

The KAIST Lectures in Materials Science and Engineering 2017

October 23~24, 2017, KAIST Applied Engineering B/D(W1), Multimedia Hall(1st Floor)

Prof. Paul C. McIntyre (Stanford Univ.)

Rick And Melinda Reed Professor In the School of Engineering and Senior Fellow, by Courtesy, At the Precourt Institute for Energy

Lecture 1

October 23, Monday / 16:30

“Applications of Atomic Layer Deposition in Solar Fuel Synthesis”

Atomic layer deposition (ALD), a cyclic form of chemical vapor deposition which occurs via a series of self-limiting chemisorption reactions, is increasingly used in fabricating microelectronic devices because of its remarkable potential for depositing a very wide range of thin films of well-controlled thickness and uniformity over a large variety of substrates. Exciting applications of ALD in energy technologies have also emerged in recent years, particularly in photovoltaics and micro-fabricated solid oxide fuel cells. In this presentation, I will summarize recent research in which ALD has been used to prepare stable photoelectrodes for efficient solar-driven water splitting to create hydrogen fuel. ALD-grown TiO₂ layers are found to be particularly effective in inhibiting oxidative corrosion of high-quality semiconductor absorbers and in electronically coupling these semiconductors to efficient catalysts for oxygen evolution, the kinetically-limiting step in water splitting. This talk will describe factors influencing the electronic conductivity of ALD-TiO₂, and design principles for optimizing the photovoltage of these protected semiconductor junctions. Atomic layer deposition of TiO₂-transition metal oxide alloy layers that can function as efficient oxygen evolution catalyst layers and high work function Schottky contacts for water splitting photoanodes will also be reported.

Lecture 2

October 24, Tuesday / 10:30

“Nanowire Structure, Luminescence Characteristics and Carrier Dynamics in the SiGe, Ge and GeSn Systems”

This presentation will describe the properties of semiconductor nanowires in the Si-Ge-Sn system, in which the nanowire geometry and core-shell structures enable independent control of strain, composition and surface defect passivation. Nanowires of 10 nm to 300 nm diameter are synthesized by locally-catalyzed vapor-liquid-solid crystal growth on both silicon and germanium single crystal substrates. Fundamental photonic and electronic characteristics relevant to nanoscale optoelectronic devices are emphasized.

Highlights include synthesis of single crystal GeSn alloy nanowires with tin content significantly higher than the bulk solubility limit and which exhibit strong direct-gap photoluminescence at room temperature. The nanowire geometry promotes a Sn-stabilized direct gap transition by minimizing compressive misfit strains resulting from 2-dimensional growth on misfitting Ge or Si bulk substrates, providing an exciting approach to group IV semiconductor light emitters. Carrier dynamics in VLS-grown Ge nanowires are probed by ultrafast pump-probe transient absorption measurements and a systematic modelling methodology. Design rules for use of larger band gap Si, SiGe and germanium oxide shells that suppress non-radiative carrier recombination in Ge-core nanowires are described.

■ Professor



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■ Bio

McIntyre's group performs research on nanostructured inorganic materials for applications in electronics, energy technologies and sensors. He is best known for his work on metal oxide/semiconductor interfaces, ultrathin dielectrics, defects in complex metal oxide thin films, and nanostructured Si-Ge single crystals. His research team synthesizes materials, characterizes their structures and compositions with a variety of advanced microscopies and spectroscopies, studies the passivation of their interfaces, and measures functional properties of devices.

Academic Appointments

- Professor, Materials Science and Engineering
- Senior Fellow (By courtesy), Precourt Institute for Energy
- Member, Bio-X

Professional Education

- ScD, MIT (1993)

Administrative Appointments

- Department Chair, Materials Science and Engineering (2014 - Present)
- Director, Geballe Laboratory for Advance Materials (2008 - 2013)

■ About “The KAIST Lectures in Materials Science and Engineering”

The Department of Materials Science and Engineering at KAIST proudly presents the KAIST Lectures in Materials Science and Engineering 2017. In this lectureship, an internationally leading researcher in materials science and engineering at a foreign institution is selected and invited to give a series of lectures. The lectures are open to students and faculty as well as alumni and friends. The visiting lecturer, in addition to giving the seminars on recent trends and advances in his / her field, is asked to participate in informal discussions with KAIST faculty and students.