Characterizing the time-dependent photocurrent of dye-sensitized solar cells

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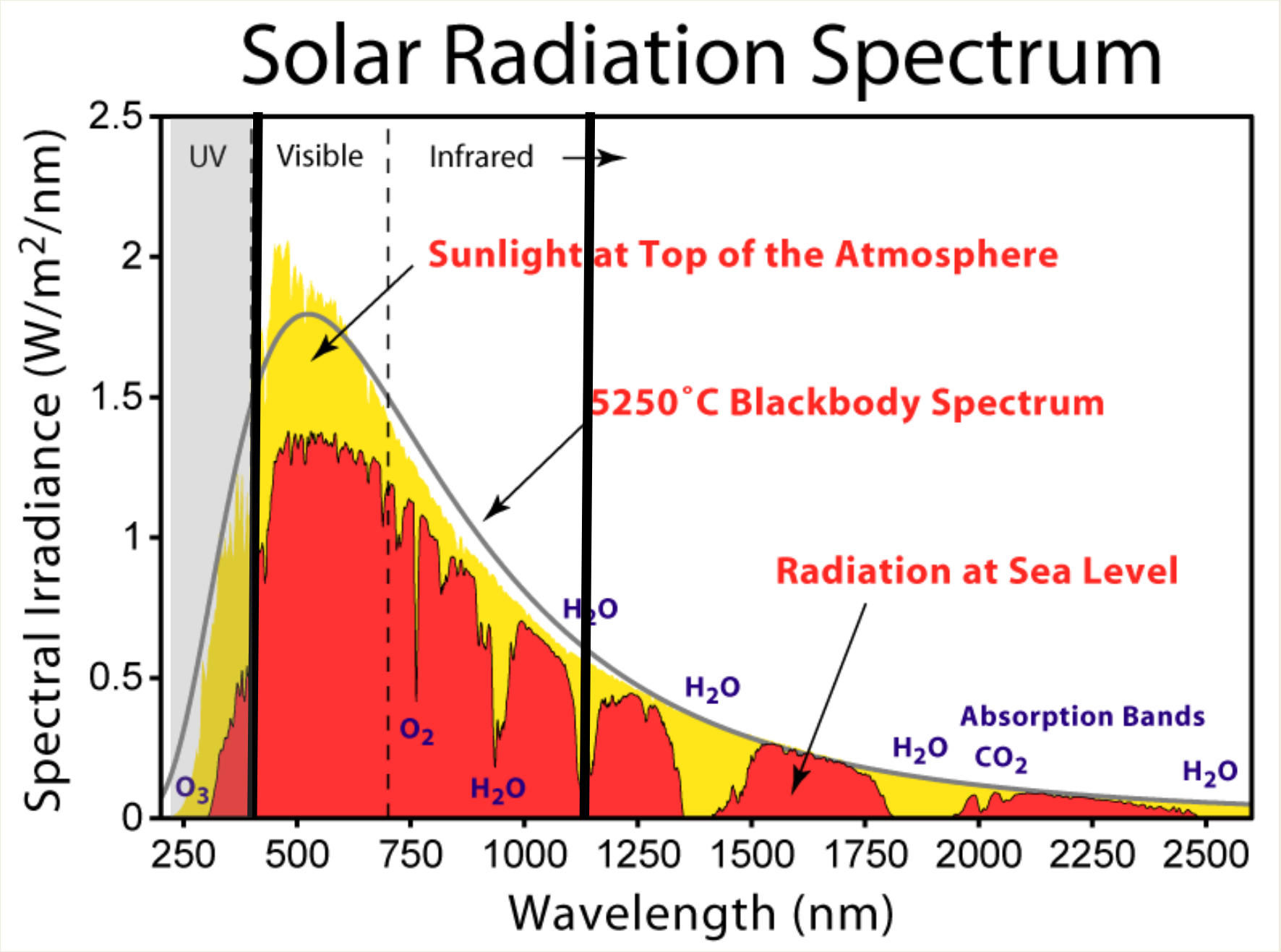
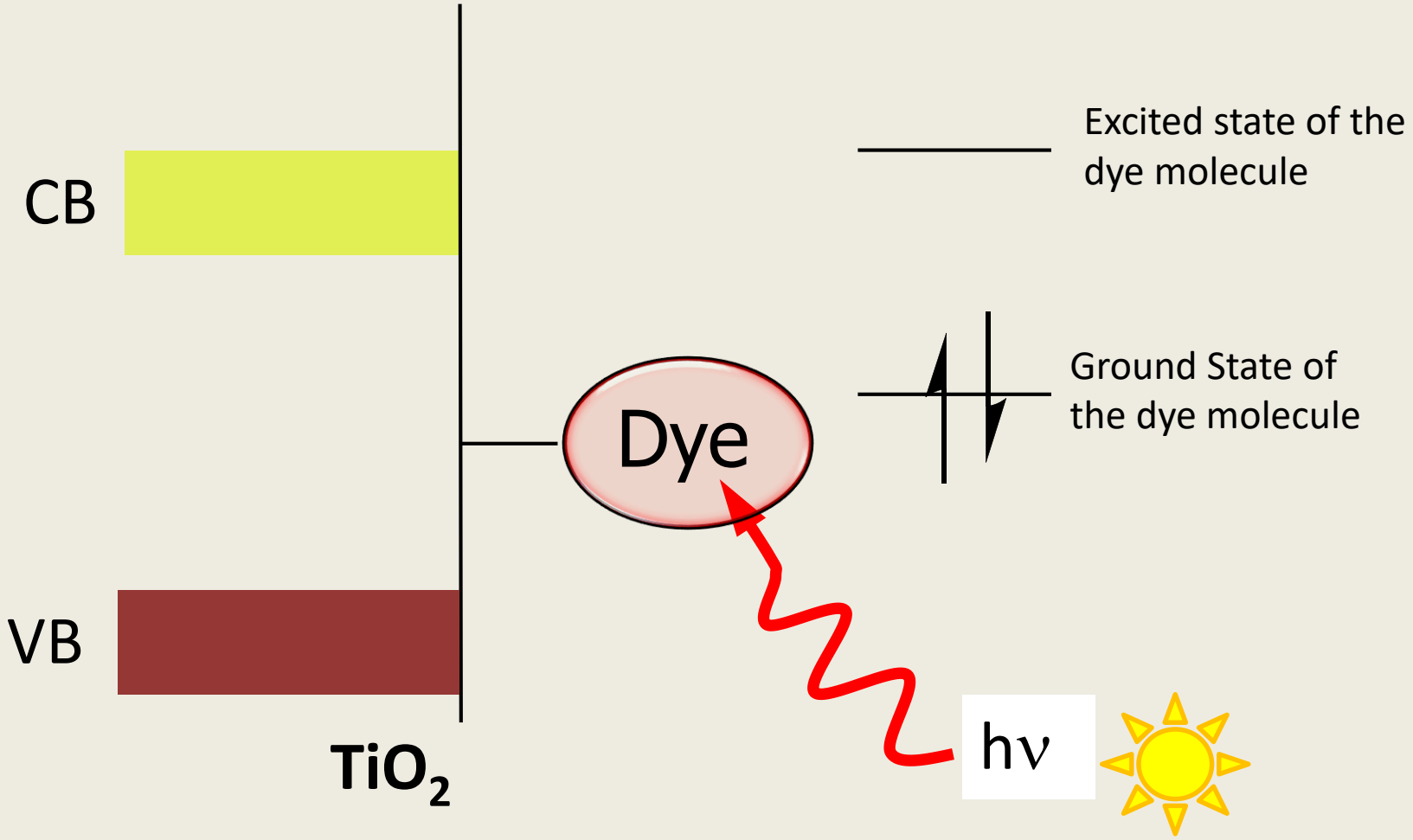
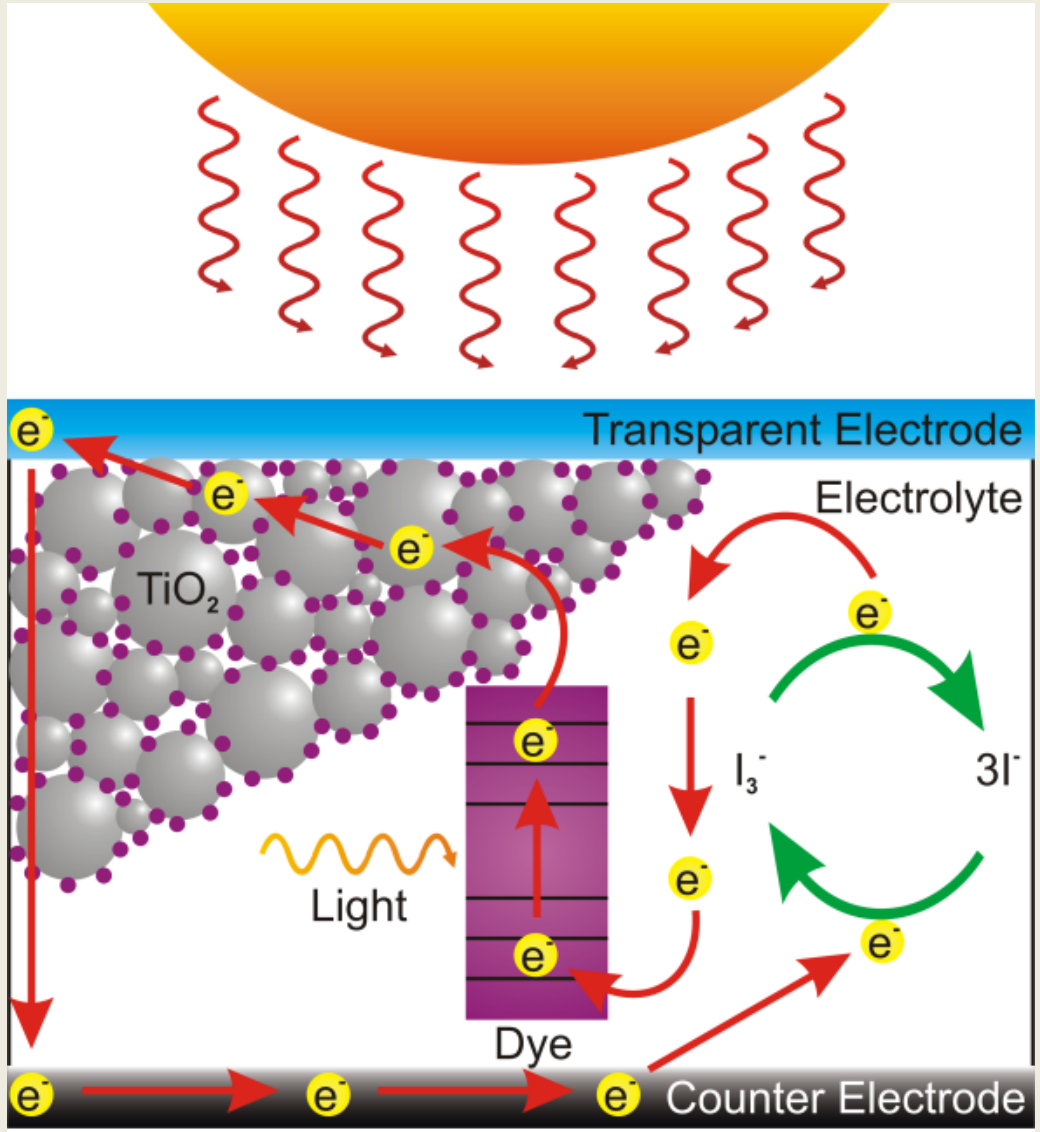


https://en.wikipedia.org/wiki/Sunlight#/media/File:Solar_spectrum_en.svg

Absorbing into the red: Sensitization



A complete Dye-sensitize solar cell

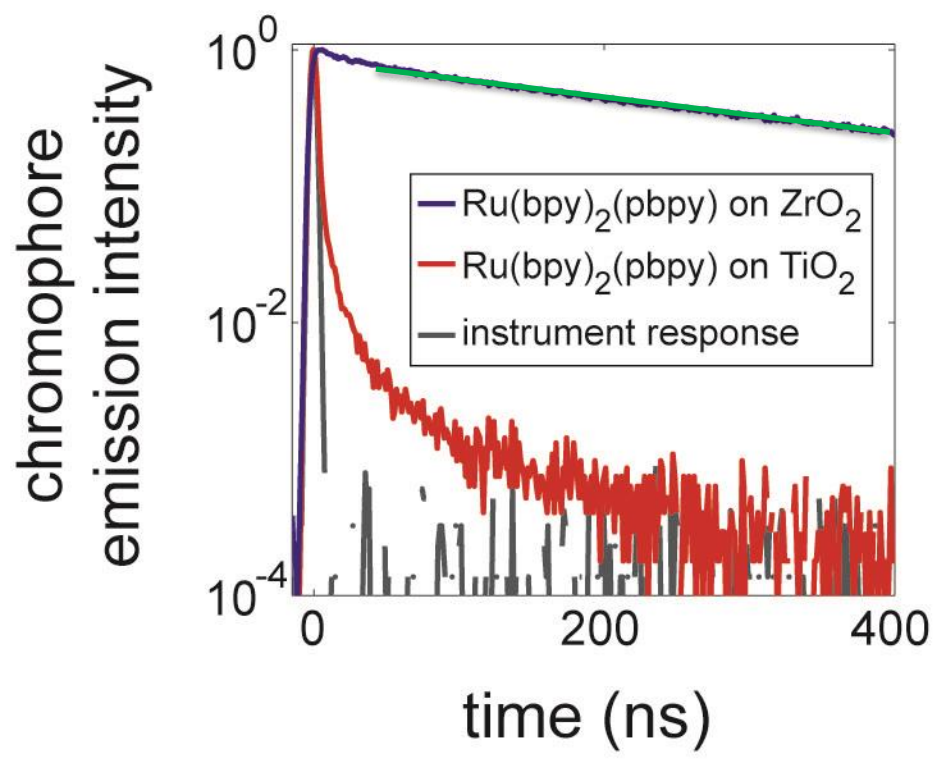


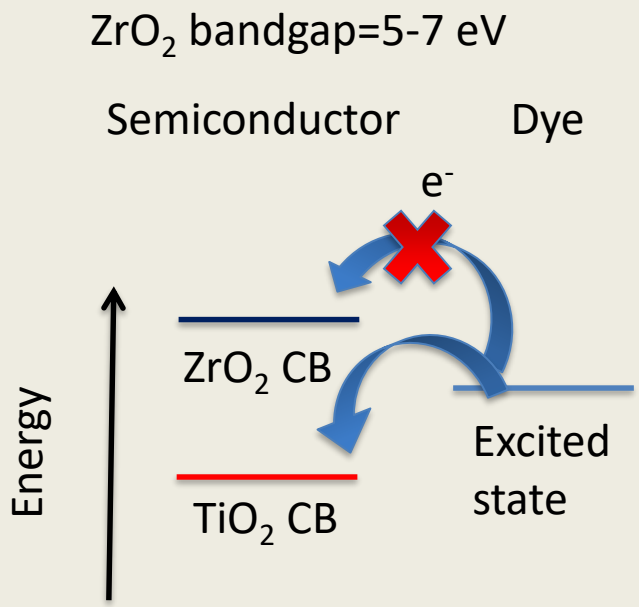
Problem: A monolayer of dye of a smooth surface does not absorb much light!

Porous nanoparticle network increases surface area!

https://commons.wikimedia.org/wiki/File:Dye_Sensitized_Solar_Cell_Scheme.png

Time-resolved emission of RuP on nanocrystalline TiO_2 and ZrO_2 films in pH 1 aqueous solution



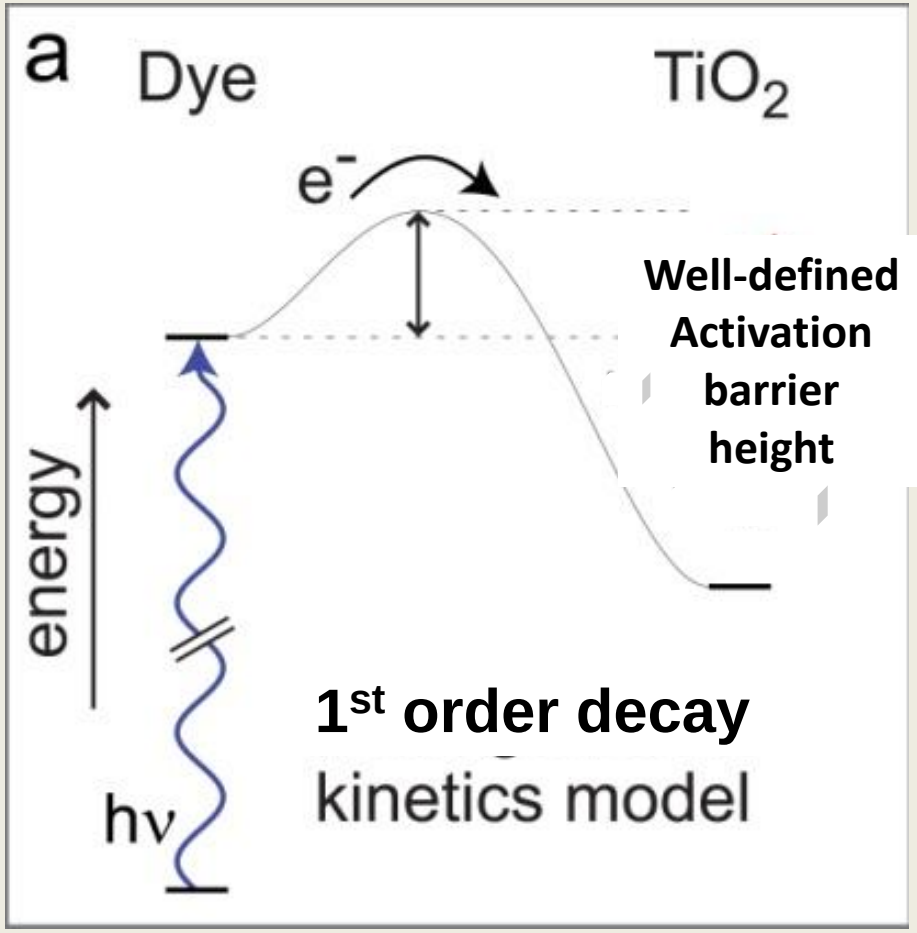


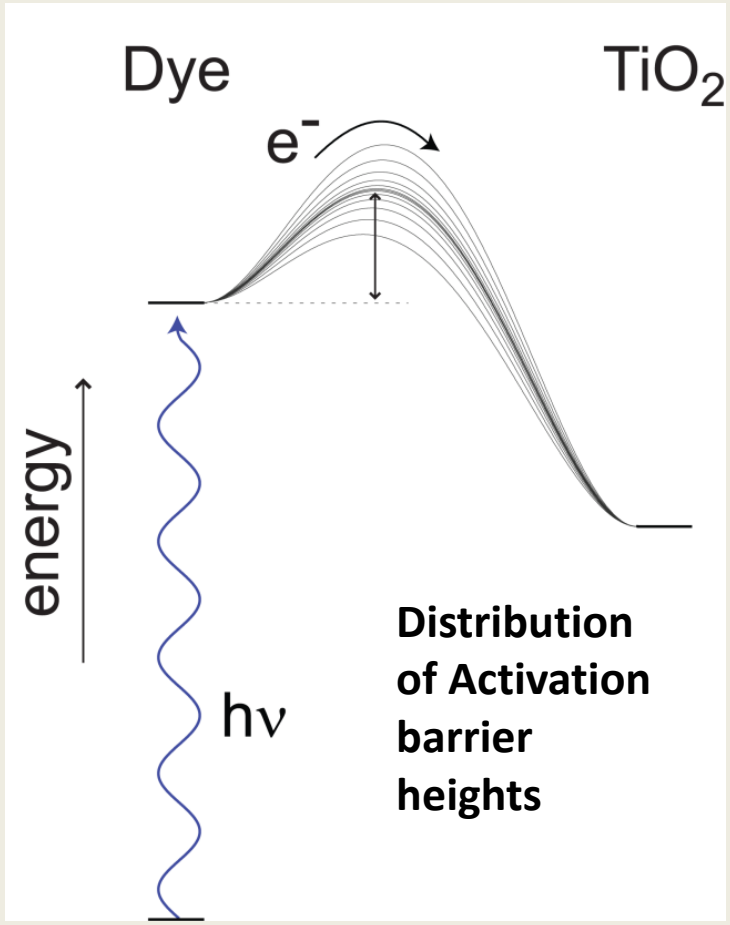
J. Phys. Chem. C 2012, 116, 30, 15888-15899

$$\ln[Ru^*] = -kt + \ln[Ru^*]_0$$

Dispersive kinetics: Moving from the ideal to the real

Dispersive Kinetic Model





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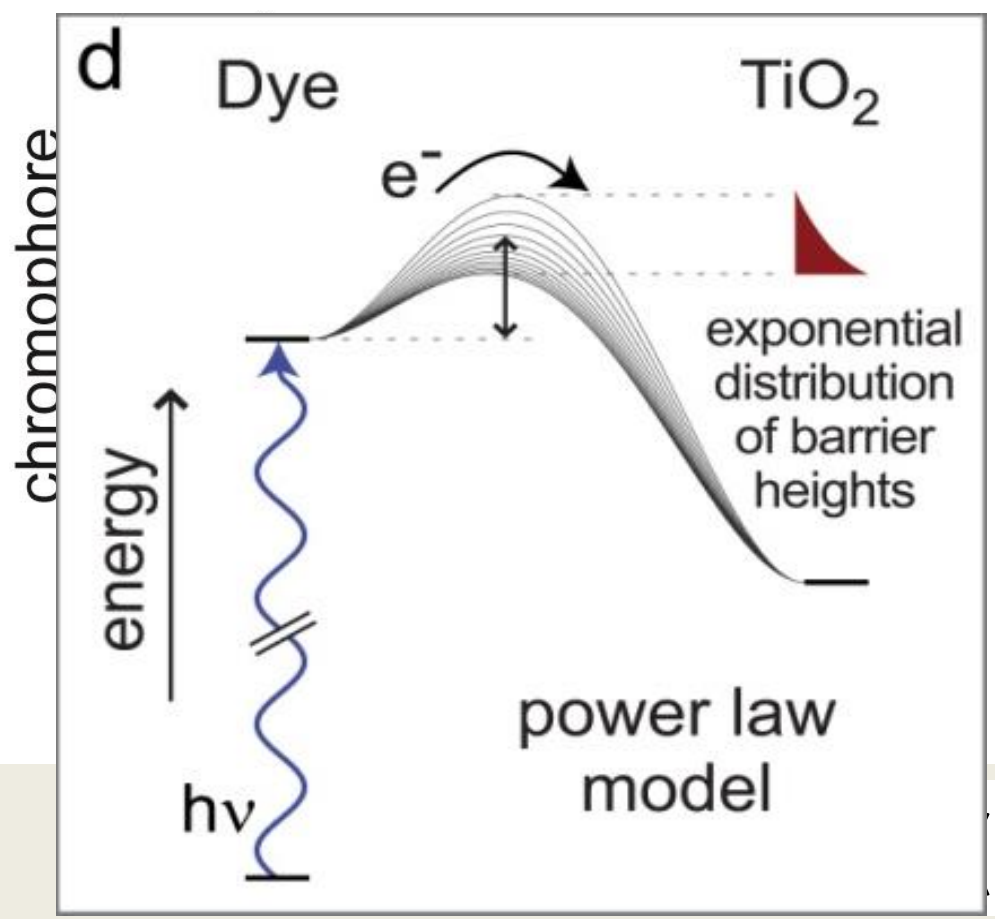
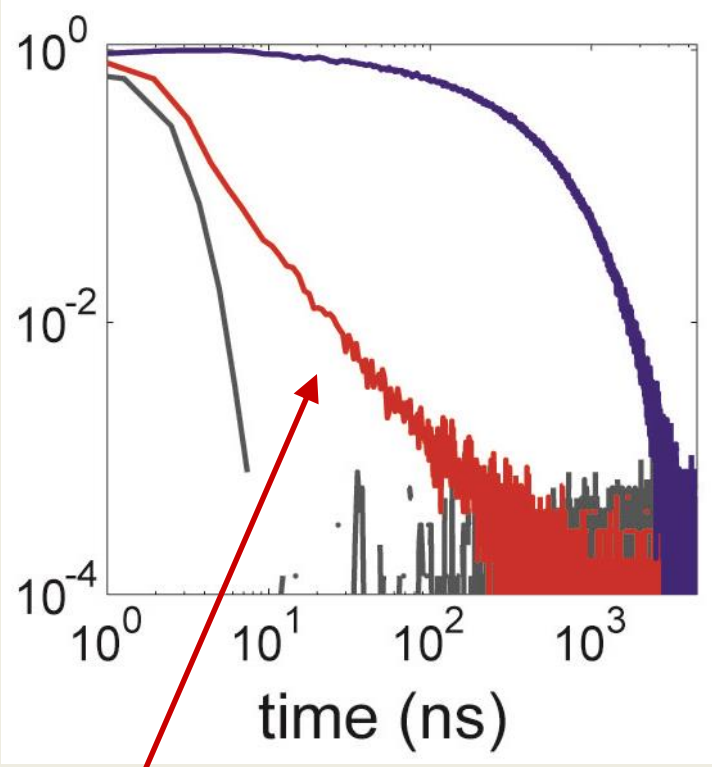
The photoluminescence decay of RuP on TiO_2 in pH 1 exhibits power law decay!





$(k_0 t)^{-1/\gamma}$

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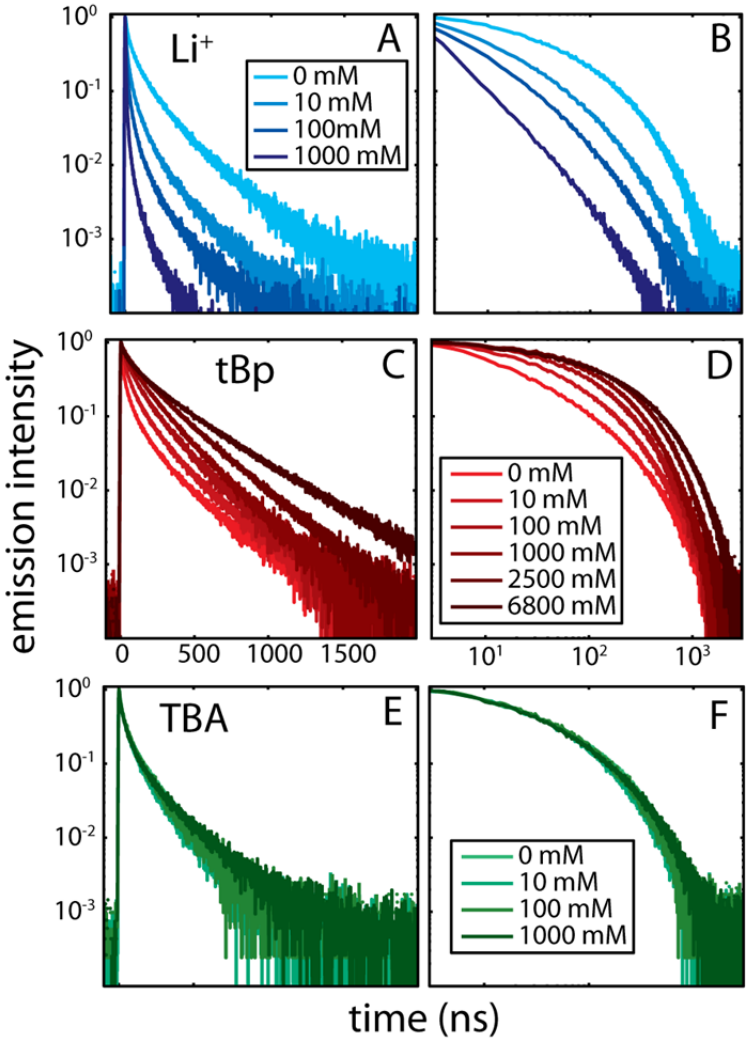
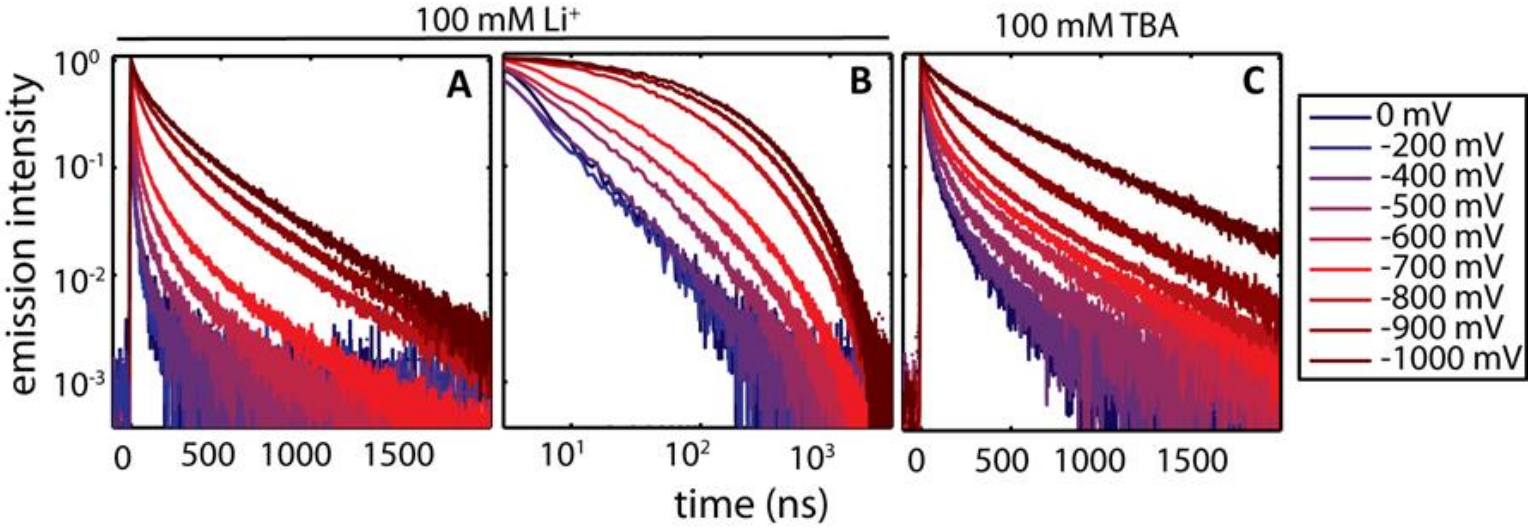
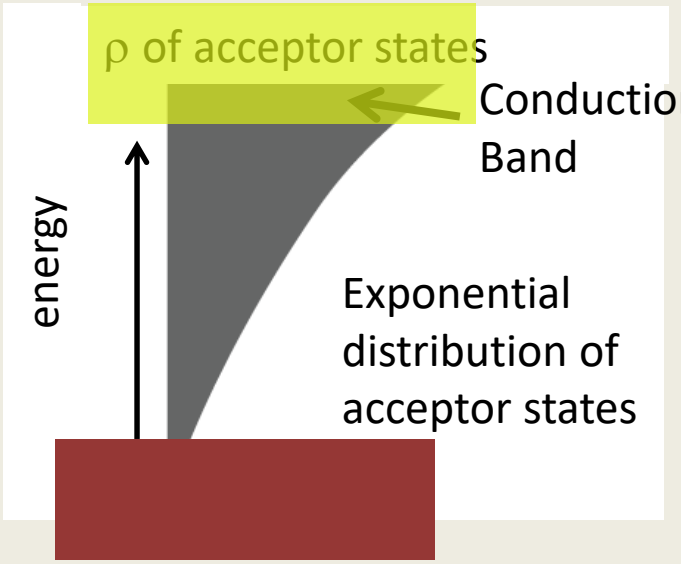
Chemical additives and electric potential can shift emission characteristics

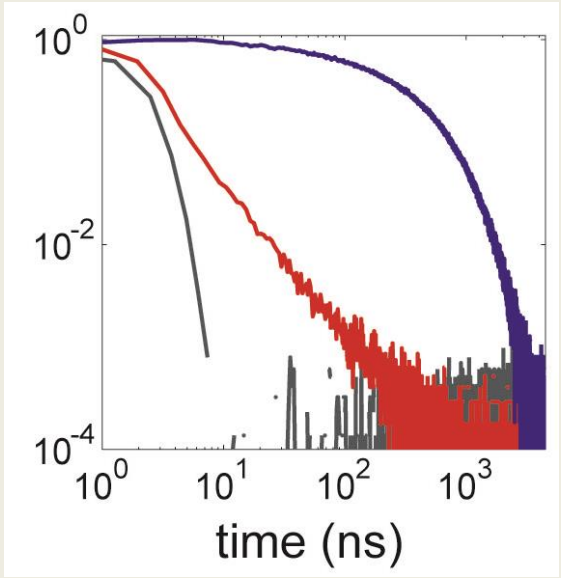




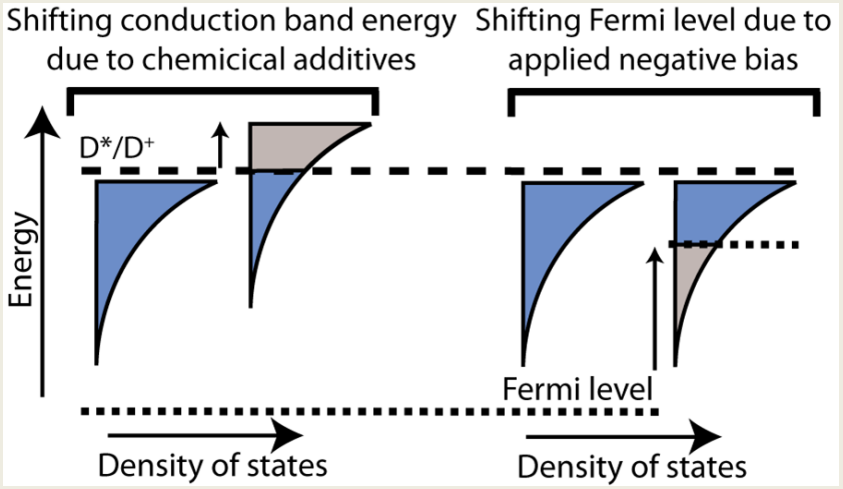
J. Phys. Chem. C 2013, 117, 34, 17412-17420

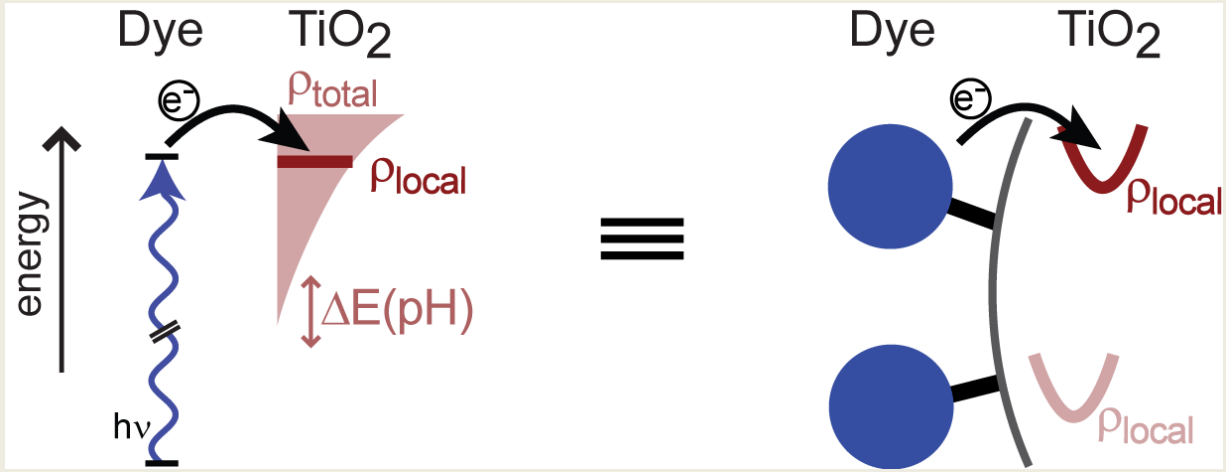
Connecting power-law charge mobility to power-law emission kinetics





Power-law emission kinetics





Injection into localized acceptor states

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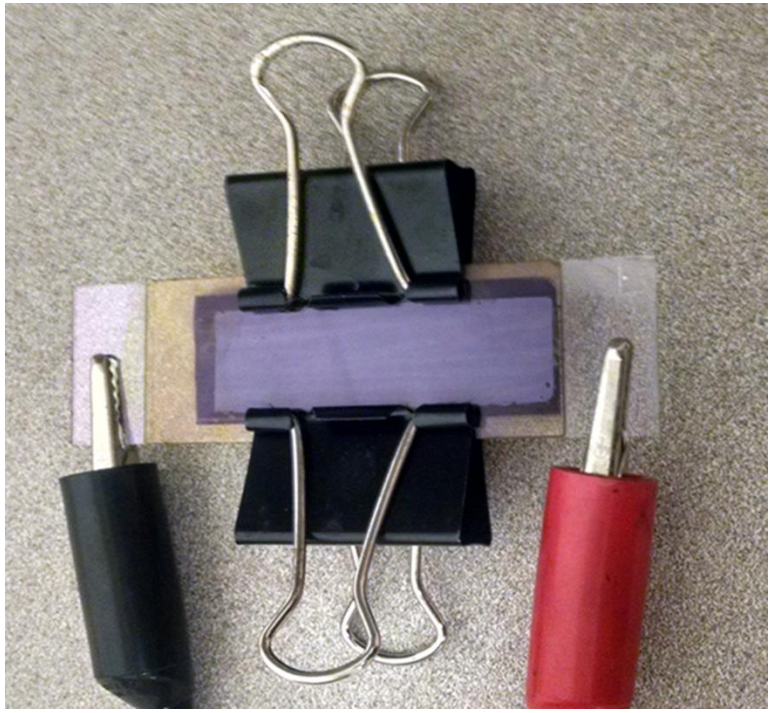
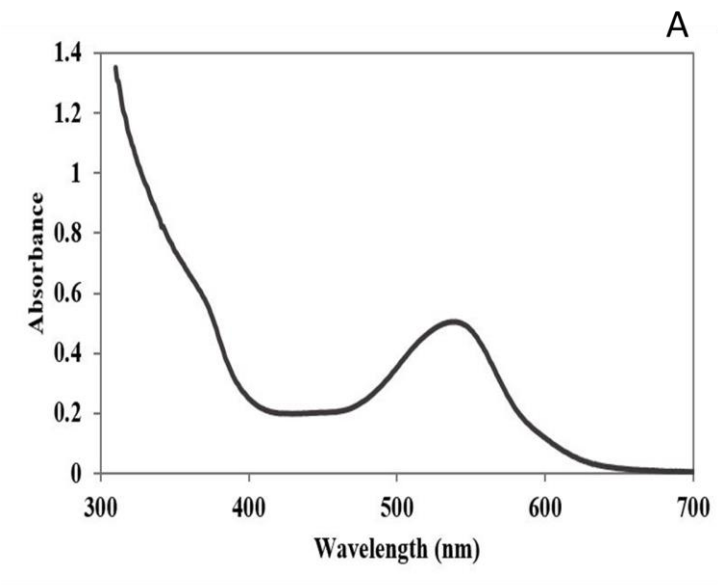
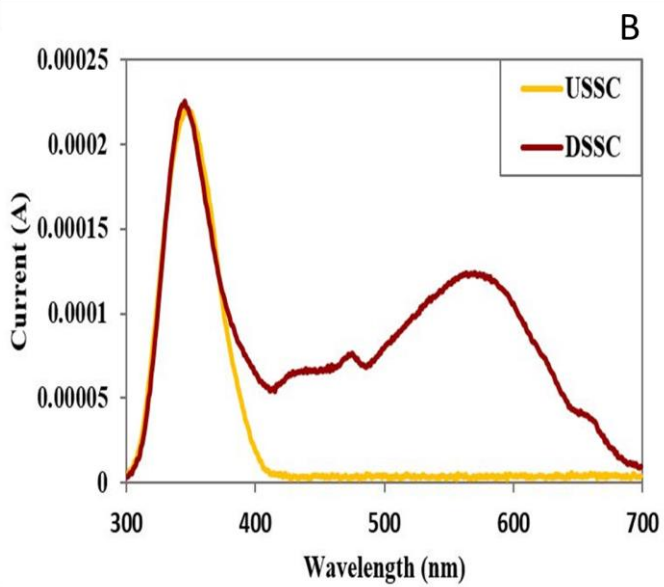
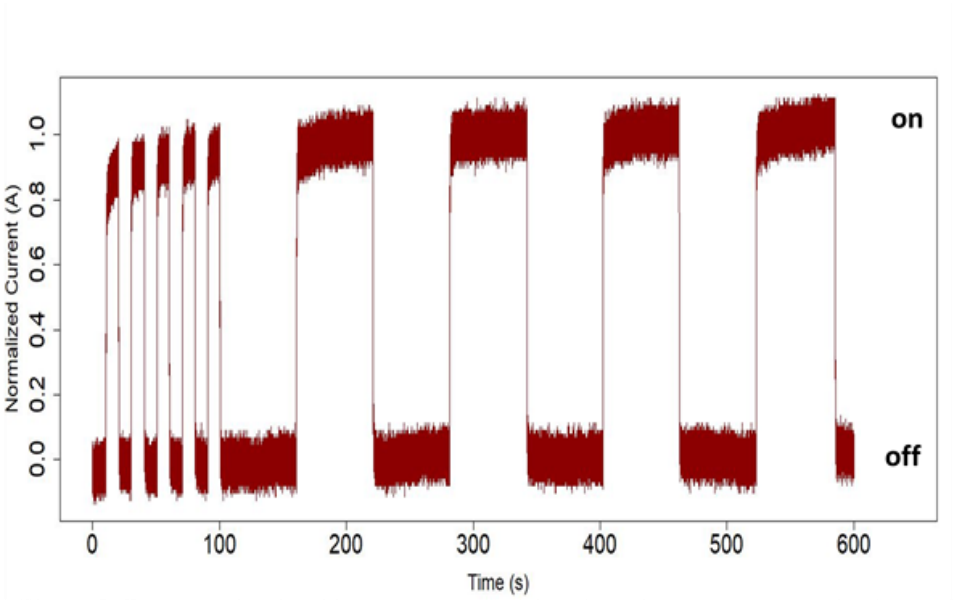
Transitioning my graduate school project to be appropriate for a PUI.

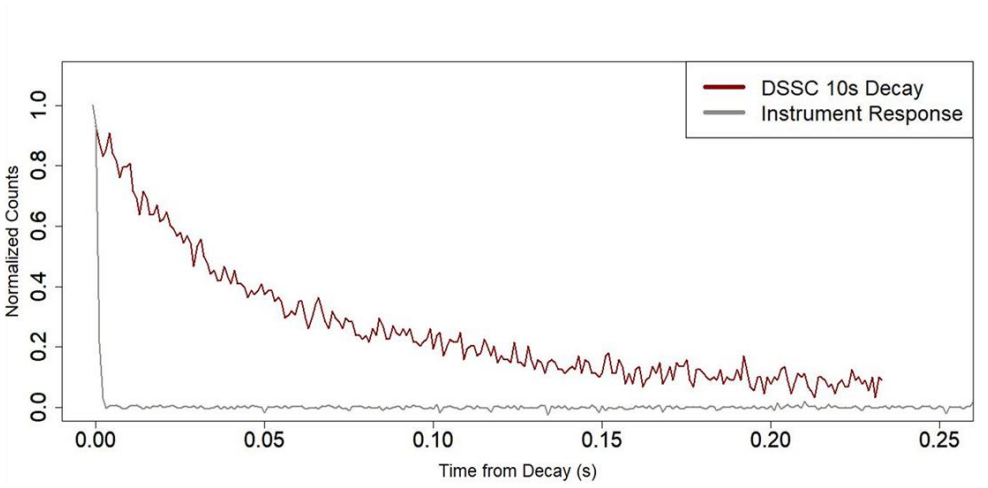




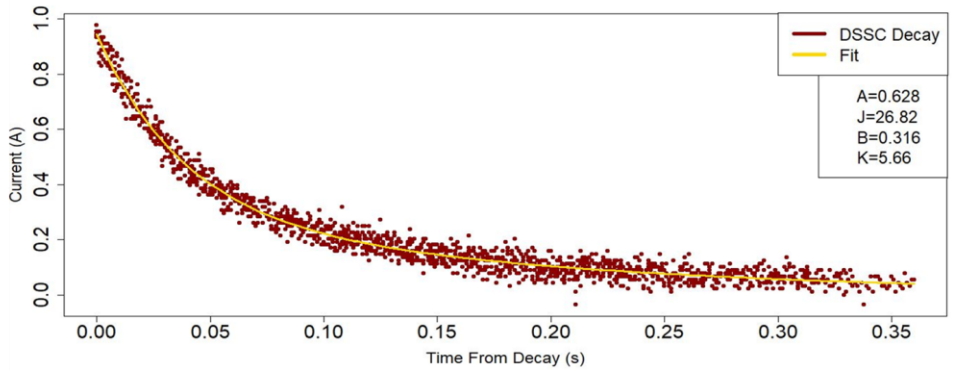


Studying the decay curves to learn about electron mobilities in these devices.





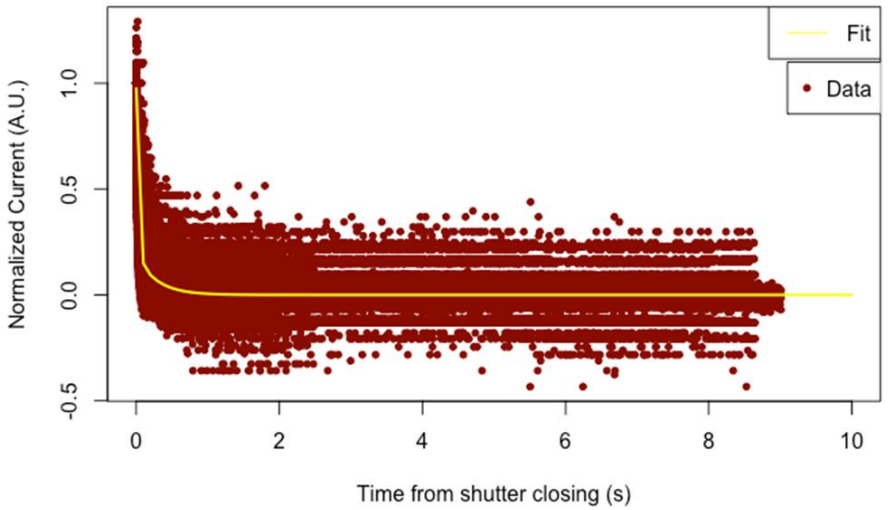
$$y = Ae^{\frac{-t}{\tau_1}} + Be^{\frac{-t}{\tau_2}}$$



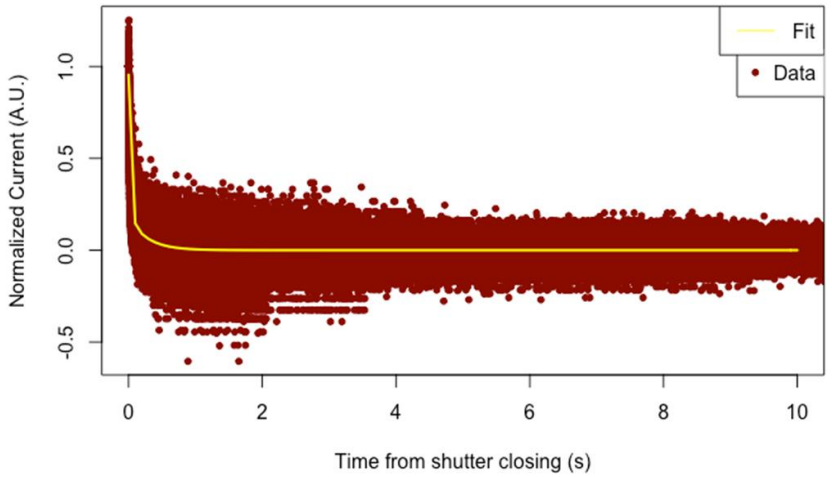
Parameters:
y is the photocurrent vs t (time)
A is the fraction with the fast component τ_1
B is the fraction with the slower component τ_2

Studying the decays

With lithium



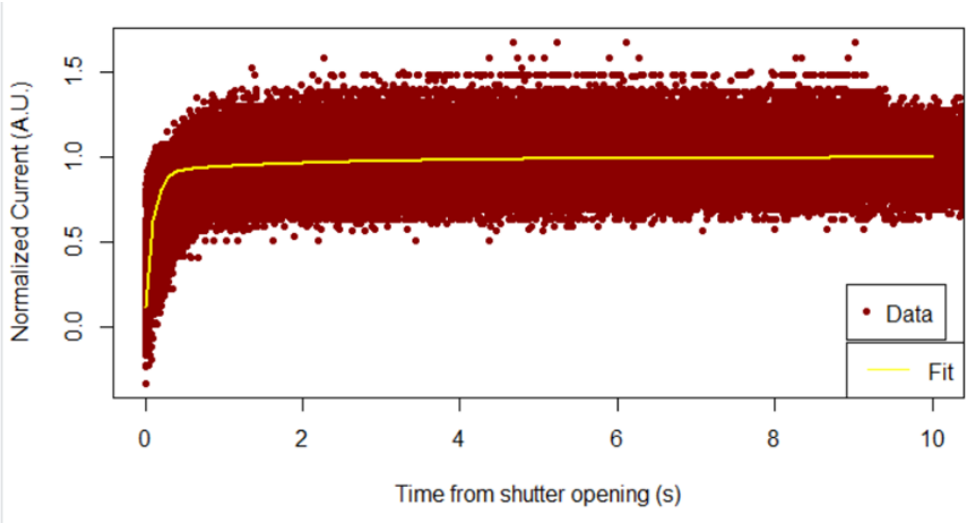
Without lithium

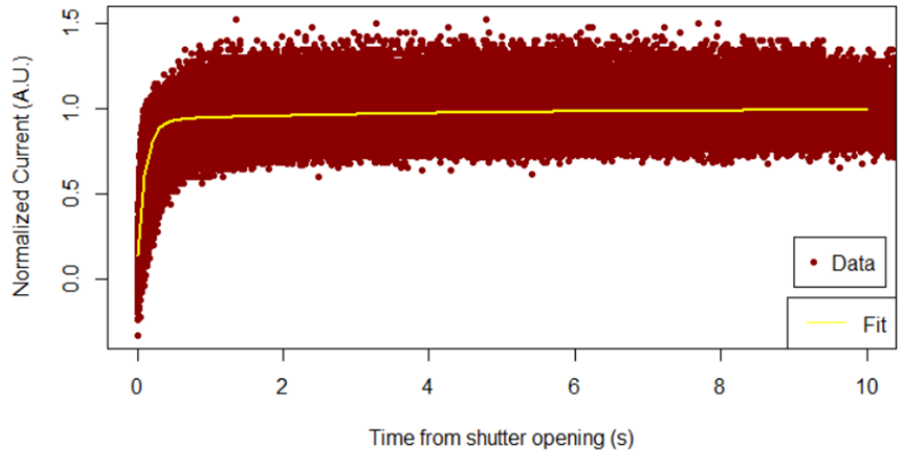


	A	τ_1(ms)	B	τ_2(ms)
DSSC w/Li^+ (10 sec)	0.7130±0.0067	22.24± 0.42	0.2813±0.0053	184.6± 3.1
(1 min)	0.7847±0.0056	25.87± 0.36	0.1898±0.0034	280.3± 5.0
(average)	0.7480±0.0043	23.71± 0.28	0.2391±0.0031	217.1± 2.7
DSSC w/o Li^+(10 sec)	0.6453 ± 0.0084	17.48± 0.43	0.3830±0.0080	112.8± 1.9
(1min)	0.7710±0.0047	26.99± 0.32	0.1838±0.0030	273.0 ± 4.4
(average)	0.7063±0.0046	20.73± 0.27	0.2951±0.0040	152.0± 1.8

Studying the growth curves

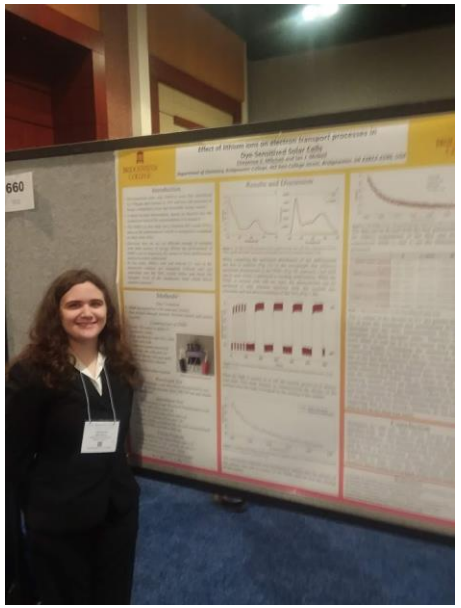
$$y = 1 - (Ae^{\frac{-t}{\tau_1}} + Be^{\frac{-t}{\tau_2}})$$





	A	τ_1(ms)	B	τ_2(ms)
DSSC w/Li^+ (10 sec)	0.7582±0.0048	63.38± 0.80	0.2122 ± 0.0036	554.1± 8.6
(1 min)	0.7800±0.0024	116.86± 0.56	0.06707±0.00040	5929± 46
(average)	0.7978±0.0019	100.89± 0.42	0.08359±0.00059	2276± 19
DSSC w/o Li^+(10 sec)	0.8512 ± 0.0040	82.34± 0.68	0.0848 ± 0.0014	1638± 31
(1min)	0.7584±0.0025	136.89± 0.70	0.07201±0.00047	5714 ± 48
(average)	0.8001±0.0020	113.21± 0.45	0.06464±0.00042	4268± 37

Acknowledgements



Cheyenne Mitchell class of 2019

Gabrielle Perkins class of 2020

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