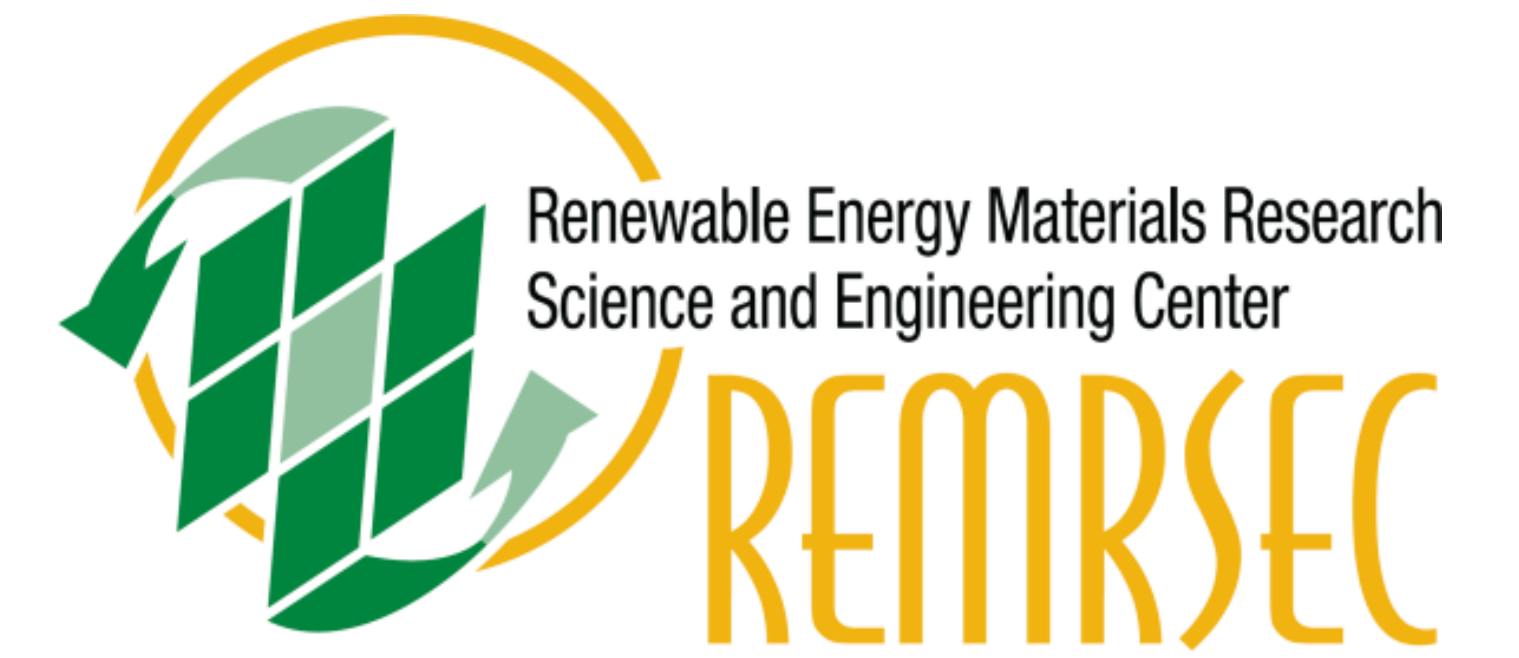


Etch Resistant $Zn_{1-x}Mg_xO$ Alloys as an e^- -Acceptor for Dye Sensitized Solar Cells

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Dye Sensitized Solar Cells (DSSCs)

- In DSSCs, dyes are used to photosensitize a nanoporous electrode, most commonly TiO_2 . Light excites the dye which then transfers an electron to the metal oxide electrode (below). The electron then travels to the conducting contact and through the external circuit. An electrolyte surrounding the electrode replenishes the electron deficiency in the dye.

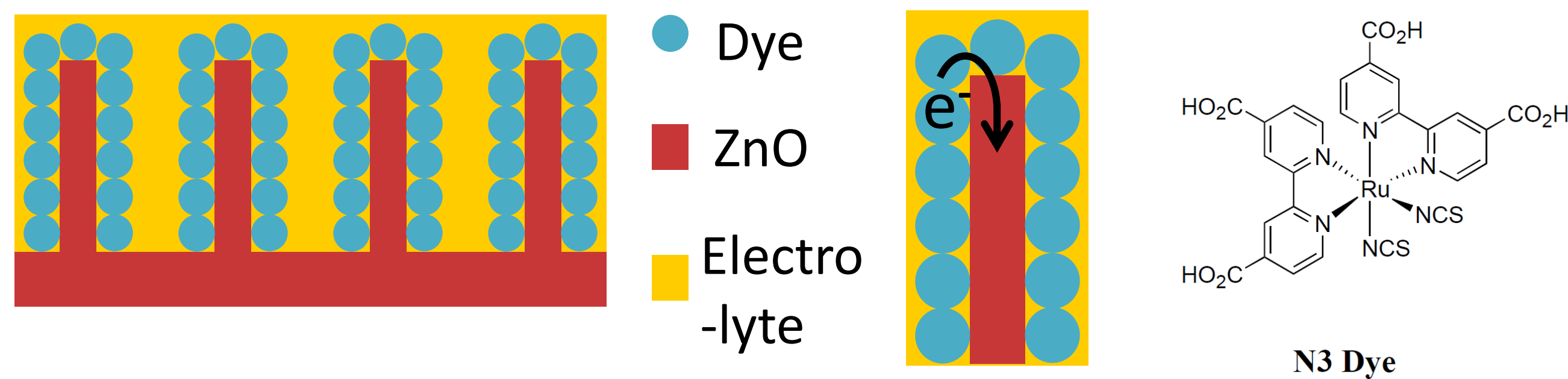


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- Zinc oxide has been explored as an alternative electron acceptor material to TiO_2 because of its abundance of easily synthesized nanostructures¹.

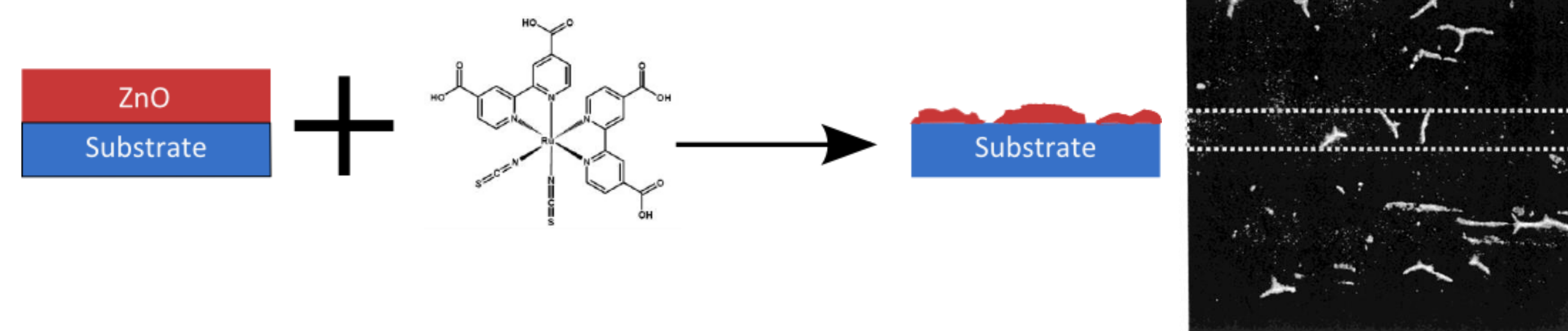
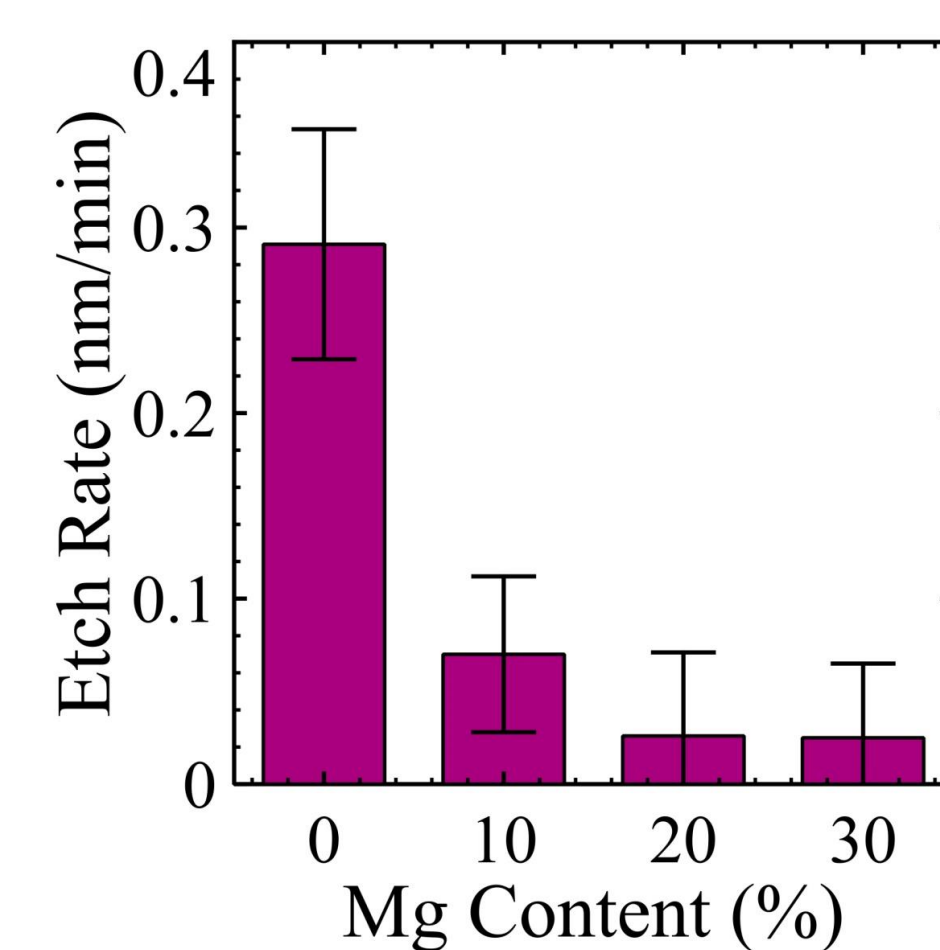
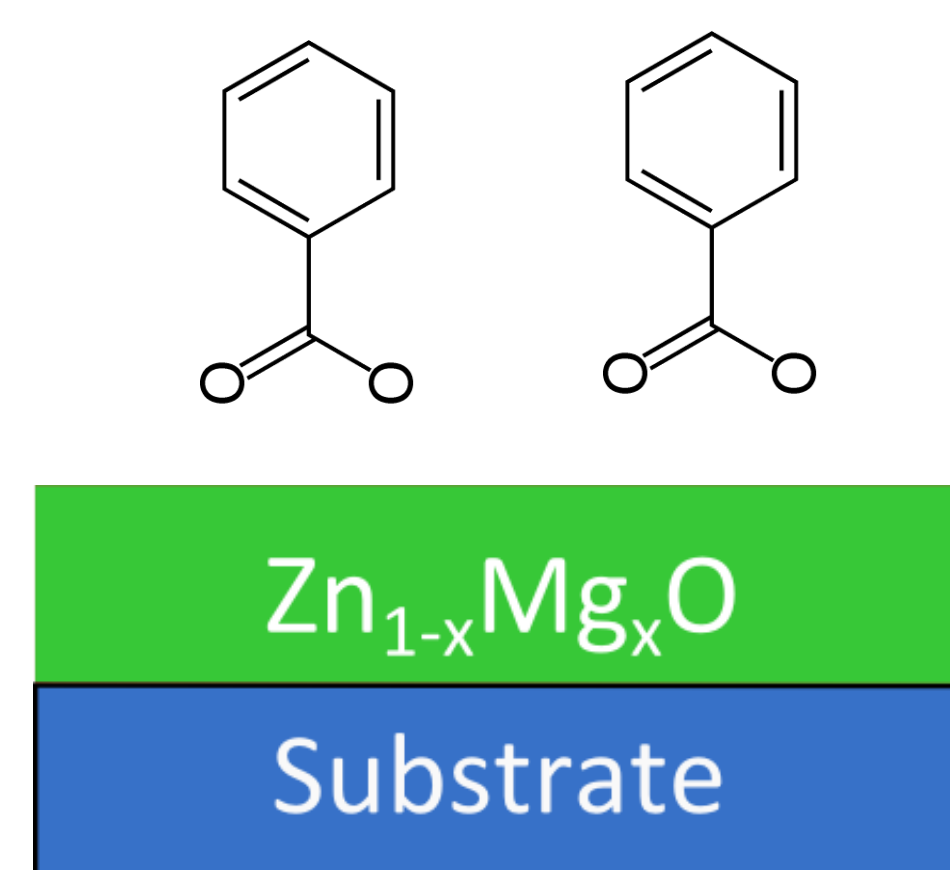


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- However, ZnO suffers from Zn-Dye aggregate formation. The carboxyl groups (CO_2H) of the dye are acidic and form aggregates through etching of surface
- Aggregates prevent efficient transfer of electrons to the ZnO matrix which instead decay through fluorescence.
- Aggregate formation can be identified through photoluminescence spectroscopy³ (above).

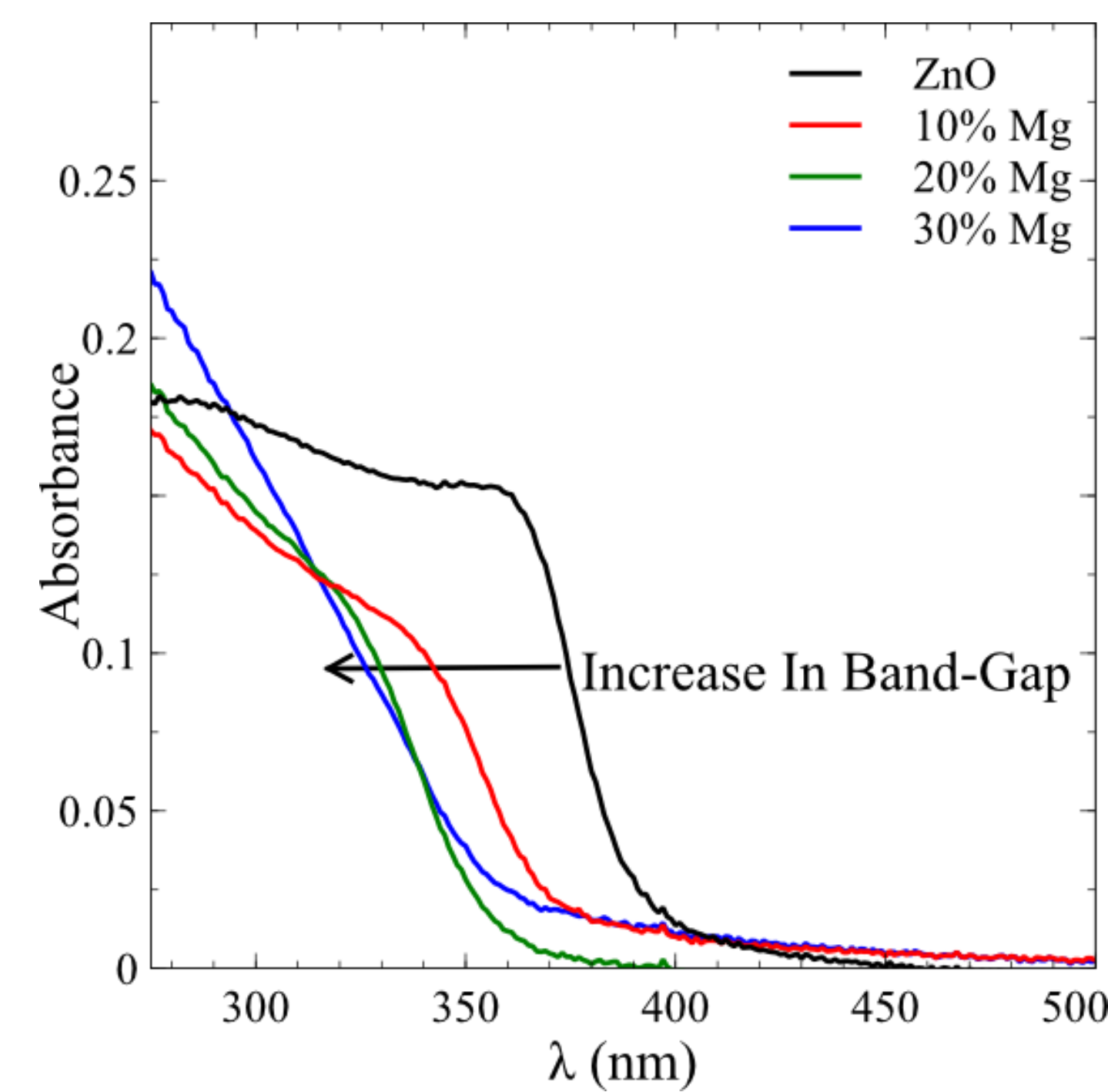
$Zn_{1-x}Mg_xO$ as an Alternative to ZnO in DSSCs

- Previous work on $Zn_{1-x}Mg_xO$ nanotips suggested that this alloy is more resistant to etching than ZnO.⁴

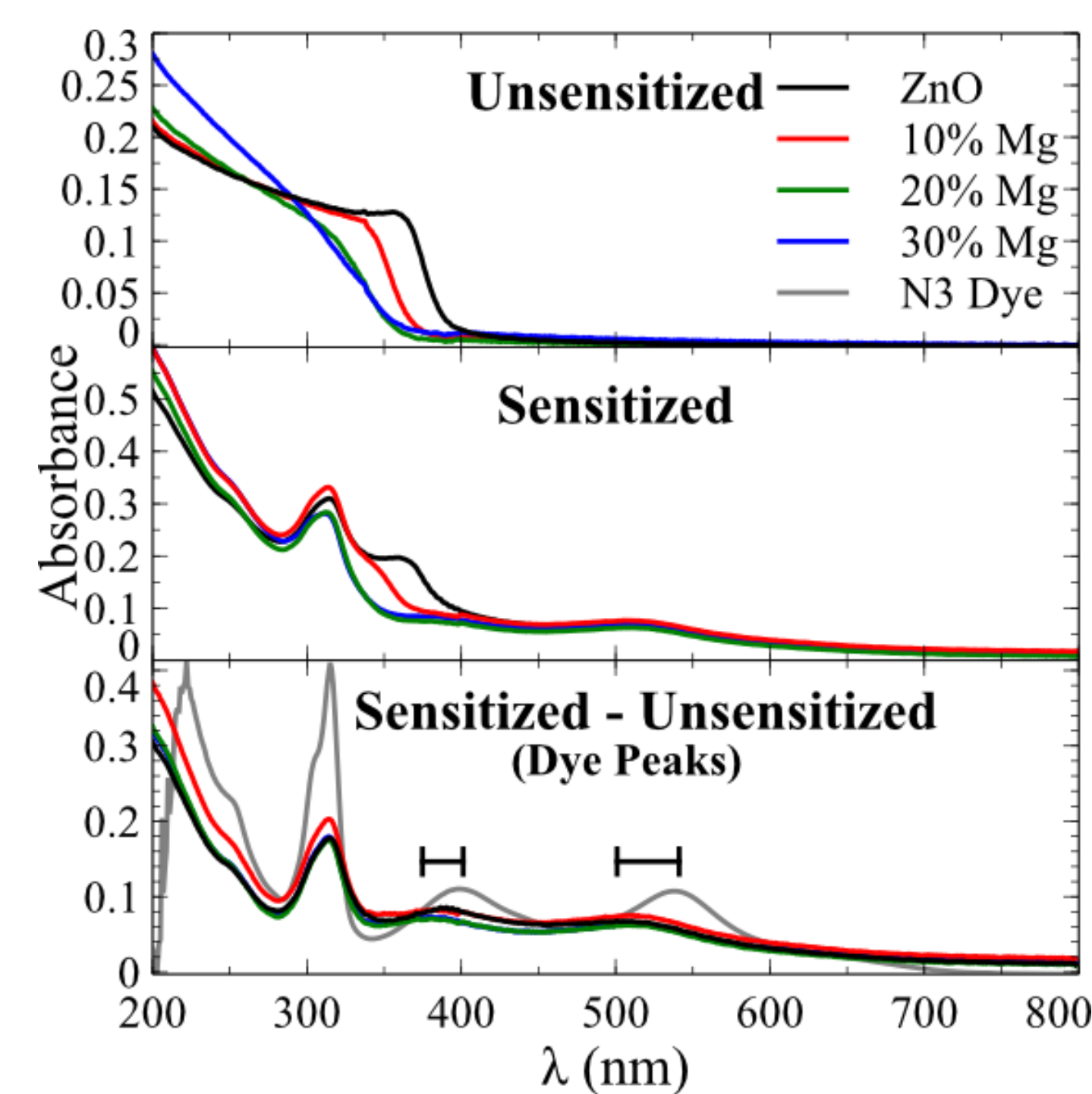


- $Zn_{1-x}Mg_xO$ showed improved etch-resistance in another REU project⁵ (above) which makes it a promising replacement for ZnO in DSSCs
- The sensitization and aggregate formation of N3 dye on $Zn_{1-x}Mg_xO$ is investigated in this poster

Attaching Dye to the $Zn_{1-x}Mg_xO$ Alloy



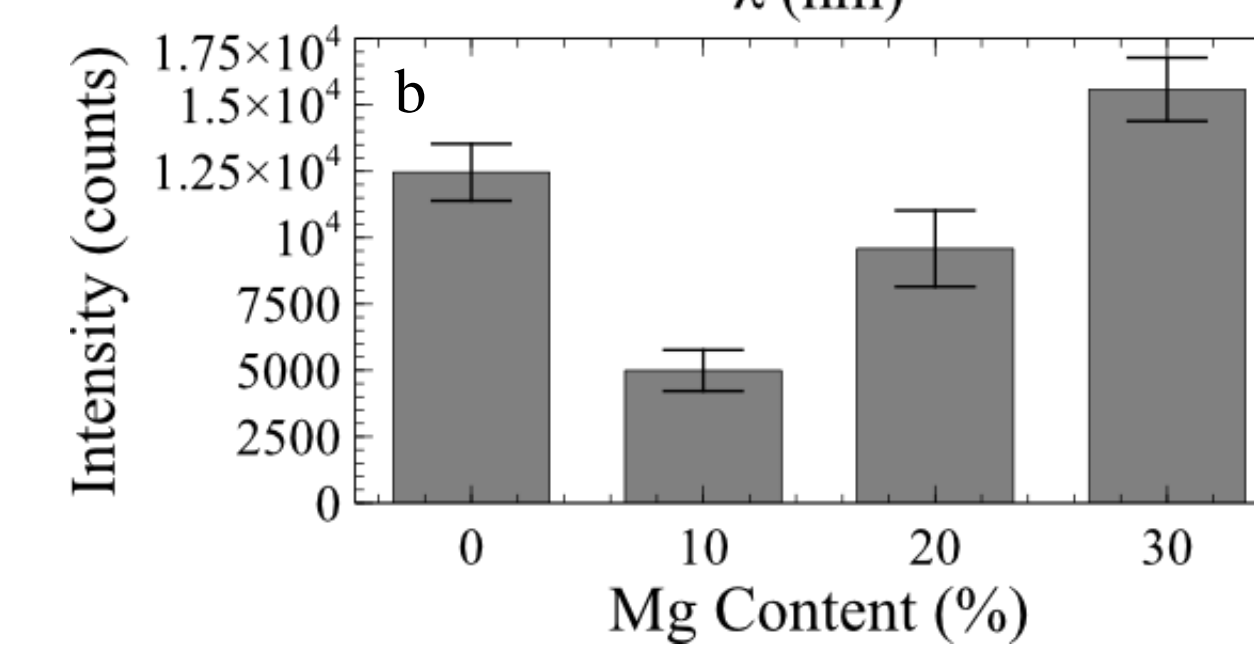
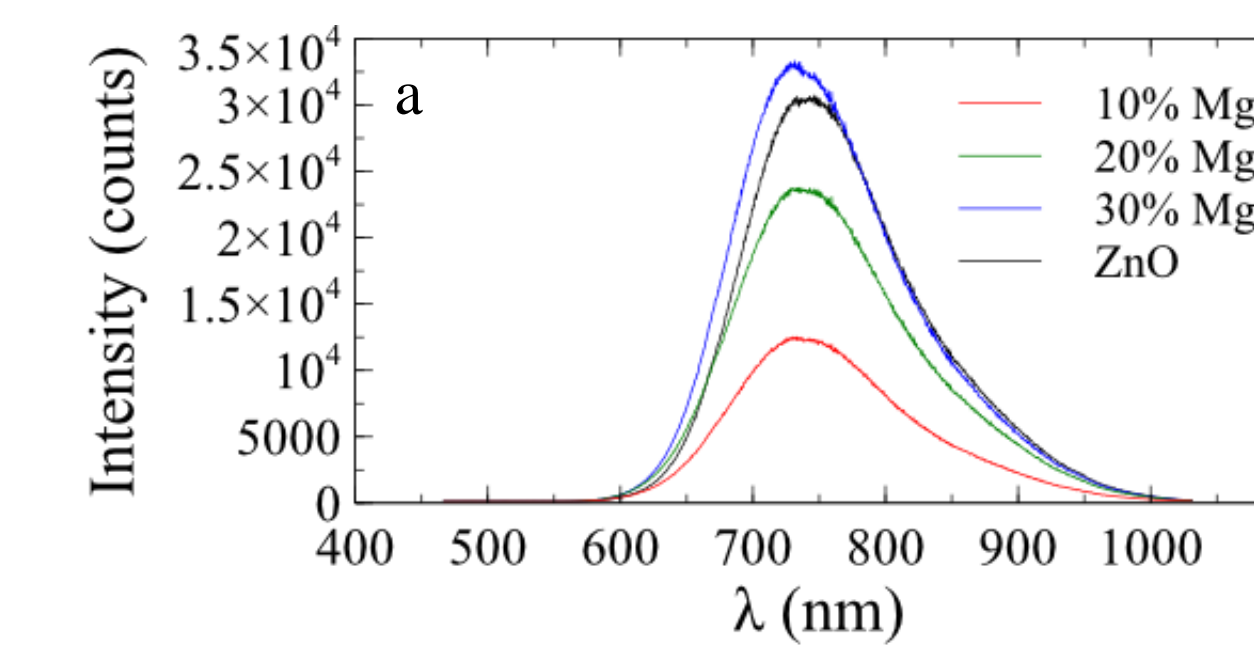
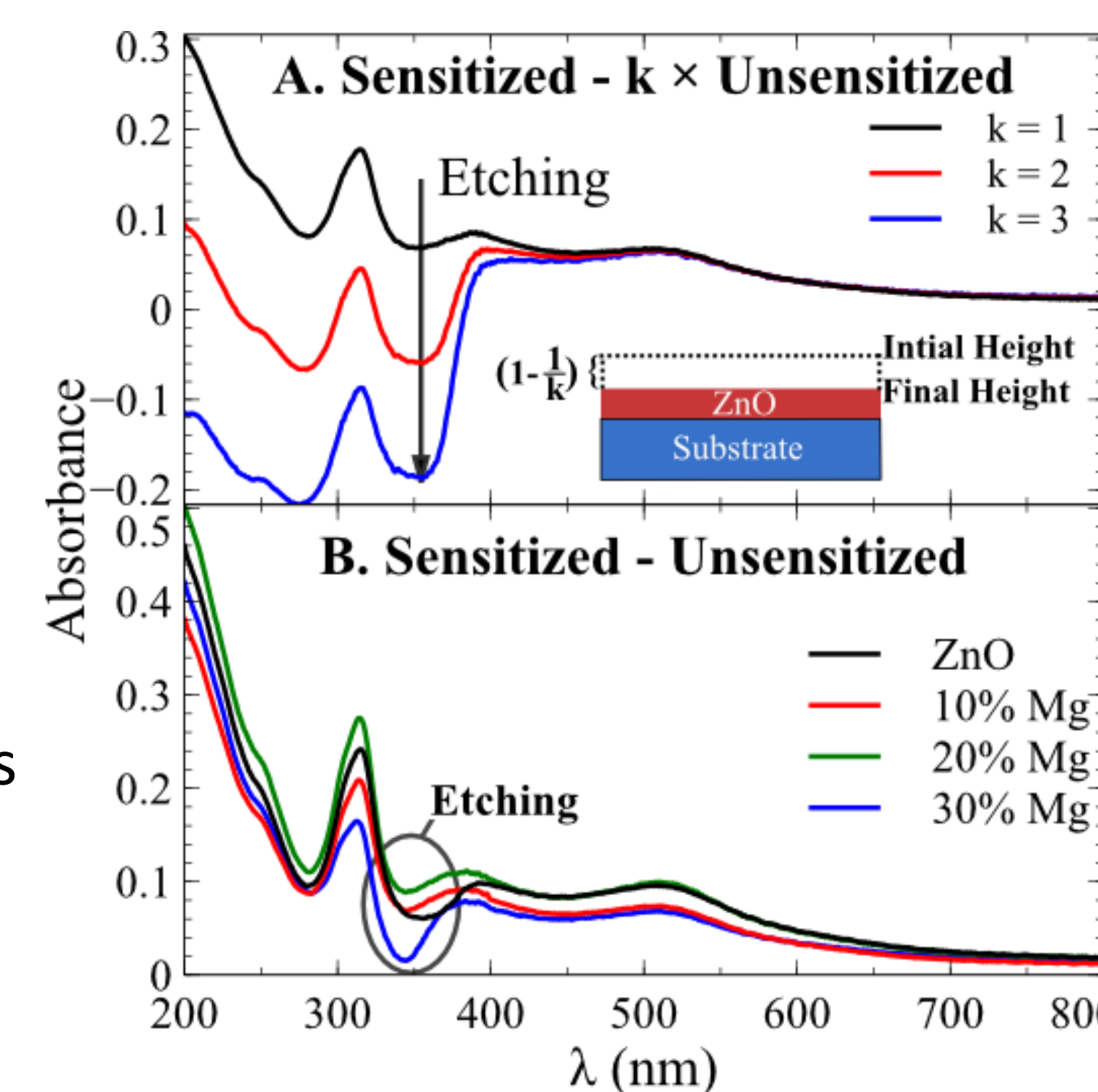
- $Zn_{1-x}Mg_xO$ thin films were produced using the sol-gel method
- The samples were measured with UV-Vis to observe any differences in the absorbance
- Bandgap changes were observed with addition of magnesium, indicating alloy formation⁶
- Spectra of 30% Mg sample indicates phase segregation



- Samples were soaked in N3 dye for 3 hours to sensitize the surface
- UV-Vis was taken before and after sensitizing. The difference was taken to see contribution of dye
- Dye peaks indicate that N3 dye is adsorbing onto surface, the peaks are slightly shifted (left, indicated by bars) due to the bonded nature of the dye. The cause of the shift could be due to the dye bonding to the surface or in aggregates

Evidence for Reduction of Aggregates

- To model the effects of etching on the surface, the sensitized (UV-Vis) spectrum was subtracted from the unsensitized spectrum scaled by a factor of k (right, A)
- The fraction of the film etched is $(1 - \frac{1}{k})$
- The valley near 350 nm is indicative of etching.
- The ZnO & 30% Mg films show signs of etching whereas the 10% & 20% do not after 15 hours of soaking in dye (right, B).
- The lack of a valley for the 10% & 20% suggests both etch-resistance and a reduction in aggregates



- Since dye aggregates are expected to luminesce, treated films were characterized with PL spectrometry
- The drop in PL intensity seen from ZnO to 10% Mg combined with the etch resistance observed in the UV-Vis suggest a reduction in aggregates (Left, A & B)

- The trend of increasing intensity with increased magnesium content requires further exploration. One potential cause may be the shift of the conduction band energy due to Mg addition⁶

Future: Better Measurement of Etching

- Through either soaking in a strong basic solution or UV/Ozone cleaning, the dye layer can be removed while preserving the $Zn_{1-x}Mg_xO$ layer underneath and measured with UV-Vis to see how the absorptivity of the oxide changes before and after sensitization

Future: Photoluminescence Quenching

- A quenching experiment with photoluminescence spectroscopy should be done in the future to measure the charge transfer efficiency of the samples

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