Charge transport in organic semiconductor devices

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Charge transport in organic semiconductor devices depends strongly on both, the intrinsic properties of the semiconducting molecules and the device structure. Indeed, a number of parameters such as charge flow direction, charge carrier concentration, electric field strength or dielectric environment are set by the device type and by its operating set-point (applied voltages) and can have strong impact on the charge carrier transport mechanism. As charge transport is generally investigated by measuring the current-voltage characteristics of a given device (e.g. organic field-effect transistor or single carrier space-charge limited current device), the extracted carrier mobility values need to be analyzed by taking into account the device specific environment. On the other hand, investigating charge transport in a given organic semiconductor by using dissimilar devices can be an efficient way to yield complementary information and allow a more profound understanding of the relationship between molecular structure and charge transport mechanism.

In this presentation, we will illustrate the above statement by describing several charge transport studies performed on different semiconducting polymers and on their blends with fullerene derivatives. In each case, both organic field-effect transistors and space-charge-limited current devices have been used. We will show in particular how this experimental methodology can lead to data on electronic density of states distributions as well as on charge transport anisotropy.