Homework for Chesapeake Project

Liangbing Hu, MSE

I am an assistant professor in MSE at UMD. I teach a graduate course titled "Nanotechnology for Energy: Principle, Materials and Devices". Last semester, I focused mainly on the technology aspects without mentioning much about sustainability. The workshop was very helpful at least on the following aspects. (1) Now I pay more attention to my personal activities, little things like do not waste water, drive less, and walk to the park (instead of driving for two hundred meters!). I would like to share personal experience with my students in my research group and the class. (2) I will include more materials on sustainability in my class. The motivation for nanotechnology based energy devices is not only about high-performance of devices so that we can have a more confortable. This is more for a sustainable future, for our future generations. I like the example in the workshop. If we think hybrid car allows us to drive five times more energy efficiently. Then we take the advantage of it and drive 10 times more distance, nanotechnology will not help us achieve a sustainable future. Human behavior with new technologies plays a very important role. (3) Lifecycle analysis, material abundance and sustainability are important. I will still focus on ways to advance our technology. But I will definitely also dedicate some time to discuss the other important, non-technical aspects related to sustainability.

Please see my course syllabus, where yellow highlights indicate modifications from last year.

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ENMA 698N: 2011 Fall

Nanotechnology for Energy: Principles, Materials, and Devices

Assistant Professor Liangbing Hu, Materials Science and Engineering Dept.

Supporting books:

Advanced Batteries: Materials Science Aspects: Robert Huggins

Electrochemical Supercapacitors: Scientific Fundamentals and Technological Applications: B. E. Conway

Electrochemical Methods: Fundamentals and Applications: Allen J. Bard

Energy and Sustainability by C. Brebbia and V. Popov

Grading

Homework: 10%

Middle Term Presentation: 30

Final project and presentation: 60%

Course Description

Renewable energy is critical for achieving a sustainable future. This is a comprehensive course with content at the intersection of nanoscale science, engineering and technology. Various types of energy devices will be covered, including solar cell, solar fuel, battery, supercapacitor, fuel cell and microbial fuel cell. Device principles, current technology status and new opportunities of nanotechnology for energy device applications will be discussed in detail.

Topics Include

- Sustainability, energy landscape, and nanotechnology
- Fundamental science of solar cell
- Solar cell devices and nanotechnology development (principle, design, fabrication, and characterization of crystalline silicon, amorphous silicon, CdTe, CIGS, and tandem and organic solar cells, emerging solar cell concept, transparent electrode, flexible solar cell, nanostructures for light trapping, nanowire solar cell, materials and lifecycle analysis, cost and manufacturing aspect of nanotech for solar cells)
- Battery (principle, electrode materials, electrolytes, separators, additives, electrode-electrolyte interface, advanced battery materials with nanotechnology, emphasis on lithium ion batteries and includes lead acid, nickel metal hydride, metal air, sodium sulfur, and redo flow battery, new battery devices, paper and textile energy storage, large scale energy system)
- Supercapacitor, ultracapacitor (principle, electrode materials, nanomaterials) and hybrids
- Solar fuel (principles, challenges, nanomaterials)
- Fuel cell, microbial fuel cell (energy from waste)