Abstract

Applications in the field of organic and hybrid electronics typically employ thin films of conjugated polymers or conjugated organic molecules forming the material class of organic semiconductors (OSCs). To control their conductivity and energy level alignment with other materials including electrodes in devices, doping of OSCs is performed by adding strong molecular donors/acceptors to the semiconductor host in order to initiate charge transfer. In this presentation, the current understanding of the phenomena observed upon molecularly p-doping OSCs will be reviewed, where two different competing scenarios have been identified [1]: integer charge transfer between OSC and dopant thereby forming ion pairs (representing the ultimate goal of doping OSC), and only fractional charge transfer, where ground-state charge transfer complexes (CPXs) through intermolecular orbital hybridization between the OSC and dopant are formed instead, which is highly detrimental to the doping efficiency.

For prototypical OSCs such as poly(3-hexylthiophene) (P3HT) [2] and various oligothiophenes of different chain length [3], I will present our recent findings on what role, (i), the arrangement of dopant and host species in thin films plays for the respective doping scenario (as resolved by synchrotron grazing incidence X-ray diffraction in combination with various spectroscopies), as well as, (ii), that of dopant strength and, (iii), OSC conjugation length. From these studies emerged design strategies for improved doping agents which we recently followed to successfully suppress CPX formation and increase the doping efficiency by exploiting steric hindrance in a novel, non-planar p-dopant of 3D shape [4].

References

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