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16:00 Room: OFLG/402
TFI-LMX SEMINAR

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Understanding Band Gap Engineering using Transient Absorption Spectroscopies

Photoabsorbers engineered for solar cell or photocatalysis applications have at least one aspect in common: both require an efficient charge extraction which is unfortunately in direct competition with charge carrier recombination within the absorber layer.

In polycrystalline thin film Cu(In,Ga)Se_2 (CIGSe) solar cells an interesting band gap engineering approach is applied making use of the Ga-content dependent band gap energy in the formed CISe-CGSe alloy. The band gap gradient allows for an enhanced minority carrier collection at the n-contact. As such, record efficiencies of >23% have been achieved combining the gradient approach with some alkali post deposition treatments.[1] Ultrafast transient absorption spectroscopy (TAS) has turned out to be a useful technique to probe excited carriers and track their movement across the band gap graded CIGSe layer. This in turn has allowed us to understand and quantify charge transport and charge recombination within the device and identify pathways to potentially boost CIGSe solar conversion efficiency even a bit further.

While in CIGSe solar cells charge extraction is engineered to be rather fast, in photocatalytic devices, reaction rates for the water splitting reactions are orders of magnitude lower. Furthermore, most metal oxide materials commonly employed in photocatalytic or photoelectrochemical water splitting suffer from low quantum yields for this reaction due to a significant degree of non-radiative recombination via defect states or due to polaron conduction as in the case of hematite.[2] Those materials showing higher quantum yields happen to be mostly UV absorbers and hence limited in their maximal attainable solar-to-fuel conversion efficiency. Hence, a band gap engineering approach has been pursued to create new materials with good photocatalytic properties and visible light absorption. Here, I will showcase our study on a new visible light absorber, La,Rh:$SrTiO_3$,[3] that is able to sustain long-lived excited charge carriers to be used for photocatalysis. I will elucidate the roles of La and Rh in this material and link photocatalytic devices to photoelectrochemical devices to explain our observations.

[1] T. Feurer, B. Bissig, T.P. Weiss, R. Carron, E. Avancini, J. Löckinger, S. Buecheler, A.N. Tiwari, *Sci. Technol. Adv. Mater.* **2018**, *19*, 263.
https://www.nrel.gov/pv/assets/pdfs/best-research-cell-efficiencies.20200128.pdf (accessed 31.01.2020)

[2] Pastor, E., Park, J., Steier, L. *et al. Nat Commun* **10,** 3962 (2019).

[3] Wang, Q., Hisatomi, T., Jia, Q. *et al. Nature Mater* **15,** 611–615 (2016).