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Organic semiconducting materials are now being considered as the active materials in displays, electronic circuits, solar cells, chemical and biological sensors, actuators, lasers and memory elements. The flexibility of their molecular design and synthesis makes it possible to fine-tune the physical properties and material structure of organic solids to meet the requirements of technologically significant applications. In contrast to inorganic materials, active organic thin films can be deposited at much lower substrate temperatures (less than 120 °C) in low vacuum or atmospheric pressure environments. It has been demonstrated that low-cost deposition techniques such as solution spin-coating, casting, and even printing can be used for deposition of solution soluble organic materials. These processing advantages, together with the natural abundance of organic solids, make semiconducting organics attractive for large-area and low cost applications.

In this talk, I will discuss our recent work on understanding various aspects in organic semiconductor designs, such as energy level, charge transport type, molecular packing, and morphology and crystallization control. The impact of these various factors on charge transport will also be discussed.