SEED : Electron-blocking and Hole-blocking Wide-gap Heterojunctions to Crystalline Silicon DMR 0819860

SEED: J.C. Sturm, A. Kahn, J. Schwartz and Y.-L. Loo
Princeton Center for Complex Materials (PCCM)

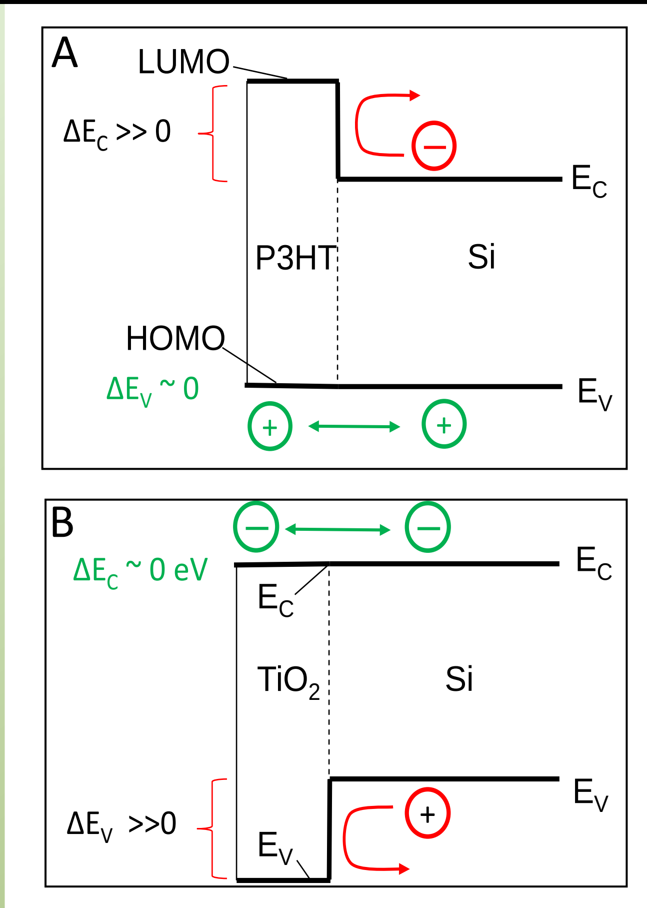

Fig. 1A The energy band edges E_c and E_v in P3HT/Si heterojunction. When the highest occupied band (HOMO) of P3HT is aligned with E_v in Si, electron flow is blocked, but holes are transmitted. Panel 1B shows hole blocking in the complementary TiO_2/Si heterojunction.

Solid-state devices rely on the control of the flow of electrons and holes at the interface (“heterojunction”) formed between different semiconductors. Silicon is the workhorse of the semiconductor industry. However, until now, creating a heterojunction between Si and other materials with a larger energy gap has been an intractable problem for the most part, because of the lack of a lattice match between Si and crystalline wide-gap materials. In this seed, Sturm, Kahn, Schwartz and Loo report two materials that do the job with complementary functionality, using polymers and inorganic amorphous materials to overcome the lattice-match constraint. The organic semiconductor P3HT has a bandgap much wider than that of Si. Due to the appropriate alignment of the band edges, PCCM researchers show [1] that P3HT is an electron blocker, but transmits holes efficiently (Fig. 1A). Conversely, amorphous TiO_2 acts as a hole blocker while efficiently transmitting electrons (Fig. 1B) [2]. Both functionalities, crucial in photovoltaic devices, show the direction towards high-efficiency low-cost cells based on silicon.

1) Avasthi *et al.*, Adv. Mat. **23** (2011).
2) Avasthi *et al.*, Appl. Phys. Lett. **102** (2013)