Nanostructural Design of Photocatalysts and Photoelectrochemical Cells

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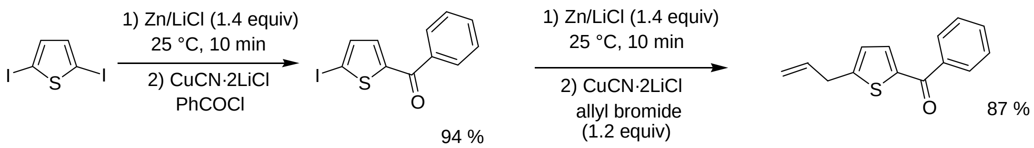
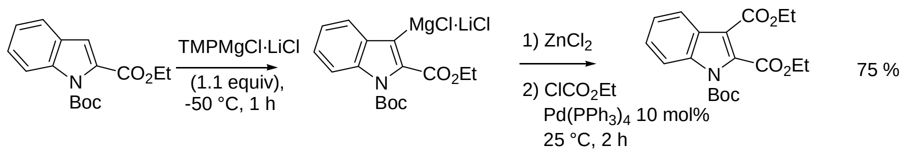
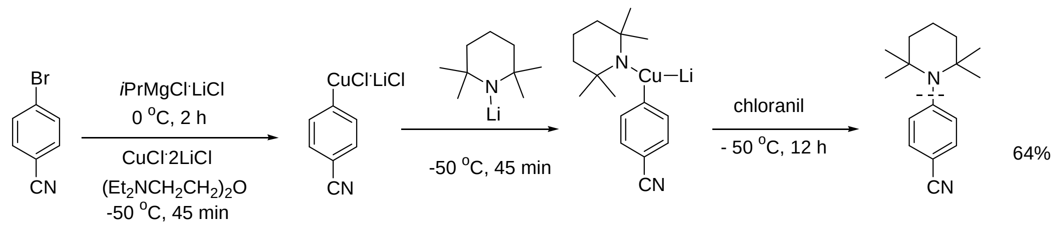
Future solar energy conversion systems (solar cells and solar water splitting catalysts) must be both efficient and inexpensive in order to be competitive with fossil fuels. The dual challenge of high efficiency and low cost presents some interesting technical problems. Inexpensive polycrystalline semiconductor devices and photocatalysts are generally inefficient because of losses due to charge carrier recombination. This talk will describe some new strategies for addressing this problem. Nanocrystals and nanocrystal assemblies offer new ways to control the flow of light and the transport of electrons in photocatalysts and photoelectrochemical cells. Dye-sensitized TiO_2 cells are inexpensive devices for converting light to electrical energy, but their efficiency is low because they do not efficiently utilize the red part of the solar spectrum. By adding photonic crystal light scattering layers, the spectral response of dye sensitized TiO_2 cells can be extended significantly into the red. We have recently fabricated tandem cells from dye-sensitized TiO_2, which absorbs well in the visible, and single crystal Si, which is most efficient in the near-IR. By coupling molecular photosensitizers to nanoparticulate oxygen evolution catalysts, it is now possible to make dye-sensitized solar cells that split water with visible light, albeit with low efficiency. This talk will also describe new photoelectrochemical cells based on "bed of nails" arrays of semiconductor nanowires (TiO_2, Si, InP), that allow one to separately control the length scales of light absorption and photochemical charge separation.







References:

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