



LINK FOUNDATION FELLOWSHIPS NEWSLETTER

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Can Bayram

Department of Electrical Engineering and Computer Science/
Center for Quantum Devices
Northwestern University

High Performance III-Nitride Optoelectronic Devices: Ultraviolet Detectors, Visible Emitters and Intersubband Devices Research Advisor: Dr. Manijeh Razeghi and Dr. Walter P. Murphy



Mr. Bayram's research focuses on III-Nitride photonic devices, which can be gap-engineered over a wide optical range from deep ultraviolet (UV) and visible towards terahertz (THz) spectra.

Ultraviolet region is very important as many biological agents (such as anthrax and smallpox) are luminescent in UV. Development of high performance UV photodiodes (based on AlGaIn materials) offer compact reliable substitutes to the bulky and fragile photomultiplier tubes, and UV-filter-requiring Si(C)-based photodiodes.

Visible region is very important as solid state lighting (SSL) offers more energy-efficient, more compact, longer-lasting, and environmental substitute for today's incandescent and fluorescent lighting sources. However, a long time the "green gap" – significant performance decrease with increased indium content in the InGaIn active layer – has prevented its penetration into our lives along with its benefits. Mr. Bayram has addressed the challenges associated with high performance green emitters for enhanced SSL applications.

Lying in the margin of electronic and photonic technologies, THz waves (3 mm to 30 μm) are a big challenge to generate. His current research on AlGaIn/GaIn-based quantum engineered devices will lead to a continuous monitoring (chemical-agents, illegal drugs, explosives, and weapons) of an environment, improving the security and safety at check-points without effecting privacy or health.

Jayakanth Ravichandran

Applied Science and Technology
University of California, Berkeley
Thermoelectric Oxides for Waste Heat Recovery
Research Advisor: Prof. Ramamoorthy Ramesh



Thermoelectric energy conversion provides attractive advantages like lack of moving parts, very high reliability and long life. In spite of these advantages, these devices are plagued by very low energy conversion efficiency. The efficiency of such devices is related to three important material parameters and increasing these efficiency is extremely difficult due to the coupling between these parameters. To put things in perspective, the state-of-the-art thermoelectric device can reach an efficiency of ~10% at an optimum temperature range, whereas the best heat engines work close to 30-40% efficiency. Our approach to this problem is to identify parameters which will help us decouple these quantities to achieve high efficiency. Particularly, we have chosen

oxides as our system of interest due to several advantages such as high temperature stability, environmentally benign nature, possibility of cheap materials processing and component elements being abundant in the earth's crust. Combined with our scientific approach, oxides will make a perfect thermoelectric material and can be one of the solutions for the global energy crisis. Thus, in the future, this work can lead to commercial technologies affecting energy supply, utilization and demand.

Adam Straith Brewer

Materials Science Program
University of Wisconsin, Madison
Organic-Copper Sulfide Heterojunctions for Economical Solar Energy Harvesting
Absorbers for Economically Efficient Photovoltaics
Research Advisor: Dr. Michael Arnold and Intersubband Devices
Research Advisor: Dr. Manijeh Razeghi and Dr. Walter P. Murphy



Cu₂S potentially has the best combination of cost and efficiency of all known absorber semiconductors. This is due to a band gap of 1.2eV and an absorption coefficient >10⁵ cm⁻¹ at 550 nm. Cu and S are also extremely abundant and nontoxic as opposed to CdTe and CIGS which are the other prominent solar materials in production today.

Using organic materials with copper sulfide to make solar cells, readily lends itself towards scalable, efficient industrial

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production, and with the great variety of small molecules and polymers available there exists an extensive array of electronic properties that could potentially be matched with copper sulfide's to form an efficient solar cell.

My research into this promising system has two thrusts. First is the development of a Cu₂S-Organic system using recent advances in the production of copper sulfide thin films. This research will focus on cost effective low temperature and solution processes, for both Cu₂S and the organic layers.

Second is the investigation of the electronic properties at the interface between the organic and inorganic layers, including interface states, charge transport, copper diffusion into the organic, and defect formation between Cu₂S and a variety of organic electron acceptors. Improving our understanding of these properties is crucial for the development of solar cells in general, and provides a foundation for moving into the promising system of copper sulfide-organic solar cells.