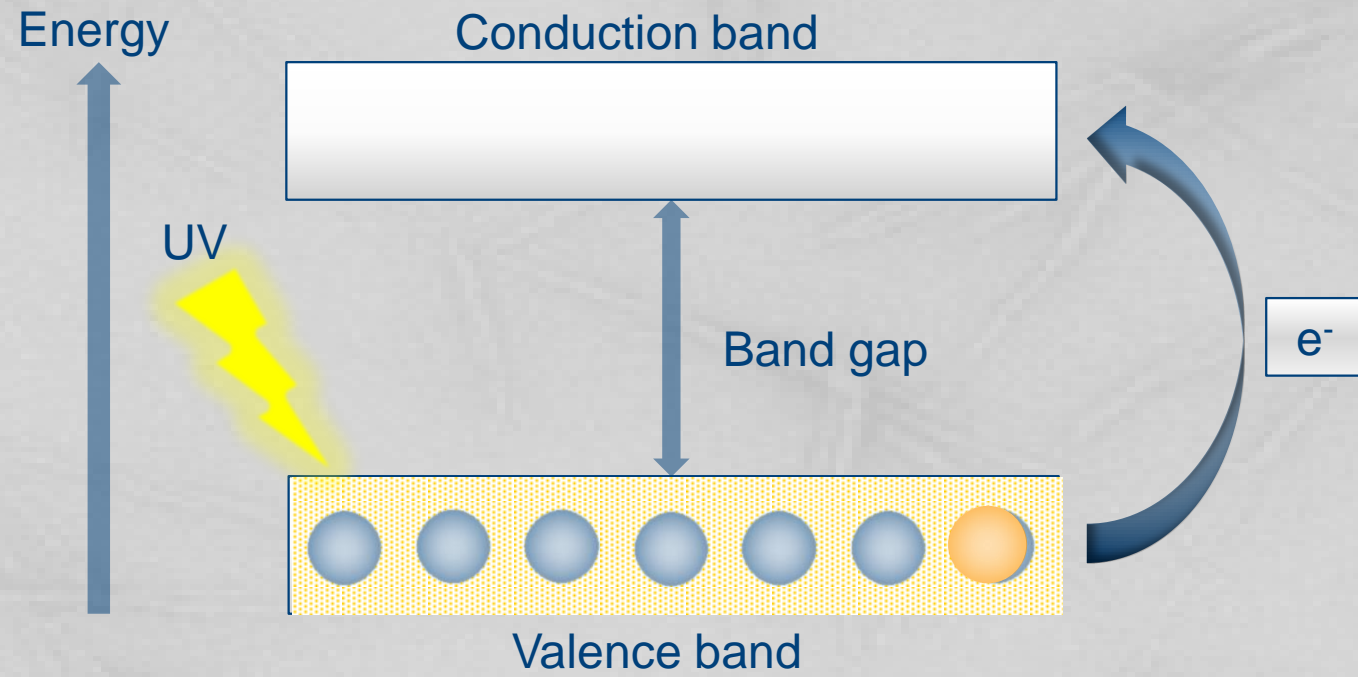


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200 nm

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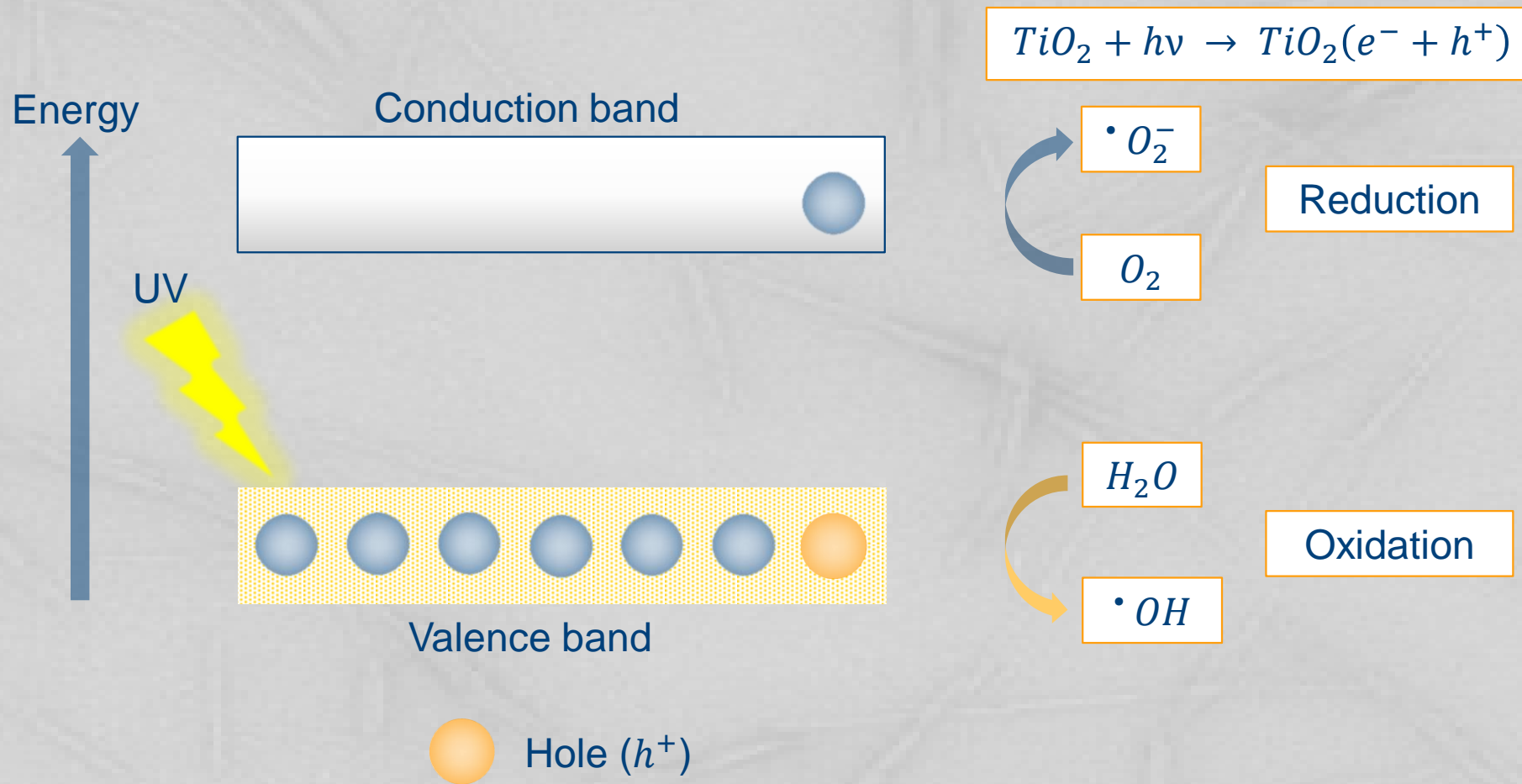


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200 nm

TiO₂ = photocatalyst

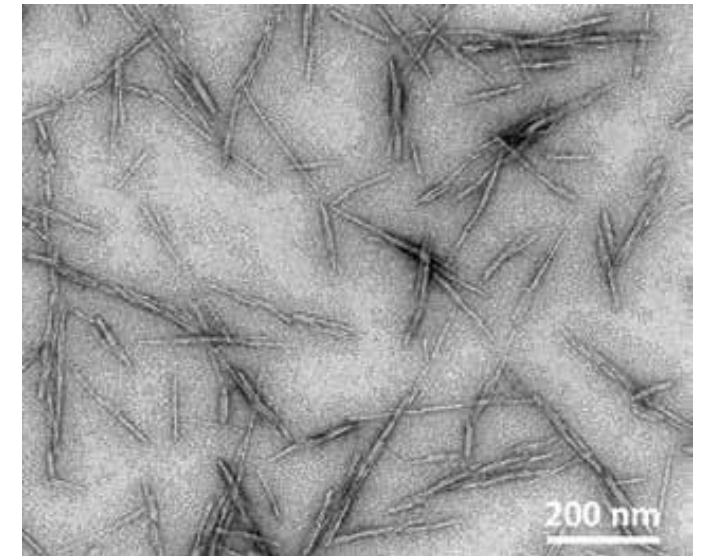
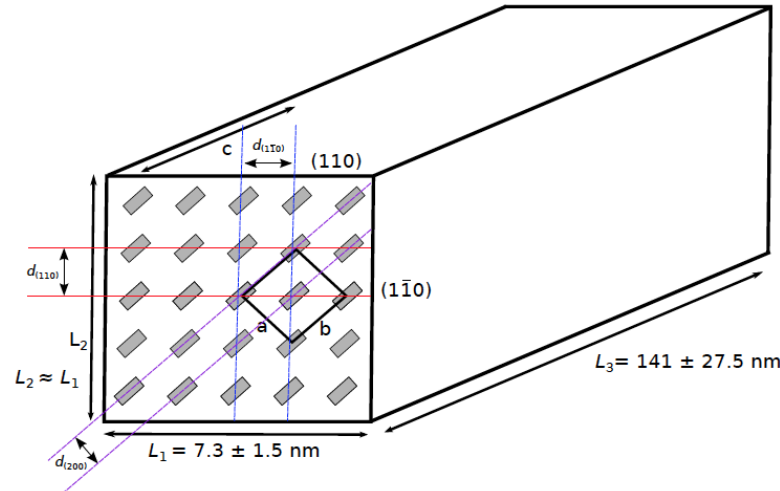
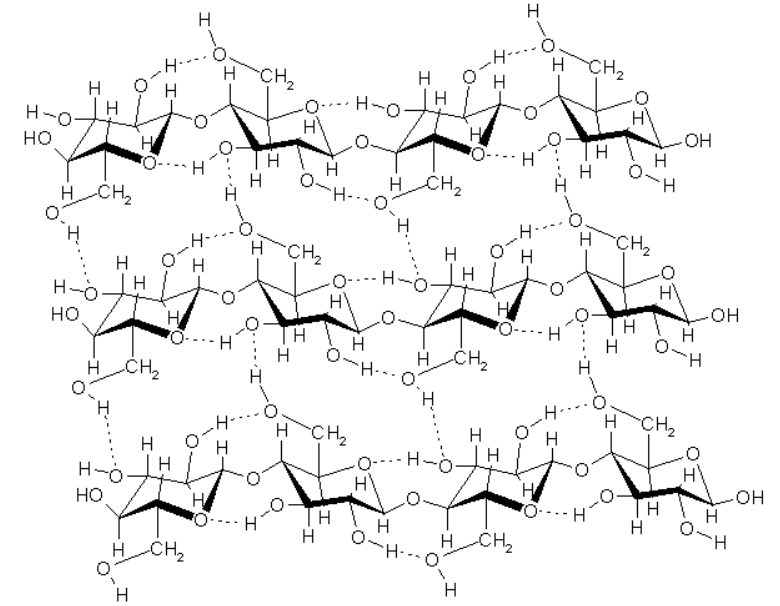
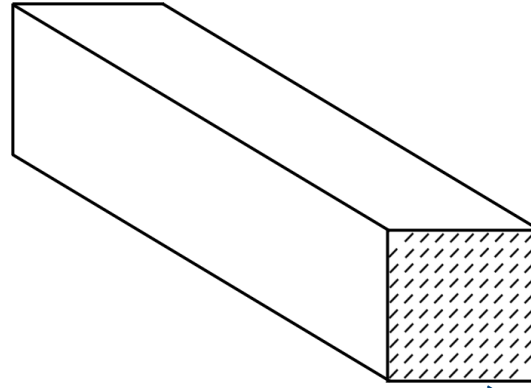


200 nm

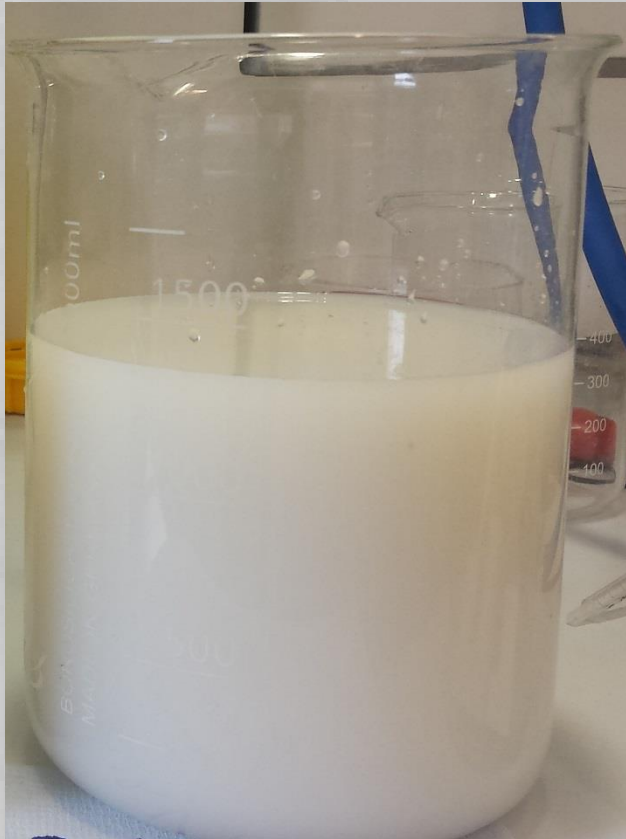
Cellulose nanocrystals (CNC)



H_2SO_4
45 °C



Cellulose nanocrystals (CNC)

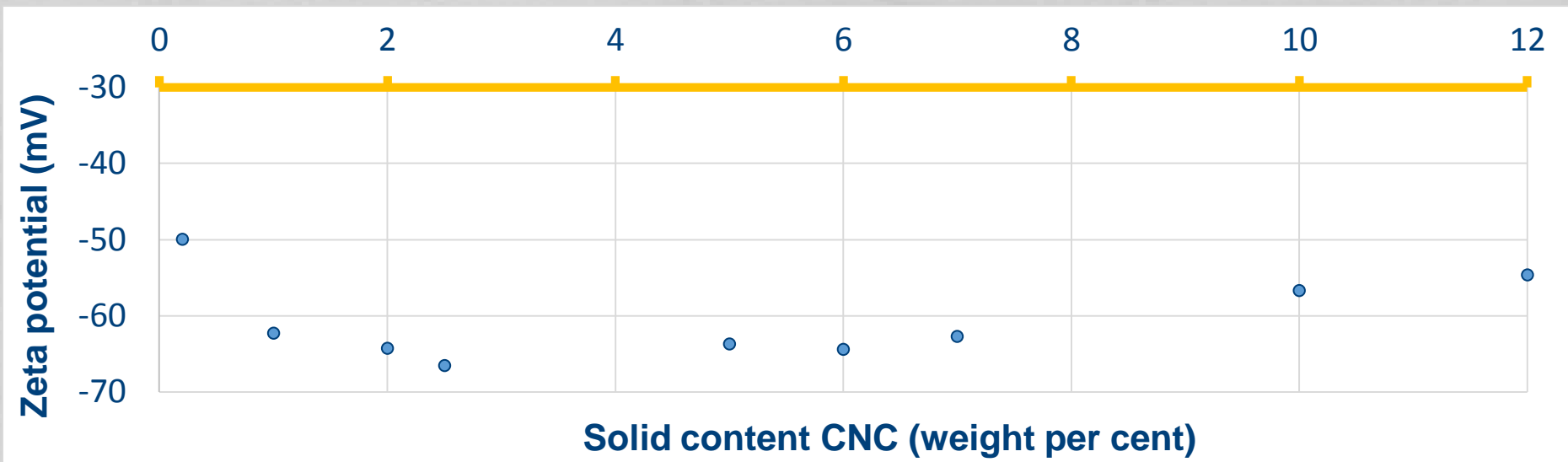
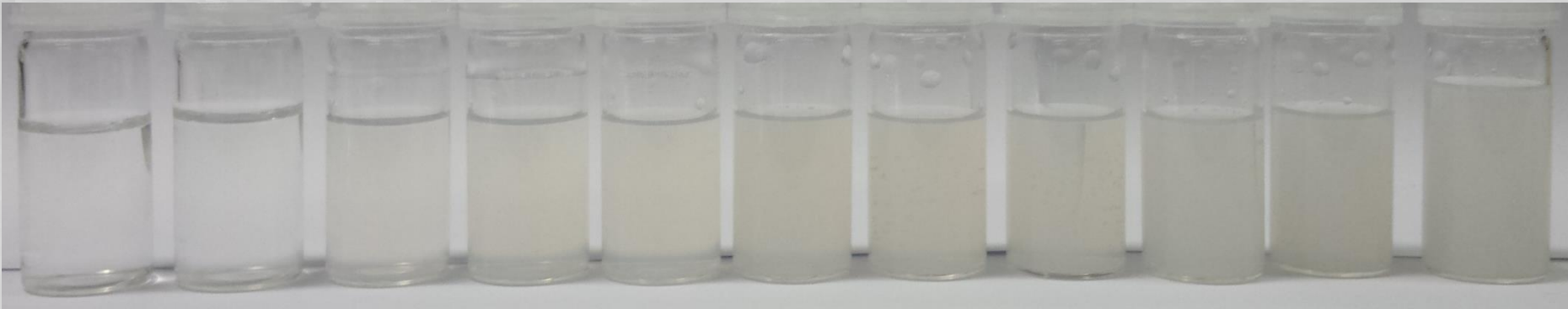


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Cellulose nanocrystals (CNC)



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CNC/TiO₂ hybrid: photodegradation of VOCs

Why ?

TiO₂: Photocatalyst

+

=

CNC: Porous scaffold



Photoactive textile



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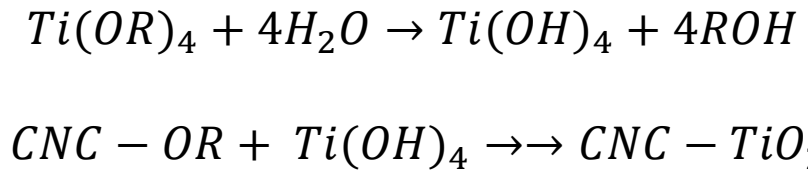
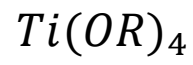
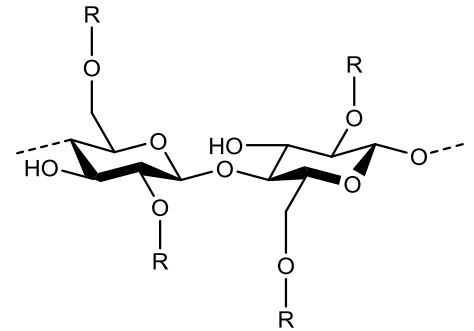
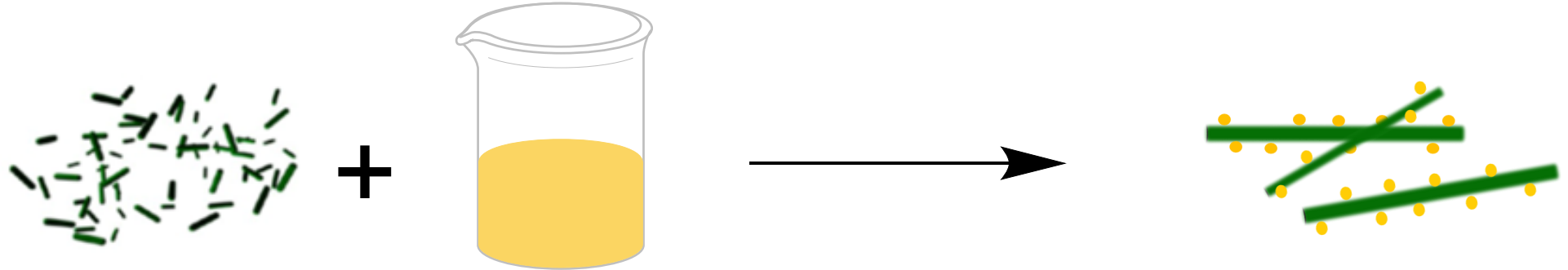
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200 nm

CNC/TiO₂ hybrid: synthesis and structure

General approach: Hydrolysis-precipitation

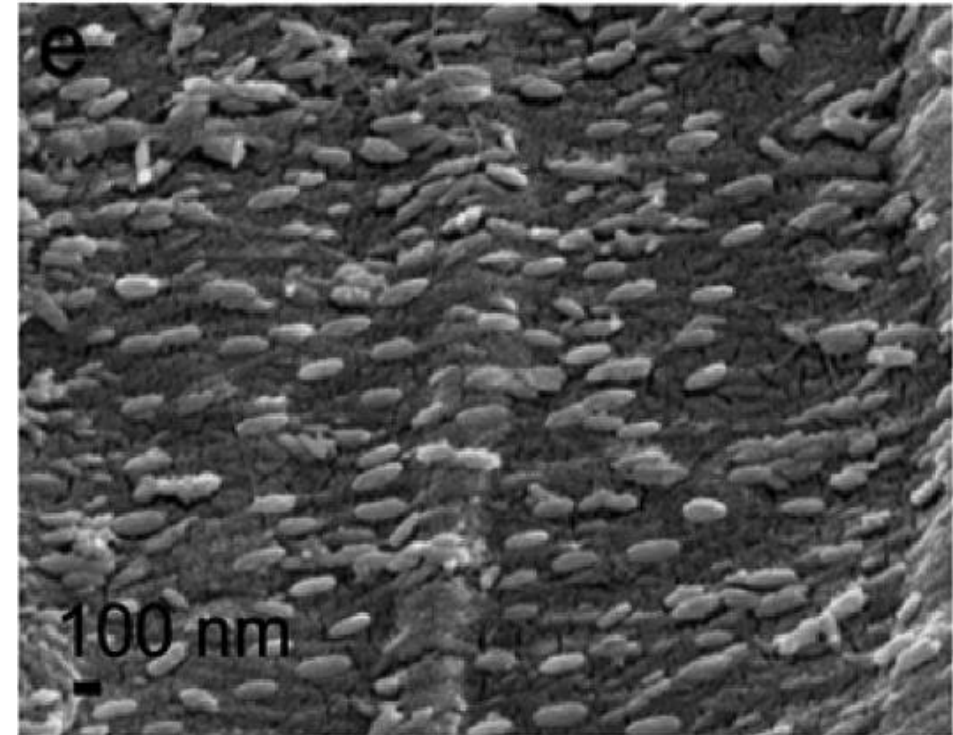
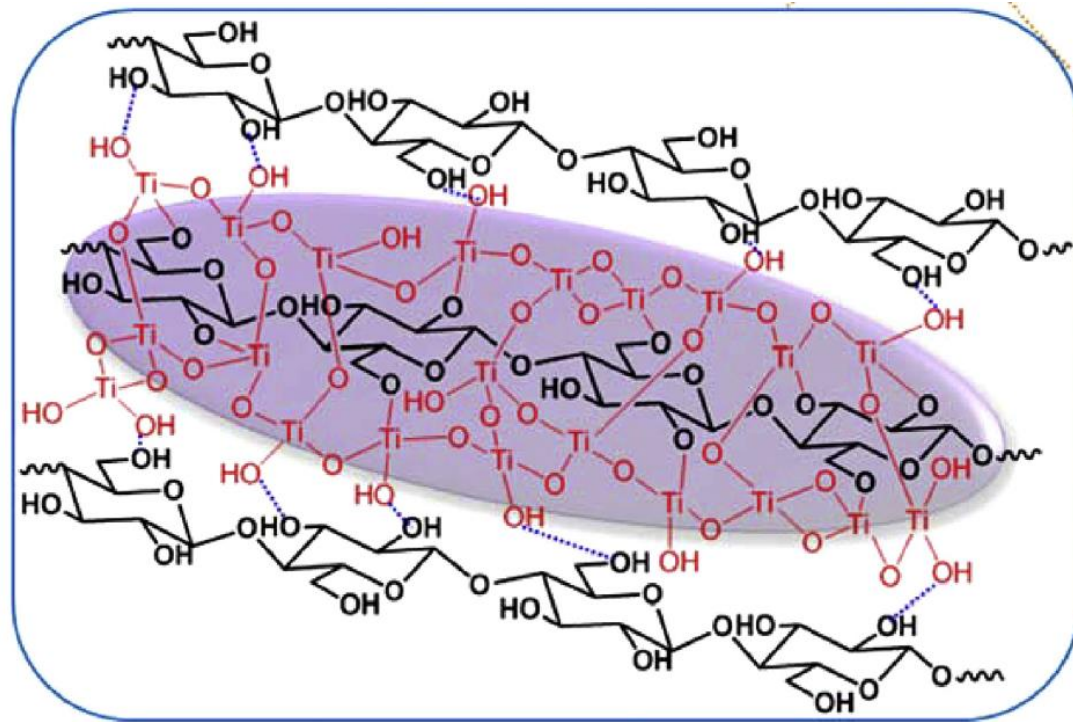


Chen X. *et al.*, Chemical Engineering Journal 295 (2016) 192–200, <http://dx.doi.org/10.1016/j.jhazmat.2015.02.051>



200 nm

CNC/TiO₂ hybrid: synthesis and structure



Li, Y. *et al.*, Journal of Hazardous Materials 289 (2015) 140–148, <http://dx.doi.org/10.1016/j.cej.2016.03.047>



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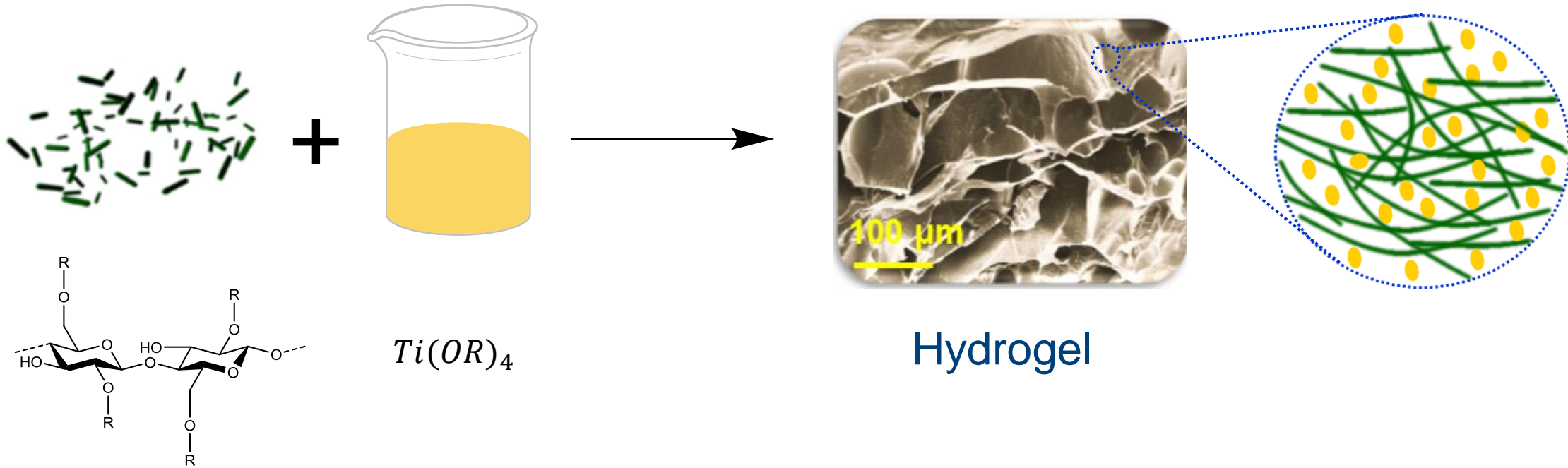
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CNC/TiO₂ hybrid: synthesis and structure

General approach: Hydrolysis-precipitation



Thomas, M. *et al.*, Journal of Photochemistry and Photobiology A: Chemistry 327 (2016) 33–43,
<http://dx.doi.org/10.1016/j.jphotochem.2016.05.005>



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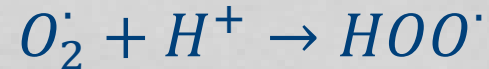
CNC/TiO₂ hybrid: photodegradation of VOCs

General mechanism: chain reaction

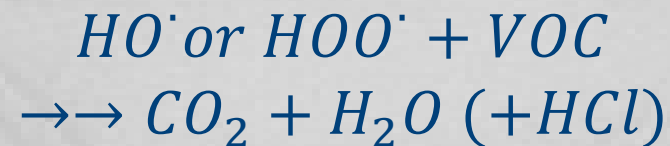
1. Initiation



2. Transfer



3. Propagation



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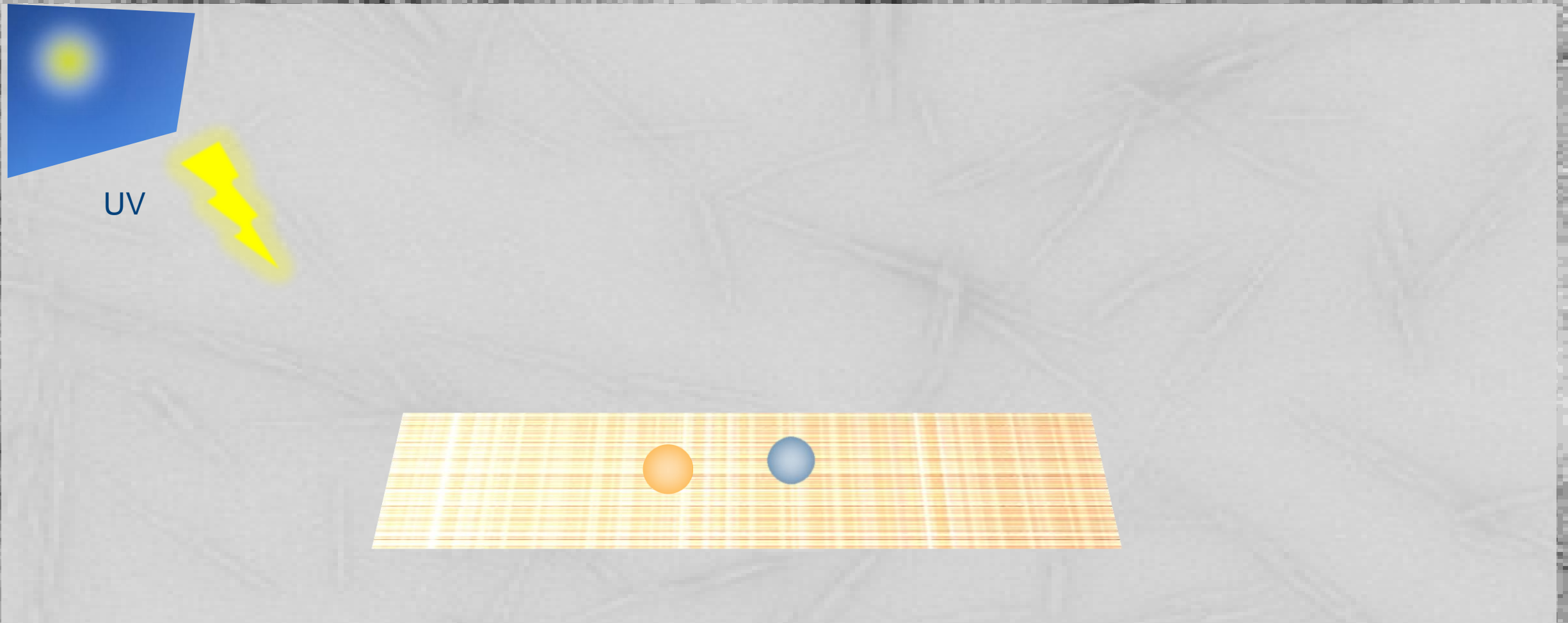
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CNC/TiO₂ hybrid: photodegradation of VOCs



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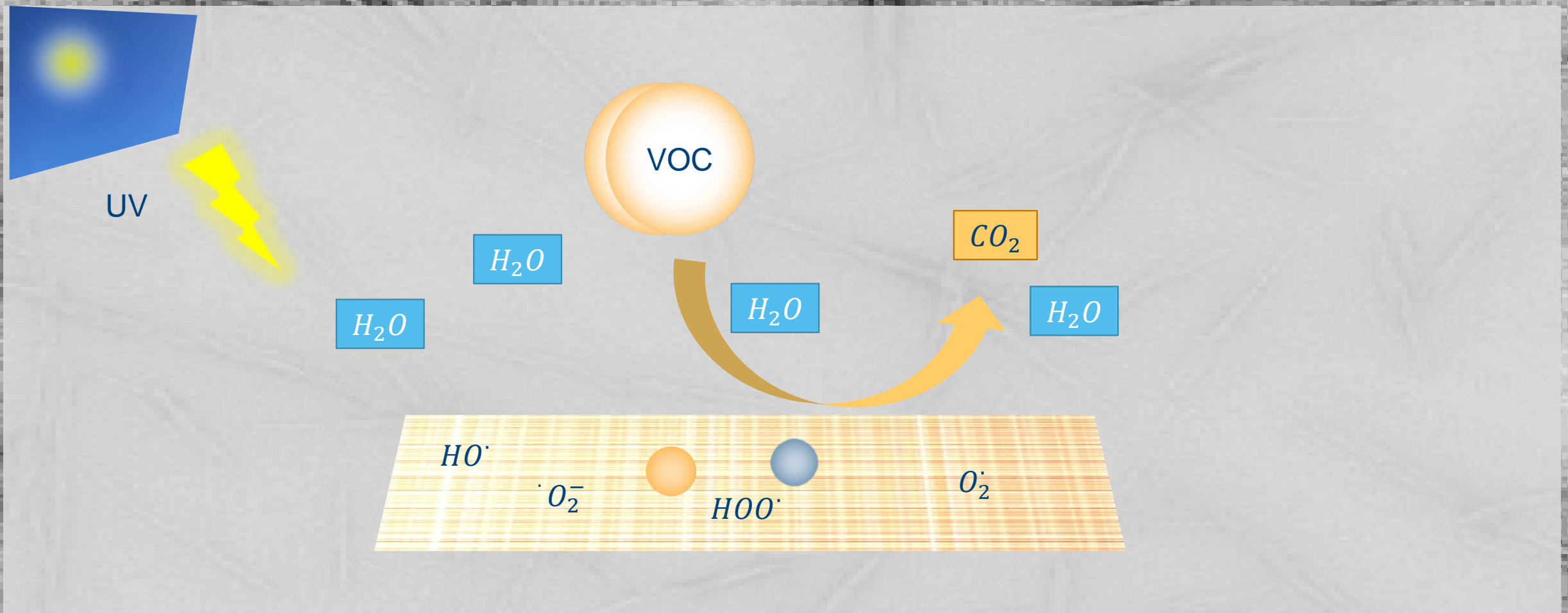
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CNC/TiO₂ hybrid: photodegradation of VOCs



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Outlook

TEXACOV project: VOC degradation using visible light

TiO₂: Photocatalyst
+
CNC: Porous scaffold

=



Photoactive textile



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Merci

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