The Final Oral Examination
for the Degree of

DOCTOR OF PHILOSOPHY
(Department of Chemistry)

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2009 University of Victoria B.Sc (Chemistry)

“Fabrication and Application of Light Harvesting Nanostructures in Energy Conversion”

Monday, December 22\textsuperscript{nd}, 2014
2:00 PM
ECS 128

Supervisory Committee:
Dr. Alexandre G. Brolo, Department of Chemistry, UVic (Supervisor)
Dr. Frank van Veggel, Department of Chemistry, UVic (Member)
Dr. Matthew Moffitt, Department of Chemistry, UVic (Member)
Dr. Chris Papadopoulos, Department of Electrical & Computer Engineering, UVic (Outside Member)

External Examiner:
Dr. Timothy Kelly, Department of Chemistry, University of Saskatchewan

Chair of Oral Examination:
Dr. Hua Lin, Department of Linguistics, UVic
Abstract

The production of an efficient and low cost device has been the ultimate goal in the photovoltaic cell development. The fabrication and application of nanostructured materials in the field of energy conversion has been attracting a lot attention. In this work, applications of surface plasmons (SPs) and photonic nanostructures to the field of energy conversion, specifically in the area of silicon solar cells and lanthanide energy upconversion (UC) luminescence applications were studied. Enhanced power conversion efficiency in bulk (single crystalline) silicon solar cells was demonstrated using an optimized mixture of the silver and gold nanoparticles (NPs) on the front of the cell to tackle the negative effect in the Au NPs plasmonic application. Then, a comparison of identically shaped metallic (Al, Au and Ag) and nonmetallic (SiO$_2$) NPs integrated to the back contact of amorphous thin film silicon solar cells were investigated to solve a controversy issue in literature. The result indicates that parasitic absorption from metallic NPs might be a drawback to the SPs enhancement. A cost-effective fabrication of large area (5x5 cm$^2$) honeycomb patterned transparent electrode for “folded” thin film solar cell application by combining the nanosphere lithography and electrodeposition were realized. Furthermore, the SPs enhanced tunable energy up conversion from NaYF$_4$:Yb$^{3+}$/Er$^{3+}$ NPs in nanoslits were also demonstrated, our results shows that the relative red/green emission can be controlled by different plasmonic mode coupling.
Awards, Scholarships, Fellowships

2010- Student poster award 3rd place, the Canadian section of the electrochemical society (ECS), Conference (2010)

Presentations

3. Exchange student 2011: UVic, ISEVic and China energy collaboration exchange
4. 217th ECS meeting 2010: Oral: Plasmon Enhanced Solar Cells
5. ECS SFU 2010: Poster: Plasmon Enhanced Performance of Photovoltaic Cell on Structured Front/back Electrode

Publications¹⁻⁵

2. Wang, P. H.; Millard, M.; Brolo, A. G. Optimizing Plasmonic Silicon Photovoltaics with Ag and Au

