Injected Electrons Populate an Electronic State at the Interface of the SnO_2 Core and TiO_2 Shell

Scientific Achievement

- Spectro-electrochemical analysis showed electrons injected into core/shell SnO_2/TiO_2 mesoporous thin films were not present in the SnO_2 core or the TiO_2 shell.
- An electronic state at the interface between the core and shell was proposed with an energetic position 200 mV more positive than either SnO_2 or TiO_2.

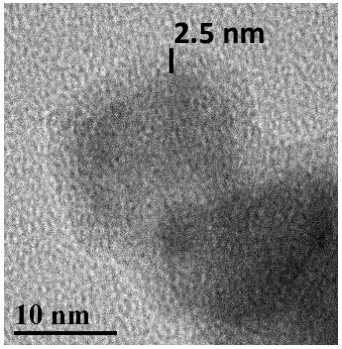
Significance and Impact

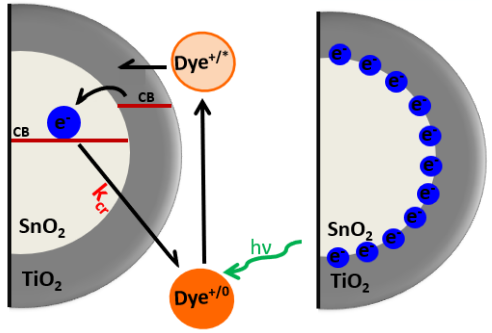
- Control of the energetic position and physical location of injected electrons enables control of unwanted charge recombination reactions and catalysis.

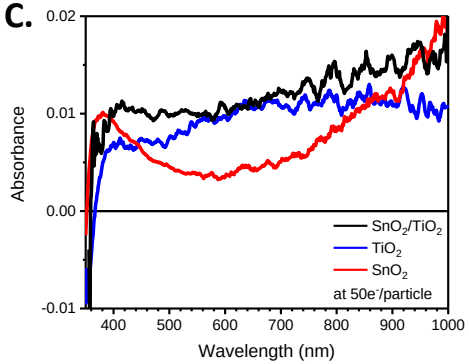
Research Details

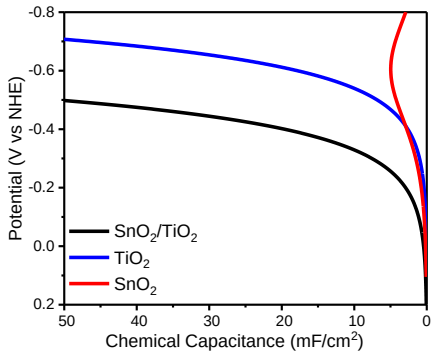
- About 2.5 nm thick rutile TiO_2 shells were formed on 15 nm diameter SnO_2 nanocrystals present in a mesoporous thin films via atomic layer deposition, followed by sintering.
- Reduction of TiO_2 and SnO_2/TiO_2 films resulted in the appearance of one unique absorption spectra consistent with the formation of one electronic state.
- Standard addition of the SnO_2 and TiO_2 absorption spectra did not simulate the SnO_2/TiO_2 data, indicating that the core/shell has an electronic state that is distinct from SnO_2 and TiO_2.
- Core/shell SnO_2/TiO_2 thin films have a higher capacitance than SnO_2, but comparable to TiO_2.

James, E. M.; Barr, T. J.; Meyer, G. J. *ACS Appl. Energy Mater.* **2018**, ASAP, DOI: 10.1021/acsaem.7b00274.

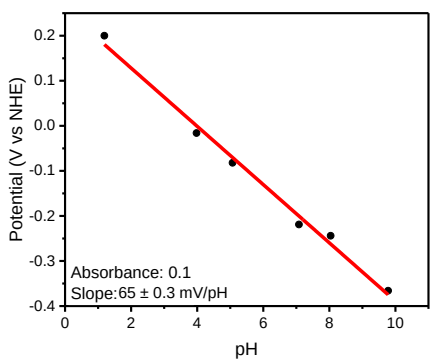








A) TEM image of a SnO_2/TiO_2 film.
B) Scheme showing idealized conduction band (CB) offsets and electrons localized at the core/shell interface.
C) UV-Vis absorption spectra of the thin films with ~50 electrons present in each nanocrystallite.
D) Density of states of the oxide semiconductors.
E) Reduction potential onset vs. pH with an overlaid linear fit.



Work was performed at University of North Carolina at Chapel Hill.

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