The ability to fabricate molecularly tailored interfaces with nanoscale precision can selectively modulate charge transport and molecular assembly at hard matter-soft matter interfaces, and facilitate transport of the “correct charges” while blocking transport of the “incorrect charges.” This interfacial tailoring can also control carrier-trapping defect densities at interfaces and stabilize them with respect to physical/thermal decohesion.

In this lecture, challenges and opportunities are illustrated for three specific and related areas of research: 1) controlling charge transport across hard matter-soft matter interfaces in electroluminescent devices, 2) controlling charge transport across hard matter-soft matter interfaces in organic photovoltaic cells, 3) controlling charge transport by active layer organization at electrodes. It will be seen that rational interface engineering along with improved bulk-heterojunction polymer structures affords solar power conversion efficiencies above 9% along with greater cell durability.