Abstract:

Solution processable photovoltaics (45mins + questions)

Industrial photovoltaics is currently still dominated by crystalline silicon solar cells, the technology that provided the first efficient solar cells in 1954. However, efforts to develop solar cells by coating and printing methods that avoid energy-intensive processing steps such as single-crystal growth have led to several solution processable thin-film technologies. These include in particular organic photovoltaics and metal-halide perovskite solar cells. These technologies are briefly introduced and their current performance levels are put into context of well-established solar cell technologies. Finally, I will discuss the key obstacles towards higher efficiencies and towards industrially and economically viable applications of solution processable photovoltaics.

Master Class:

Charge carrier recombination in lead-halide perovskites (45mins + questions)

The master class talk will focus on recombination of charge carriers in halide perovskites. Recombination is a key factor that distinguishes successful from less successful photovoltaic technologies. Lead-halide perovskites show remarkably low rates of non-radiative recombination at a fixed carrier concentration. Nevertheless, the technology does not yet reach the same levels as GaAs based solar cells. Therefore, the master class will briefly discuss the theoretical background of non-radiative recombination, the current state of the art in perovskite solar cells and then focusses on how to measure recombination. Here, the methods of choice are often photoluminescence based methods. Both transient and steady state photoluminescence PL have been frequently used to analyze the properties of halide perovskite films[1] and recently also layer stacks, i.e. films with interfaces.[2-4] Here, we present our current level of understanding of how to analyze the data. In the case of films, long decays in transient PL correlate well with strong steady state PL. The shape of the decays allows us to determine bimolecular and monomolecular recombination coefficients, the former of which is clearly affected by photon recycling.[1, 5] In the case of films with one interface, we show that high luminescence is still beneficial for high open-circuit voltages in devices and still correlates with long photoluminescence decays.[2] We show by simulation how the combination of steady state PL with tr-PL can be used to better understand band alignment at interfaces and how it provides an estimate of the surface recombination velocities. Finally, we discuss the case of layer stacks with two contacts and of full devices. Here, additional effects such as the conductivity and capacitance of contact layers become important.

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