UNIVERSITY OF CALIFORNIA
UC RIVERSIDE

The Department of Mechanical Engineering

PRESENTS

Stephen Exarhos, Ph.D. Student
Thomas Lopez, Ph.D. Student

Friday, June 5, 2015
WCH Room 205/206, 11:10AM-12:00PM

Department of Mechanical Engineering Colloquium

Aerosol spray pyrolysis synthesis of CZTS nanostructures for use as the absorber layer in thin film photovoltaics,

By: Stephen Exarhos

Abstract:

As harmful effects caused by the extraction, purification, and combustion of natural resources for energy generation become more clearly understood, the need for economically competitive renewable energy becomes more desirable. Solar energy-generation is a technologically feasible method, though its primary drawback is cost. Traditional single-crystal silicon-based photovoltaics are too expensive to compete with nonrenewable energy generation, while alternative materials such as cadmium telluride and copper-indium-gallium-selenide contain expensive and unsustainable elements, while cadmium is a known carcinogen. Copper-zinc-tin-sulfide (CZTS) is an another alternative material, though the technology is not yet advanced enough to have reached the market.

The work presented is a study of the viability of synthesizing CZTS nanostructures using aerosol spray pyrolysis in an inexpensive, environmentally friendly, and industry-scalable way. We aerosolize a precursor solution with dissolved copper, zinc, and tin compounds and pass the droplets through a furnace, where the precursors dissolve and thermally form CZTS structures. Using this method, we can generate thin films — by placing a substrate within the furnace — and nanoparticles. While stoichiometric CZTS seems to be formed consistently, the films grown tend to be inhomogeneous in composition and morphologically unstable, yielding an inefficient material for two-dimensional photovoltaics. Nanoparticle synthesis seems to be the more appropriate application of spray pyrolysis with this material system. We have shown the ability to control the composition and doping of CZTS nanoparticles, and preliminary efforts in coating and sintering the nanoparticles into crystalline films are promising.

About the Speaker:

Stephen is a second-year PhD student in Lorenzo Mangolini's lab at UC Riverside, having joined in the fall of 2013. In 2013, Stephen also worked as a software engineer at PNNL. In 2012, he graduated with a BA in physics from Lawrence University in 2012, where he spent a summer studying non-intrusive diagnostic techniques for toroidally-confined pure-electron plasma. He also conducted an independent project studying the effect of surface morphologies and materials on performance in commercially available soccer balls.

Bulk nanostructured materials from non-thermal plasma produced nanopowders

by Thomas Lopez

Abstract:

The use of a continuous flow non-thermal plasma reactors (CFNTPRs) for the formation of silicon nanoparticles has attracted great interest because of the advantageous properties of the process [1]. Despite the short residence time in the plasma (around 10 milliseconds), a significant fraction of the precursor, silane, is converted and collected in the form of nanopowder. CFNTPRs give the ability of controlling size, structure, and surface termination of nanoparticles. This unique capability allows for an unprecedented degree of control on the structure of bulk materials obtained via hot press densification processes. This technique is applied to produce nanostructured bulk systems of silicon, to investigate the influence of nanoparticle processing conditions on thermal transport properties.

1. Mangolini, L., et al., Nano Letters, 2005. 5(4): p. 655-659.

About the Speaker:

Originally from Saint Paul, Minnesota
Received a B.S. in Physics and Mathematics from Augsburg College in 2011
4th year PhD student currently working in Lorenzo Mangolini's Lab