

The paper reports the first design and synthesis of structurally simple organic semiconductor that exhibits high hole and electron mobility of up to $2.6 \text{ cm}^2/\text{Vs}$ and $0.13 \text{ cm}^2/\text{Vs}$, respectively, exceptional operational (no degradation in $>10^4$ cycles) and storage stability, along with high solid state emission (photoluminescence quantum yield $\sim 70\%$) and electroluminescence property. These outstanding results challenge the common belief in the field of organic electronics, that efficient π - π interactions and crystalline order required for achieving high charge mobility in organic semiconductors, necessarily gives rise to increasing nonradiative decay paths for excitons that result in partial or complete quenching of the solid state luminescence in the solid state. Indeed, all of the previously reported OSC with charge mobility exceeding that of amorphous silicon ($\sim 1 \text{ cm}^2/\text{Vs}$) showed low or no luminescence in the condensed phase. Density functional theory calculation and analysis of the published literature data gave us an insight into the poorly understood loss mechanisms associated with high charge mobility and derived us to conclusion that singlet exciton fission is one of the main fluorescence quenching mechanism in crystalline organic semiconductors. Accordingly, we proposed a new principle for design of emissive organic semiconductors, based on the relative energy of S1 and T1 excited states ($S_1 > 2T_1$).

