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Project 09 - Nanowire Photovoltaics
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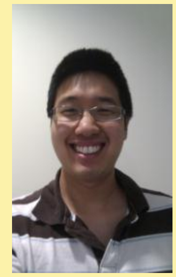

Annual Network Meeting and Scientific Conference Report

At the Annual Network Meeting, I gained exposure to a wide variety of approaches to PV research and this expanded my horizons with respect to the direction of the field. At times, it is easy to be caught up with our own specific research, but this conference has shown me that there are a wide variety of concepts such as inorganic, organic and hybrid solar cells with different focuses such as improving current 2nd generation technologies or developing new 3rd generation technologies. When examined in the big picture, each of these technologies has a specific niche and will hopefully serve a specialized role in the advancement of PV in Canada.

Qn 1: Evaluate the success of Ontario's FIT (feed-in tariff) program and discuss its future outlook.

Due to its significant economic incentives, Ontario's FIT program has been largely successful. It has led to significant private investment in the solar energy market in Ontario, leading the province to become the second largest market in the world for solar power technology in 2010.

The future outlook of Ontario's FIT program, however, appears quite volatile. Similar to Great Britain's past FIT program, Ontario's FIT program may be vulnerable to modifications implemented by the changing governmental policies. This poses a sizeable obstacle to future foreign and private investment. However, despite the FIT program's volatility, PV research is still a strategic area of research in Ontario because the worldwide demand continues to grow and it is vital for Canadians to provide expertise in that market.

Qn 2: Discuss the current state of 2nd generation solar cells

There have only been mild improvements to current thin film solar cells. Significant material challenges and expensive vacuum processes associated with CdTe, CIGS and amorphous Si cells have prevented either significant improvement to the efficiency or reduction of cost.

On the other hand, organic cells show great promise of flexible solar cells and extremely low cost due to roll to roll processing and inexpensive plastics, thus giving it a niche in novel applications. Its main drawback, however, remains the separation of the exciton in the solar cell. Organic solar cells have a higher exciton binding energy, so the exciton is only separated at donor-acceptor interface. To address this, current research has given rise to large improvements in exciton diffusion lengths and higher interface surface areas with the use of nanostructures. In industry, organic solar cell efficiencies have been growing steadily with Konarka already achieving an efficiency of 8%.

Qn 3: Discuss some promising 3rd generation PV designs. What role does nanotechnology play in these designs?

Triple-junction tandem solar cells have the highest efficiencies of all solar cells, but suffer from extremely high costs. However, by implementing them into concentrator cells, the cost can be greatly reduced. The efficiency of these tandem cells can be further increased by using the third generation technology of quantum dots (QDs) as is being pursued by the Hinzer group at the University of Ottawa. Triple Junction tandem cells have a stiff requirement of current matching to optimize device performance. QDs can be implemented in tandem cells to tune which parts of the solar spectrum specific junctions absorb, thus allowing for current matching and optimal performance.

As an alternative approach, efficiencies equivalent to those of triple-junction solar cells can be achieved by making a double-junction tandem solar cell consisting of a 1.7 eV bandgap material on silicon, However, it is difficult to this fabricate this double-junction because there is no 1.7 eV bandgap material which is lattice-matched to silicon. One promising method of avoiding this lattice matching condition is the use of nanowires (NWs) in solar cell design as is being pursued by the LaPierre group at McMaster University. AlGaAs NW solar cells can be grown on existing silicon solar cells to make tandem cells. Even though these materials are lattice-mismatched, the NWs will be defect free due to the relaxed lattice matching conditions for NWs. As such, a double-junction solar cell with high crystal quality can foreseeably be fabricated.