Title: From materials deposition to flexible systems: integrating devices with printing technologies

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Abstract: Traditionally printed and flexible devices were mainly applied to displays and solar cells. In recent years wearable electronic gadgets and Internet of Things have also been identified as potential areas where added flexibility, conformability and lower fabrication cost are desired. The shift in applications may bring new opportunities for printing technologies as lifetime requirements for wearables is different than that of large area electronics. The focus of materials development however remains the same. Printable materials need to be stable in air and processing cannot compromise the electronic performance of materials. Most systems are composed of sensors, electronic circuits and power sources. We have focused our research efforts on printing light sources, photodetectors, batteries, solar cells and passive components. Using these devices as building blocks, we combine screen-printing, inkjet printing, spray deposition and blade coating to integrate devices and demonstrate systems. In this talk, we will discuss details of each printing process and the design of an energy storage and harvesting system for wearable electronics. The battery consists of printed anode and cathode layers based on graphite and lithium cobalt oxide, respectively, on thin flexible current collectors. It displays energy density of 6.98 mWh/cm2 and demonstrates capacity retention of 90% at 3C discharge rate and ~99% under 100 charge/discharge cycles and 600 cycles of mechanical flexing. A solar module with appropriate voltage and dimensions is used to charge the battery under both full sun and indoor illumination conditions, and the addition of the solar module is shown to extend the battery lifetime between charging cycles while powering a load. Furthermore, we show that by selecting the appropriate load duty cycle, the average load current can be matched to the solar module current and the battery can be maintained at a constant state of charge. Finally, the battery is used to power a pulse oximeter, demonstrating its effectiveness as a power source for wearable medical devices.