Synchrotron photoemission; understanding photovoltaics

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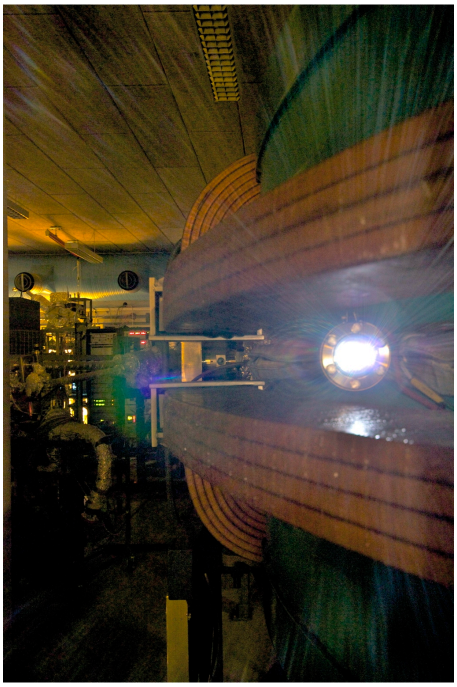

Figure 1: Synchrotron light, generated by the accelerator "ASTRID" in Aarhus, Denmark.

"Intermediate band (IB) photovoltaics" are a new generation of solar cells, with performance superior to existing silicon based cells. IB photovoltaics are semiconductors with large bandgaps, but with a significant density of states (DOS) within the gap. This means that electrons can be promoted across the gap, either by absorbing a single photon (as in a traditional photovoltaic), or in a two-step process involving the impurity states as a "stepping stone". This means that the main challenge is to develop materials with a suitable bandgap, and a suitable density of IB states.

Chromium doped ZnS is the most common of these materials, and is grown at NTNU by a variety of processes. The Cr dopants can take a variety of oxidation states (i.e. Cr^{2+}, Cr^{3+}, etc), or form a metallic cluster, depending on the fabrication method. The performance of the cell is critically dependent on these dopants, yet it is very difficult to understand the underlying processes.

In this project, we use synchrotron photoemission (using the accelerator facilities in Aarhus University). This allows us to resonantly excite carriers from the bands within the bulk bandgap, and to quantitatively report their density. This is a non-standard technique, performed as part of the development of the accelerator facilities, and hence an important aspect of the project is to demonstrate the feasibility of this approach.

The student(s) will attend a synchrotron experiment in Aarhus (in September 2014) where he/she will participate in all aspects of the measurements, together with Ph.D. student Federico Mazzola and our Danish collaborators. Data analysis will be performed afterwards. We aim to publish a high impact paper based on this work, demonstrating the techniques, and its relevance to this important class of materials.

Interested students should have an aptitude for experimental work, and a background in solid state physics. Possible candidates are encouraged to contact Assoc. Prof. Justin Wells to discuss any questions or further details.

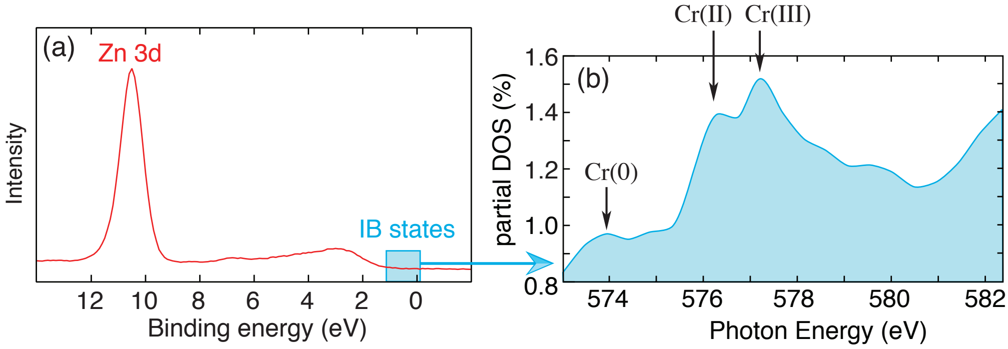

Figure 2: Preliminary data from MAXlab in Sweden, showing that the density of IB states can be directly measured using resonant photoemission.