



Research Projects on Next Generation Solar Cells, Lithium Ion Batteries, Wellness sensors and Intelligent Precision Agriculture Sensor Systems

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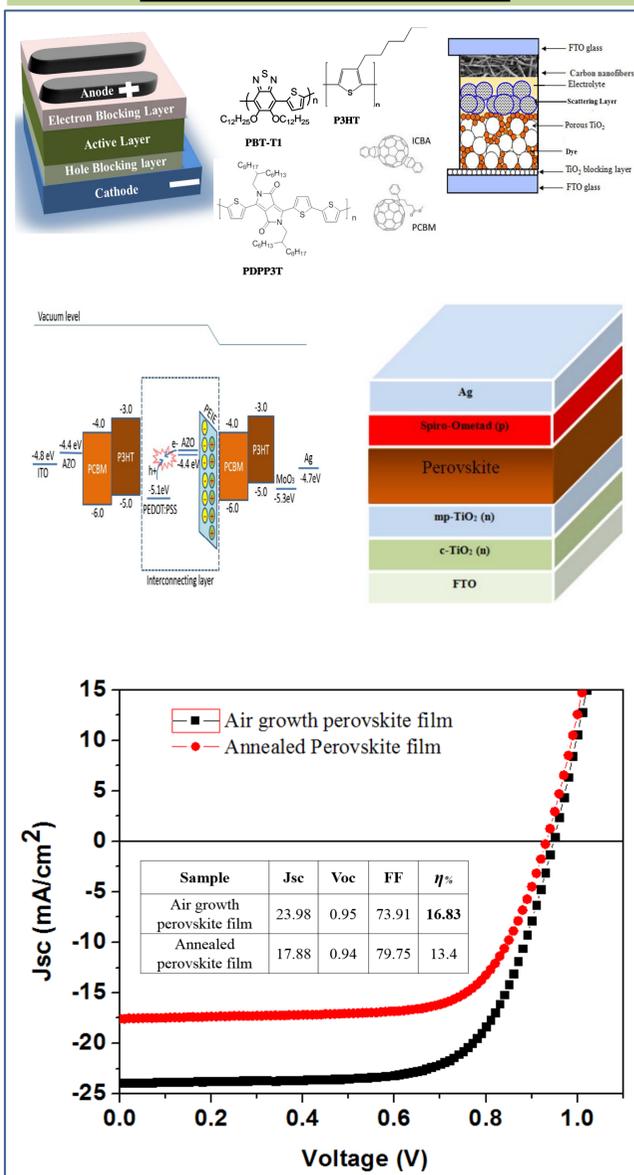
Objectives

- ❖ Develop low cost solution processable next generation high efficiency and high stability solar cells.
- ❖ Create light weight portable lithium ion batteries with larger charging/ discharging cycles.
- ❖ Develop graphene based flexible wellness sensors to detect glucose, alcohol and diabetes.
- ❖ Generate electrochemical sensors for precision agricultural applications.
- ❖ Simulate devices (e.g., solar cells, batteries, sensors) using kinetic Monte Carlo method.

Motivations

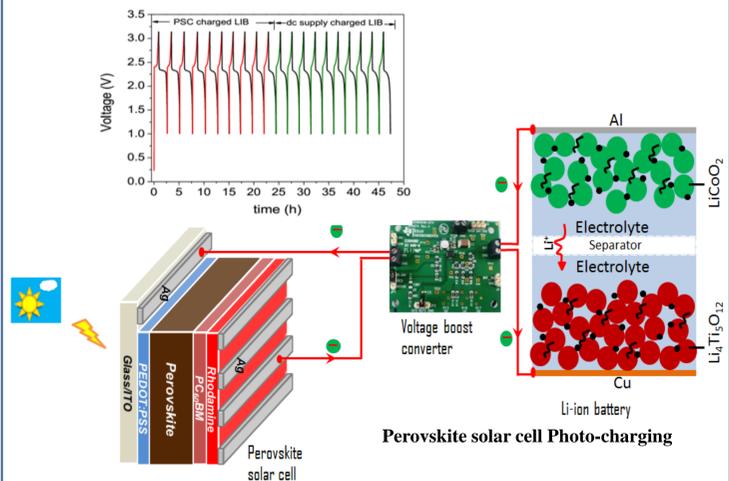
- ❖ Need high performance solar cells and batteries for renewable energy generation and storage.
- ❖ Need novel sensors with high sensitivity, selectivity and reliability for biomedical and precision agriculture applications.

Next Generation Solar Cells

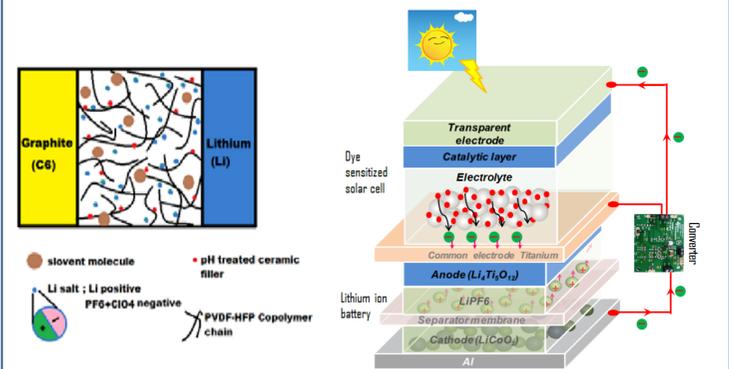


Solar Rechargeable Batteries

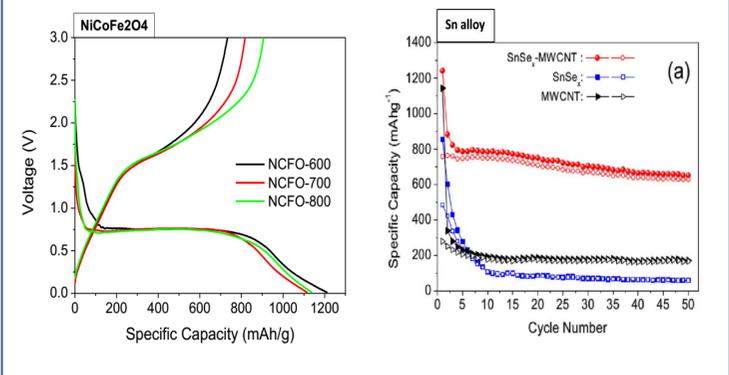
- ❖ Isolated photo-charging was investigated using DC-DC power conversion and energy generation from Perovskite solar cells.



- ❖ Integrated solar cell - battery devices combine two functions: solar energy generation and storage into one unit. Integrated photo-charging is being investigated using DC-DC power conversion and energy generation from dye sensitized solar cells.

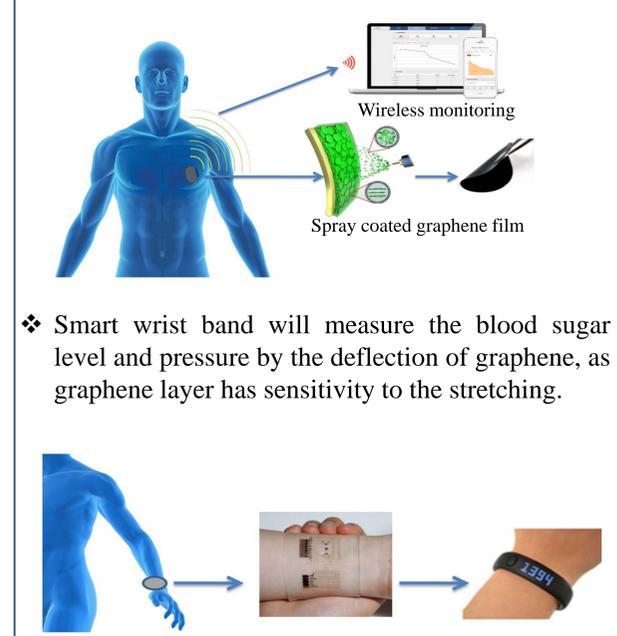


- ❖ Novel high capacity battery materials such as Tin alloys, transition metal oxides, composite gel polymer electrolyte with nano-fillers were synthesized and investigated.

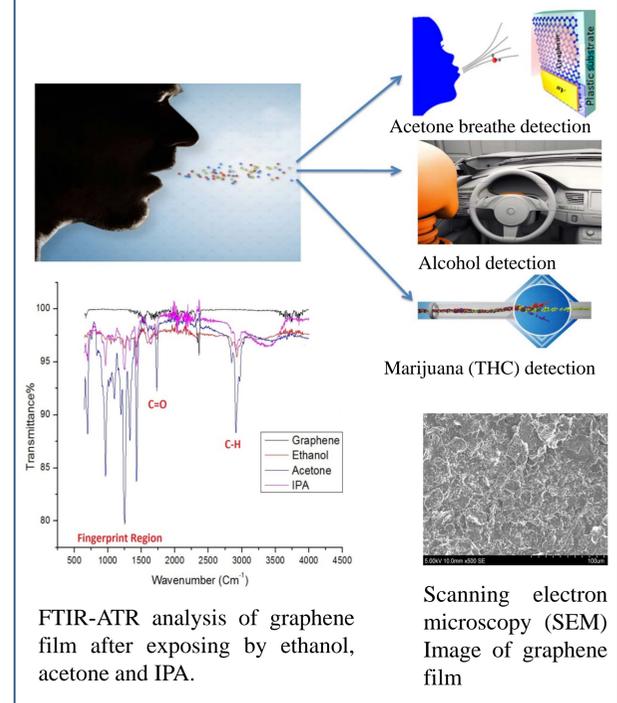


Flexible Wellness Sensors

- ❖ Biosensors monitor heartbeat rate using graphene as an active layer. Data was transferred from digital bands to ProfilePlan.net, personal computers, laptops, and/or Mobile Apps.

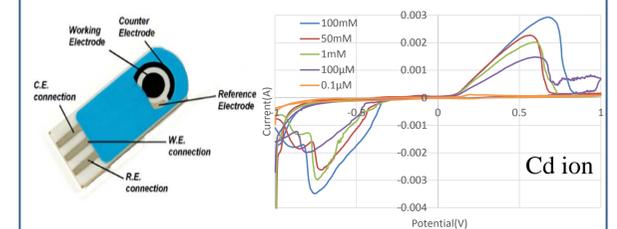


- ❖ Smart wrist band will measure the blood sugar level and pressure by the deflection of graphene, as graphene layer has sensitivity to the stretching.
- ❖ Graphene based breathing sensors can detect diabetes, alcohol and marijuana from breathing because graphene has strong sensitivity to ethanol, acetone and tetrahydrocannabinol (THC) which usually present in the persons breathing if they are drunk, diabetes patient or induced by marijuana (accordingly) more or less.

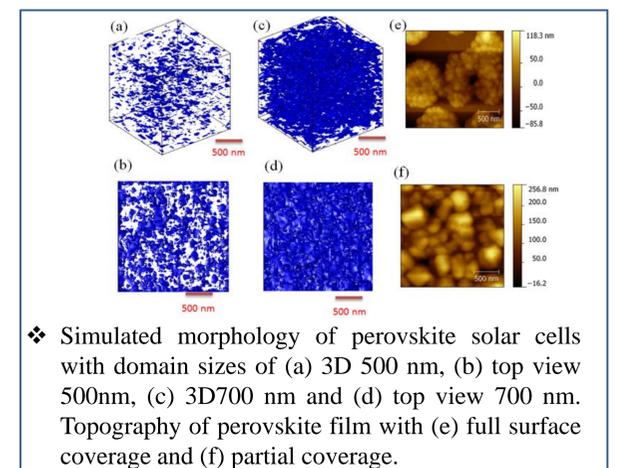


Agriculture Sensors

- ❖ Graphene oxide/silver nanowire (AgNW) electrode is very promising for detecting heavy metal ions (Pb, Cd) in the soil or water.



Device (e.g., Solar Cells, Batteries) Simulation



Conclusions

- ❖ Achieved low cost air grown highly efficient perovskite solar cell with an efficiency of ~17%.
- ❖ Accomplished photo-charged lithium ion batteries using DC-DC power conversion and low cost solution processable solar cells.
- ❖ Graphene/graphene oxide based wellness and agricultural sensor is on their promising way to be developed.
- ❖ Highly accurate simulator to model devices (e.g., solar cells, batteries) with fundamental physical processes and predict device performance by coupling kinetic Monte Carlo simulation with analytical approaches.

Acknowledgements

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