

Organic ambipolar semiconductors for TFT applications

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Abstract: In the last years we have devoted some effort to the search of new high-mobility semiconductors with ambipolar performances, good processability and environmental stability. Our approach, which is one of the most widely used, consists in the combination of donor and acceptor moieties in the conjugated skeleton, which allows fine tuning of the frontier molecular orbitals.^{1,2} For OTFT applications, low-lying HOMOs are essential to resist air oxidation and thus increase device stability. However, if the HOMO energy is too low, the resulting barrier to hole injection may compromise the transistor performance. Thus, a delicate balance between these two effects is needed.

In particular, we have combined naphthaleneimide-derived moieties as electron accepting groups with electron-rich oligothiophene fragments.³⁻⁵ In these materials, we have found that the presence of ambipolar transport in these planar molecules can be understood on the basis of three interrelated properties: (i) the absence of skeletal distortions allows closer intermolecular π - π stacking and enhanced intramolecular π -conjugation, (ii) increased π -conjugation raises the HOMO energy, which approaches the Fermi level of common used electrodes; and (iii) more planar structures translate into lower Marcus reorganization energies. However, one of the limitations of these types of semiconductors is the presence of a molecular dipole moment, which forces the molecules to pack with pairwise intermolecular interactions orienting the naphthaleneimide cores in opposite directions, decreasing in some cases molecular orbitals overlapping.³⁻⁵ In recent contributions, we have devoted our efforts to analyze the effect of molecular interactions, through chemical modifications in order to induce parallel and antiparallel molecular packing, on the electronic properties of ambipolar semiconductors.

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