

2D Organic Semiconductor

The discovery of organic semiconductors based on π -conjugated systems opened the opportunities to fabricate low-cost and flexible electronic devices in the near future. Currently, most organic semiconductors can be regarded as one-dimensional charge transporting material because the charge carriers (hole and electron) mainly transport along one π -stacking axis. Random molecular orientation is usually observed in thin film and this results in much lower charge carrier mobility in thin films in comparison to that in crystalline form.

To resolve this problem, we present a concept of using 2D semiconductor which allows 2D charge transport in thin films. A 6,6'-dipentacenyl (**TIPS-DP**, Figure 1) molecule was thus designed and prepared from the corresponding bispentacenequinone by following a similar chemistry to that for pentacene derivatives. **TIPS-DP** showed very good solubility and high thermal and photostability in comparison to other pentacene compounds. More interestingly, this molecule adopts a cruciform shape due to the steric repulsion between the two pentacene units. Such a cross-shaped molecule can self-assemble into an ordered structure and both pentacene units in each molecule can form π - π stacking with the neighboring molecules. As a result, two π -stacking axes (*a* and *b*) are formed as disclosed by single-crystal crystallographic analysis (Figure 1). Therefore, this molecule can be regarded a novel 2D semiconductor allowing 2D isotropic charge transport along the two π -stacking axes. Thin film field-effect transistors (FETs) were fabricated by vapor deposition of the samples onto the self-assembled monolayer modified SiO₂ substrate at various temperatures. Under optimized conditions, the devices exhibited FET mobility up to 0.11 cm²/Vs which is the highest among all cross-shaped semiconductors. Our research represents a new concept on the design of new organic semiconductors in the future. This work was highlighted by T. M. Swager et al in *Synfacts* (2010, 3, 0299).

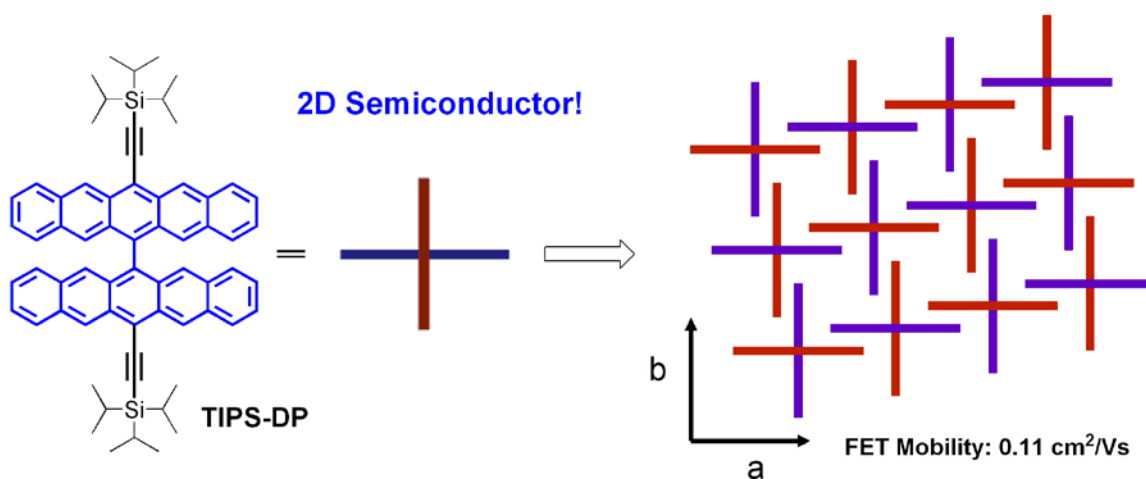


Figure 1. Structure and 2D self-assembly of the cruciform 6,6'-dipentacenyl (**TIPS-DP**).