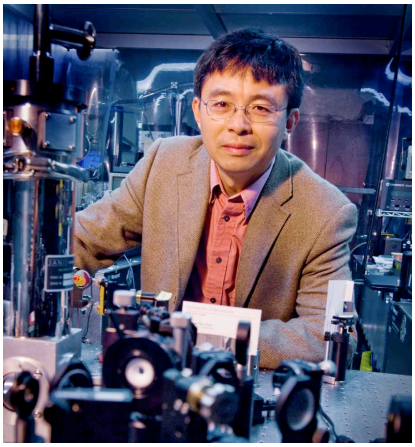
Physical Chemistry Seminar

Tuesday, February 5, 2013 | **11:00 am** | **Room 1315 Chemistry Building**

Solar Energy Conversion Beyond the Limit



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Host: Professor Song Jin

The maximum solar-to-electric power conversion efficiency of a conventional solar cell is determined by the Shockley-Queisser limit of ~31% [1]. There are mainly two reasons for energy loss: 1) the semiconductor material does not absorb photons with energy below the bandgap; 2) absorption of photons with energy exceeding the bandgap creates “hot” electrons and holes with excess kinetic energy, but this excess energy is quickly lost before the electrons and holes are captured. In this lecture, I will discuss two viable approaches to exceed the Shockley-Queisser limit. The first approach is based on harvesting hot electrons/holes before their excess energy is lost and I will show recent developments in my lab using inorganic or grapheme quantum dots in achieving hot electron harvesting [2-4]. The second approach is to create two electron-hole pairs from the absorption of one photon in a process called singlet fission. I will illustrate how singlet exciton fission can occur in organic semiconductors due to a many electron quantum coherent process, and how to efficiently extract two electrons from singlet fission based on Le Châtelier principle for a quantum equilibrium [5-7]. These discoveries take us one step closer to designing solar cells with power conversion efficiency potentially exceeding the Shockley-Queisser limit.

[1] W. Shockley, H. J. Queisser, *J. Appl. Phys.* 32 (1961) 510-519.
[2] W. A. Tisdale, K. J. Williams, B. A. Timp, D. J. Norris, E. S. Aydil, X.-Y. Zhu, Science 328 (2010) 1543-1547.
[3] L. Miaja-Avila, J. Tritsch, A. Wolcott, W.-L. Chan, C. A. Nelson, X.-Y. Zhu, Nano Lett. 12 (2012) 1588-1591.
[4] K. J. Williams, C. A. Nelson, X.-Y. Zhu, to be published.
[5] W.-L. Chan, M. Ligges, A. Jailaubekov, L. Kaake, L. Miaja-Avila, X.-Y. Zhu, Science 334 (2011) 1541.
[6] W.-L. Chan, M. Ligges, X.-Y. Zhu, Nature Chem. 4 (2012).
[7] W.-L. Chan J. Tritsch, X.-Y. Zhu, to be published.

Refreshments will be available prior to the seminar at 10:45 a.m. outside room 1315

Graduate Students may meet with the speaker at 1:00 p.m. in Room 8335