

“BNC Seminar”

April 13th, 2015 @ 11:00am

BRK, ROOM 1001

Devin MacKenzie

Title: Towards Roll-to-Roll Manufacturing Enabled by Solution Processable Optoelectronic and Energy Storage Materials

Bio: Devin MacKenzie is an expert in emerging printable and flexible electronic materials with 15 years of experience starting and leading research and development in these fields in the US, Europe and Asia. He is currently the CEO of Imprint Energy, a UC Berkeley spin-out developing ultrathin, zinc polymer flexible batteries based on large-area and roll-to-roll printing processes for wearable electronics, medical devices and the internet of things. Previously, as the CTO of Add-Vision, Inc., Dr. MacKenzie led all materials, device and process development for fully printed flexible OLED displays. At Add-Vision, Devin was directly responsible for increasing OLED device lifetimes by 1000X and developing a fully printed, flexible OLED printing and encapsulation process on sheet and roll-to-roll systems. Prior to Add-Vision, he initiated and led printed Si RF device engineering at Kovio, Inc., an MIT Media lab startup, resulting in the demonstration of printed, thin film GHz devices. In the UK, Dr. MacKenzie co-founded the world's first printed transistor company, Plastic Logic, from the University of Cambridge while he was a research staff member in the Department of Physics researching self-assembled organic photovoltaics OLEDs. He has 110 patents and publications and doctorate, master's, and undergraduate degrees from the University of Florida and MIT with specialization in nanoscale, Si, and III-N optoelectronic materials, devices, and processing.

Abstract: Over the past two decades there have been substantial advances in molecular, polymeric, and nanoscale electronically and optically functional materials. At the same time, 1D and 2D nanomaterials and high conductivity, stable ionic liquids have been developed which can enhance the performance of capacitors and batteries and allow for lower volatility, lower toxicity and more stable electrochemistry. These materials can bring remarkable new optical, sensing and storage capabilities, tunable by chemistry, in new form factor displays, energy harvesters, biosensors, supercapacitors and batteries. Perhaps even more disruptive is the ability of these new materials to be deposited from solution in printing and coating processes. This allows electronics manufacturing to move away from conventional vacuum deposition, subtractive patterning and low throughput assembly process in controlled environments. In contrast, these new materials can enable additive roll-to-roll printing of large area integrated electronics and energy storage with reduced carbon footprint, materials waste, toxicity and environmental impact. Case studies will be presented where carbon-based, semiconductors, conductors and ionic liquids have been combined in novel ways to overcome key challenges in the manufacturing of flexible batteries and OLEDs. These challenges include electrode instability, electrolyte ionic conductivity versus volatility, process throughput and environmental control, and liquid ink to solid film morphology control. Electrochemically doped printed OLEDs, with long luminance and product lifetimes exceeding vacuum deposited plastic substrate equivalents have been demonstrated for mobile applications. Using printable fluorinated copolymer and ionic liquid gels and engineered electrode inks, highly flexible non-toxic, zinc rechargeable batteries with energy densities as high as 300 Wh/L and discharge rates of $>10C$ and 20 mA/cm^2 have been demonstrated. This exceeds the capacity of inflexible, inert gas assembled lithium polymer cells at equivalent thicknesses. These non-toxic printed zinc polymer batteries have been effectively integrated with sensors, displays and wireless connectivity modules in wearable and medical devices. These two demonstrations show the path towards integrating flexible display, sensing and energy storage devices in continuous, low carbon footprint, environmentally friendly high throughput monolithic printed processes.