Supporting Information for “Charge transport in mixed organic disorder semiconductors: trapping, scattering, and effective energetic disorder”

Derivation of equation 6:

Assume that two materials are in the mixed organic semiconductors: material A with a content of x (mol), a energy level of ε_A, a disorder (standard deviation) of σ_A and a density function of $p(A)$; material B with a content of 1-x (mol), a energy level of ε_B, a disorder (standard deviation) of σ_B and a density function of $p(B)$.

Then the equations below are obtained:

$$\int p(A)\, d\epsilon = 1,\ \int p(B)\, d\epsilon = 1$$

$$\int \epsilon \cdot p(A)\, d\epsilon = \varepsilon_A,\ \int \epsilon \cdot p(B)\, d\epsilon = \varepsilon_B$$

$$\int \epsilon^2 \cdot p(A) = \varepsilon_A^2 + \sigma_A^2,\ \int \epsilon^2 \cdot p(B) = \varepsilon_B^2 + \sigma_B^2$$

And the density function of the mixed system, p_m, and the average energy level of the mixed system, ε_m, will be

$$p_m = x \cdot p(A) + (1-x) \cdot p(B) \text{ and } \varepsilon_m = x \cdot \varepsilon_A + (1-x) \cdot \varepsilon_B.$$

The deviation of the mixed system, σ_m^2, will be

$$\sigma_m^2 = \int (\epsilon - \epsilon_m)^2 \cdot p_m d\epsilon$$

$$= \int [\epsilon - (x \cdot \varepsilon_A + (1-x) \cdot \varepsilon_B)]^2 \cdot \big(x \cdot p(A) + (1-x) \cdot p(B)\big) d\epsilon = I_A + I_B$$

where $I_A = \int [\epsilon - (x \cdot \varepsilon_A + (1-x) \cdot \varepsilon_B)]^2 \cdot x \cdot p(A) d\epsilon$ and

$I_B = \int [\epsilon - (x \cdot \varepsilon_A + (1-x) \cdot \varepsilon_B)]^2 \cdot (1-x) \cdot p(B) d\epsilon.$

$$I_A = \int [\epsilon - (x \cdot \varepsilon_A + (1-x) \cdot \varepsilon_B)]^2 \cdot x \cdot p(A) d\epsilon$$

$$= \int \epsilon^2 \cdot x \cdot p(A) d\epsilon + \int 2\epsilon \cdot (x \cdot \varepsilon_A + (1-x) \cdot \varepsilon_B) \cdot x \cdot p(A) d\epsilon + \int (x \cdot \varepsilon_A + (1-x) \cdot \varepsilon_B)^2 \cdot x \cdot p(A) d\epsilon$$

$$= x \cdot (\varepsilon_A^2 + \sigma_A^2) + 2x \cdot (x \cdot \varepsilon_A + (1-x) \cdot \varepsilon_B) \cdot \varepsilon_A + x \cdot (x \cdot \varepsilon_A + (1-x) \cdot \varepsilon_B)^2$$

$$= x \cdot \sigma_A^2 + x \cdot (1-x)^2 \cdot (\varepsilon_A - \varepsilon_B)^2.$$

Similarly, $I_B = (1-x) \cdot \sigma_B^2 + (1-x) \cdot x^2 \cdot (\varepsilon_A - \varepsilon_B)^2.$

So we get $\sigma_m^2 = I_A + I_B = x \cdot \sigma_A^2 + x \cdot (1-x) \cdot (\varepsilon_A - \varepsilon_B)^2 + (1-x) \cdot \sigma_B^2$.

This equation is valid for any type of DOS.

Generalization of our conclusion to the TPD hosted system and NPB hosted systems[12,13] reported by So *et al.*

Table S1. The critical ΔE and the effects of traps and scatters on hole transport characters in TPD hosted system and NPB hosted system.

Host	μ_h (cm^2/Vs)	$\Delta E_{critical}$(eV)	σ_{exp} (meV)	λ		ΔE	μ_h (cm^2/Vs)	σ_{exp} (meV) [c)]	λ
TPD[12]	7.87×10^{-2} [a)]	0.20	76	2.1	TPD: Rubrene	-0.1 (shallow trap)	3.21×10^{-2}	80 (79)	2.4
					TPD:DCM1	-0.2 (shallow trap)	4.29×10^{-3}	103 (88)	6
NPB[13]	6.6×10^{-3} [b)]	0.23	75	1.3	NPB:DCM1	-0.2 (shallow trap)	1.0×10^{-3}	100 (88)	Dispersive
					NPB:DCM2	-0.2 (shallow trap)	1.5×10^{-3}	98 (88)	Dispersive
					NPB:TBu-TBD	0.4 (high scatter)	4.7×10^{-3}	74 (75)	1.5
					NPB:BCP	1.0 (high scatter)	6.2×10^{-3}	77 (75)	2.0
					NPB:CuPc	-0.3 (deep trap)	6.0×10^{-3}	— (75)	2.5

[a)] Hole mobilities of the TPD system are the zero field mobilities.
[b)] Hole mobilities of the NPB system are under the field of 0.29 MV/cm.
[c)] Data in the brackets are the effective energetic disorders calculated via **equation 6**.