The Optimization of TiO_2 Thin Films for Photocatalytic Water Purification

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Ksepw

Build an efficient water purification system through photocatalysis using UV light and titanium dioxide.

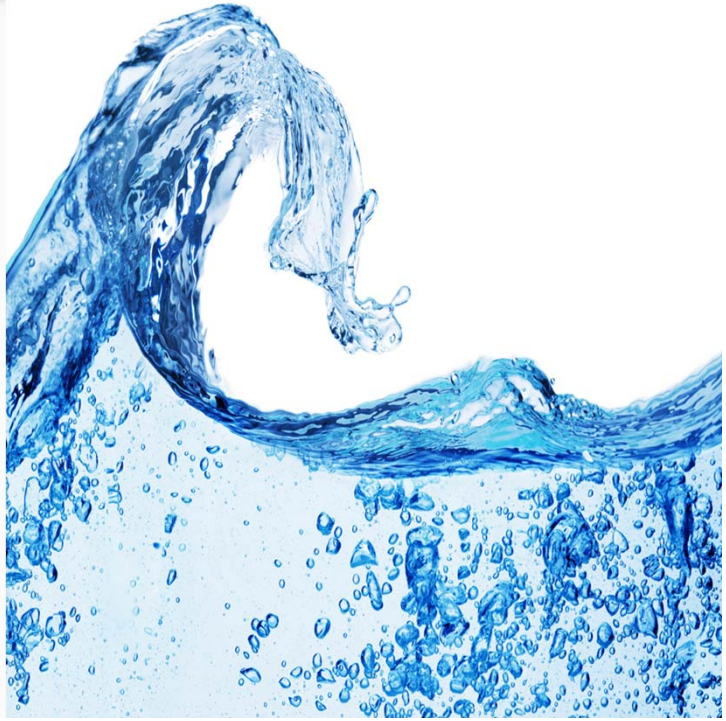
Decreasing the amount of pollutants in water supplies and having safer drinking and usable water.

Tyvtswi$

783 million people do not have access to clean water. [1]

6-8 million people die a year from water related diseases and disasters.[2]

Many water purification systems are costly and not efficient.



Tlsxsgexep}wmwC$

Catalyst: A substance that speeds up a chemical reaction

Photocatalysis: A catalytic process facilitated by light

Tlsx sgexep}xmg$Tvsgiww$jsv$[exiv$Tyvmjmgexmsr

Xli$Ferh$Ket

Two energy bands in TiO2

Valence band (V_b)- holds outer electrons

Conduction band (C_b)- The band that accepts the electrons from V_b. When electrons move to C_b, they become mobile and transport charge[3, 4]

Xli$Ferh$Ket$gsrxmryih22

Electron can be raised from V_b to C_b[3, 4]

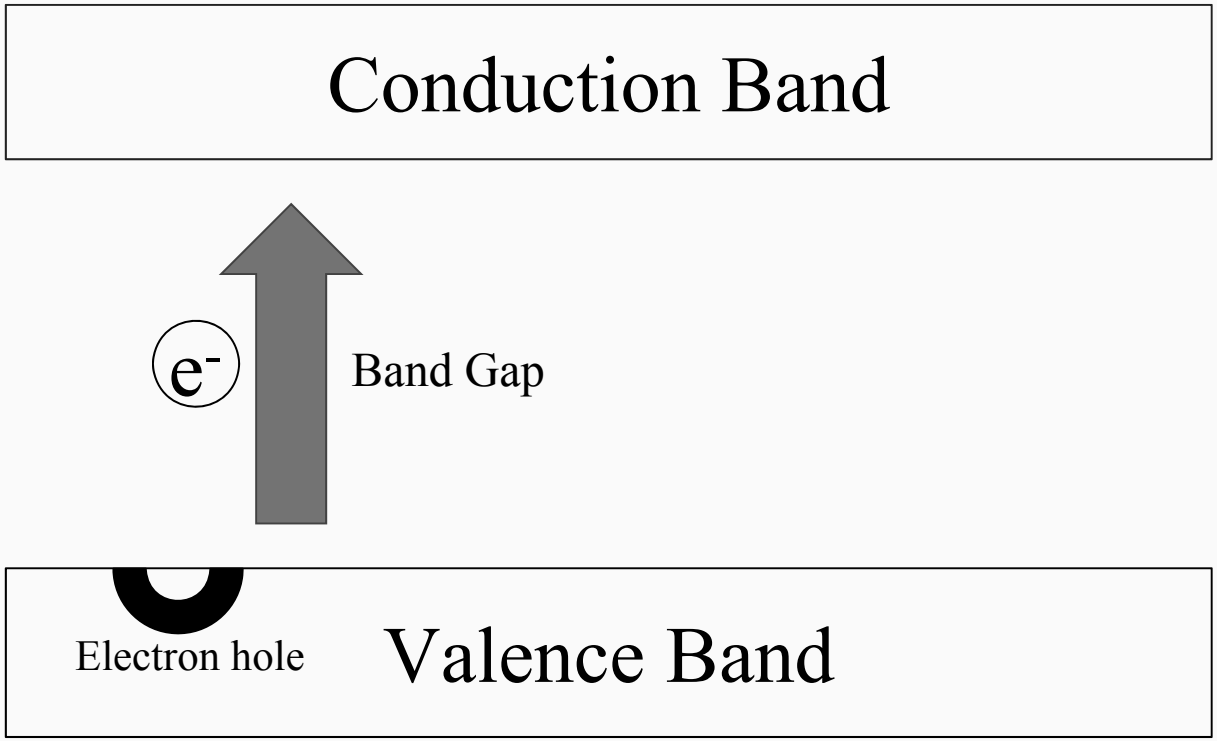
Has become excited

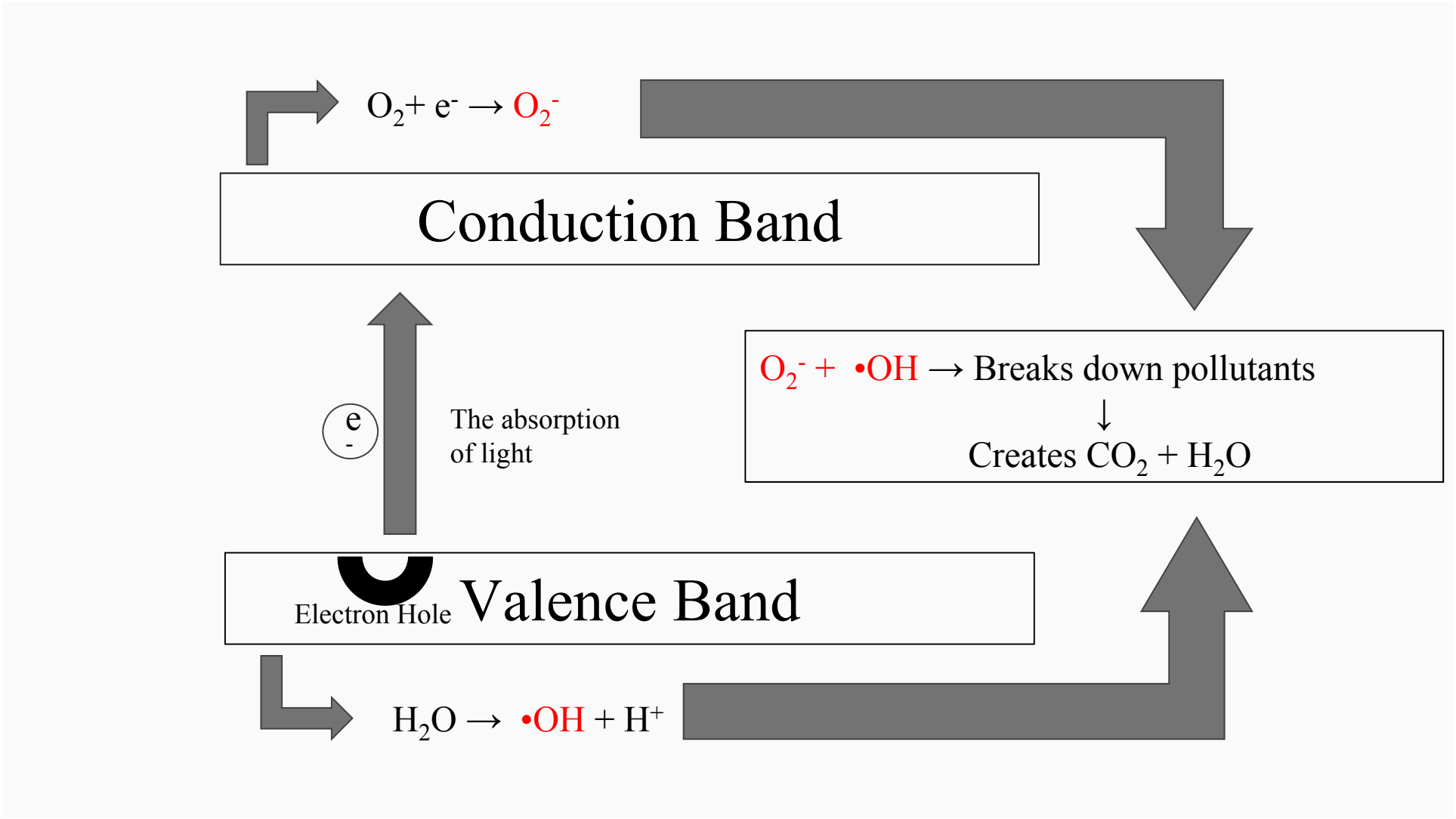
C_b will have a negative charge due to gaining of electron

V_b will have a positive charge in the form of an electron hole

Electron holes facilitate the oxidation of a pollutant

Oxidation purifies the water


Conduction Band
e-
Band Gap
Electron hole
Valence Band


$O_2 + e^- \rightarrow O_2^-$
Conduction Band
$O_2^- + \bullet OH \rightarrow$ Breaks down pollutants
↓
Creates $CO_2 + H_2O$
e -
The absorption of light
Electron Hole
Valence Band
$H_2O \rightarrow \bullet OH + H^+$

[l}$Xmxermyq $Hns|mmiC$

A semiconductor

Harmless to the environment and human/animal population[3]

Cost effective and easily attainable[3]

Synthesis Procedure

- Sol-Gel coating precursors
  - Titanium Tetraisopropoxide (TTIP)
  - Acetylacetone (ACAC)
  - Ethanol Alcohol (EtOH)
- The catalyst
  - Titanium dioxide (TiO_2)- formed after calcining

The sol-gel before TiO2 is added

XliWspKip$W}rxliwmw$Tvsgiww$

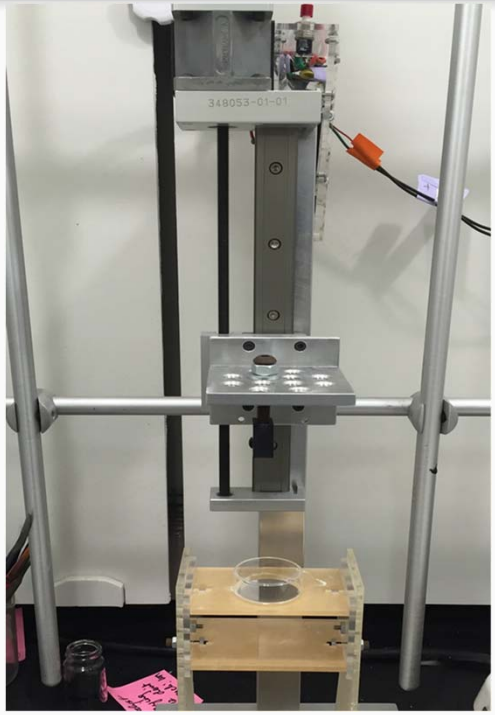
Magnetically stir the TTIP, ACAC, EtOH together to thoroughly combine each precursor

Add TiO_2 particles to the sol-gel

Clean quartz slide substrates

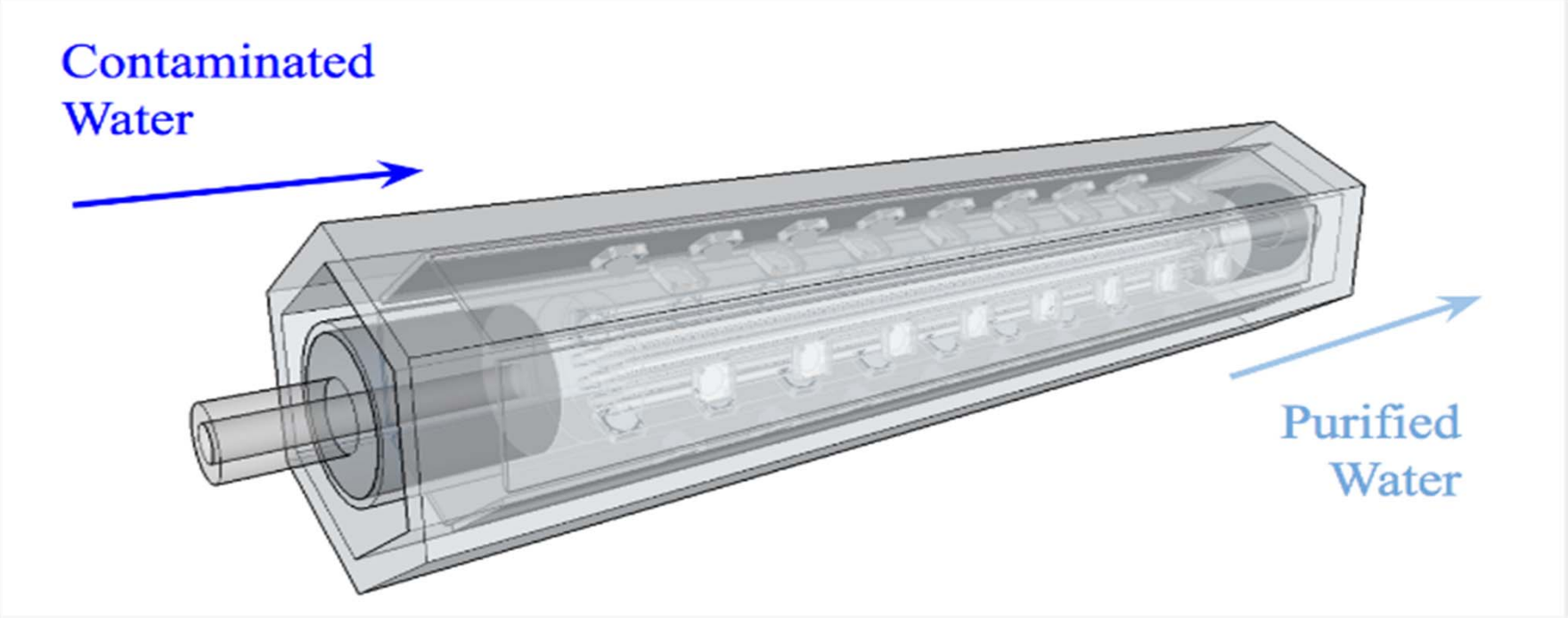
Dip each slide in the sol-gel solution

Dry slides



[l}$WspKip$Hmt$GsexC$

Build a reactor with dip-coated rods and UV-lights for photocatalytic reaction to take place in and degrade the contaminants inside the water.[5]



Viwievgl$Uyiwxmsr$

How does the thickness of the sol-gel coating affect photocatalytic ability?

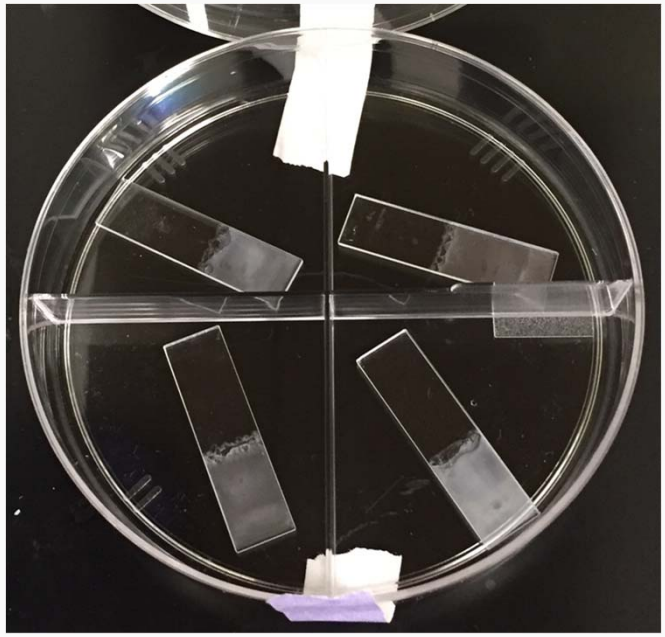
XvhprhErpjwmw$

Manipulated variable: Coating thickness

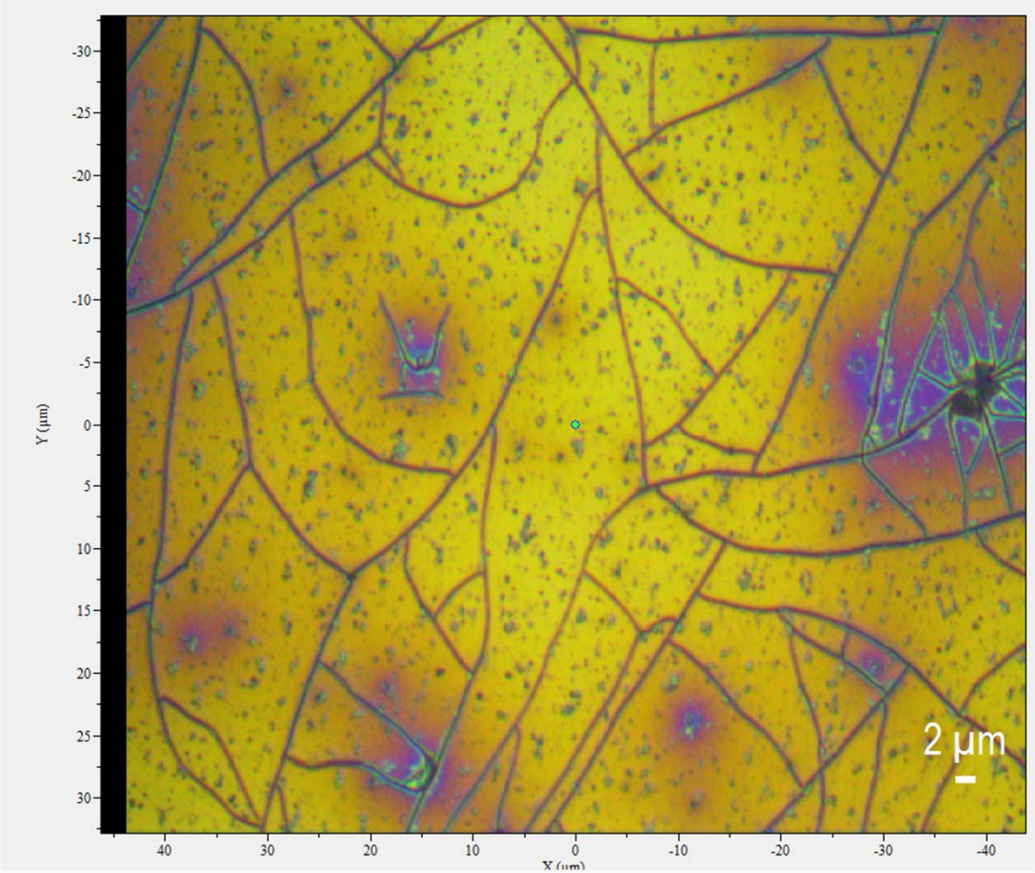
2, 4, 6, 8 dip trials in TiO_2 sol-gel

Raman spectroscopy imaging

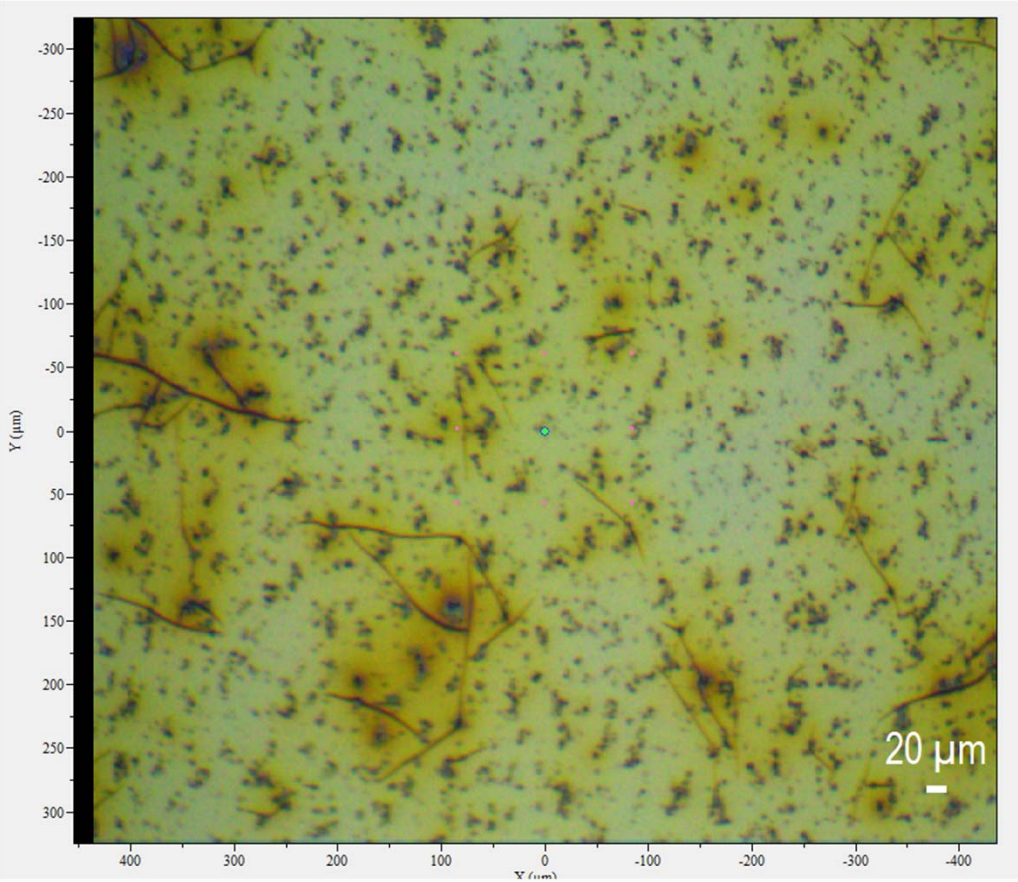
UV-Vis Methylene blue degradations



Viwypxw>$Veq er$Wtigxvswgst}$Mq ekiw



2 dips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Y (µm)
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-100
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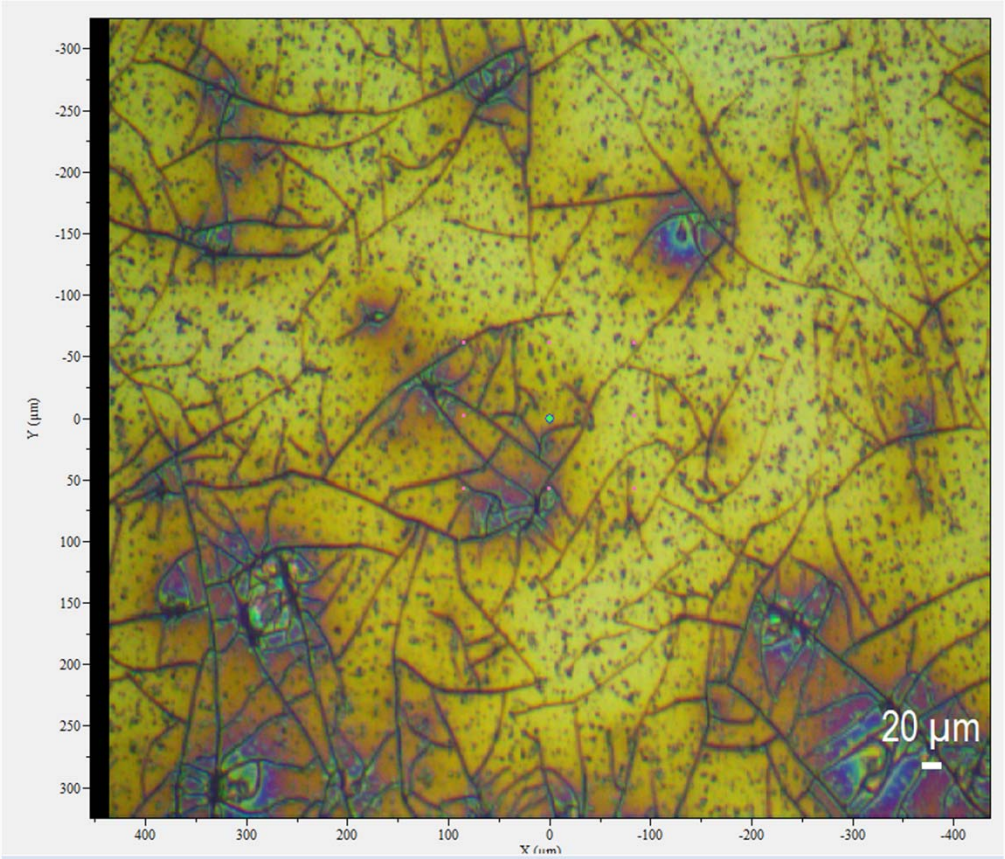
-300
-400
20 µm

4 dips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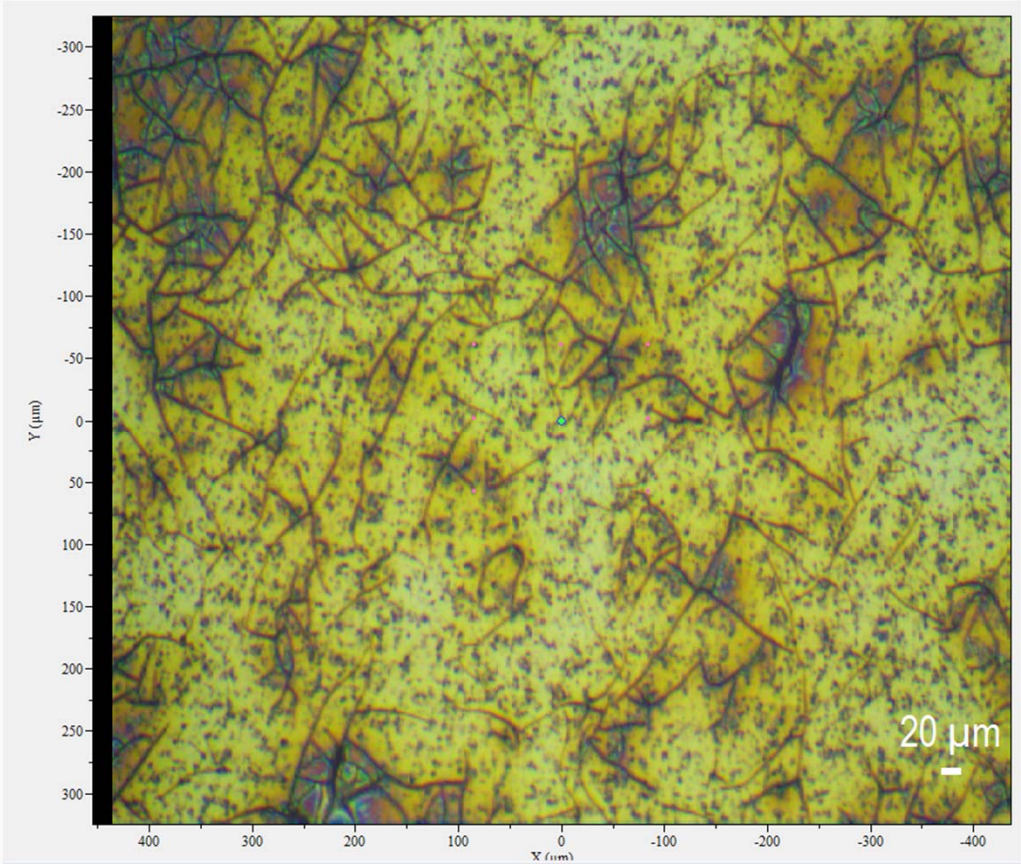
-100
-200
-300
-400
20 µm

6 dips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100
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Y (µm)
400
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100
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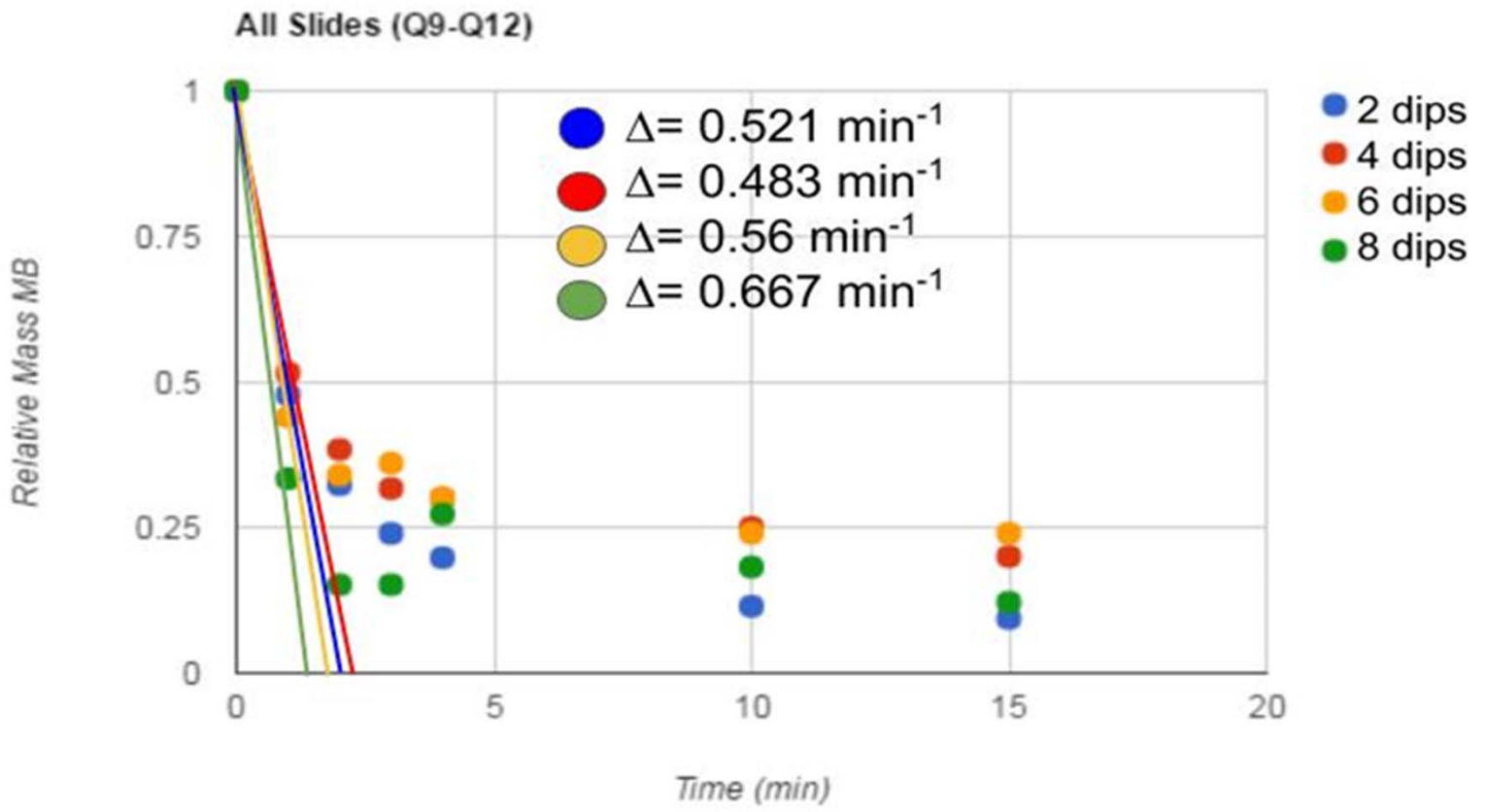
-100
-200
-300
-400
20 µm

8 dips

Q ixl}piri$Fpyi$YZ1Zmw$Hikvehexmsrw$



Hmwgywwmsr$

All slides has some form of cracking and spotting

Drying the slides in a vacuum oven reduced, but did not eliminate, cracking

P25 particles are clearly visible on all slides

The 8 dip slide degraded the most pollutant during the first minute

Gsrgpywmsr

No certain thickness of coating prevents cracking on the surface of slide.

The thicker the sol-gel coating on the slide, the better its degradation ability on a pollutant.

Jyxyvi$Ksepw$

Dip coat quartz rods in the optimal sol-gel solution, for a photocatalytic reactor

Run degradation trials within the reactor

Egors{ pihkq irxw$

Thank you to:
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Dr. Jun Jiao
Simon Fowler
Ryan Catabay

Vijivirgiw$

[1] "Facts About Water & Sanitation." *Www.water.org*. Water.org, 2015. Web. 7 Aug. 2016.

[2] "Facts and Figures." *2013*. UN Water, 2013. Web. 07 Aug. 2016.

[3] Hashimoto, Kazuhito, Hiroshi Irie, and Akira Fujishima. "TiO2 photocatalysis: a historical overview and future prospects."*Japanese journal of applied physics*44.12R (2005): 8269.

[4] Lee, Seul-Yi. "TiO2 Photocatalyst for Water Treatment Applications." *TiO2 Photocatalyst for Water Treatment Applications*. ScienceDirect, 16 July 2013. Web. 07 July 2016.

[5] S. Fowler, R. Catabay, and J. Jiao. Optimization of Photocatalytic Films for Water Purification. [2015].