

Plants-Electronics Interface

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Monday, December 9, 2019

11:30 – 12:30 p.m. – Room 66-110

Plants are complex biological organisms that comprise our primary source of food, but are also a source of oxygen, renewable energy, materials, medicines and regulators of the ecosystem. The interface of plants with electronic materials and devices has not been widely explored although there are many possibilities from controlling plant functions, to energy, sensing and bio-hybrid systems. We demonstrated that water-soluble conducting polymers and oligomers can self-organize or polymerize in vivo, with the plant acting as the catalyst and template for the chemical reaction. We manufactured analogue and digital circuits in the organs of a plant as well as super capacitors for energy storage. Our latest findings show that the conjugated oligomers organize and form conductors in parallel with the growth of the plant. The polymerization of the conjugated oligomers is driven from the lignification process, integrating the conducting polymers in the cell wall. The biohybrid system is further explored in energy applications.

In addition, we are developing bio-electronic devices to sense and actuate plant functions. We fabricated a capillary based organic electronic ion pump (c-OEIP) that enables implantation in soft tissue. The c-OEIP is used to control the stomata in leaves. Stomata, the microscopic pores in the leaves of plants are fundamental to the plant function as they control the photosynthesis and transpiration rate. By delivering abscisic acid, ABA, also known as the stress hormone, we trigger the stomata closure on demand. The stomata next to the c-OEIP close faster than the ones further away implying dose dependence and revealing the signal propagation kinetics. No significant wound effect from the insertion of the c-OEIP is observed signifying the potential of our method as non-invasive. Furthermore, we developed sensor based on organic electrochemical transistors for biomolecules monitoring in in-vitro and in-vivo plant systems. With this technology we can offer new tools for fundamental understating of plant physiology but also adaptation of plants to environmental changes.
