The thin film transistor characteristics of a soluble molecular semiconductor, terrylene tetracarboxdiimide (TDI), a homologue of perylene tetracarboxdiimide (PDI), have been investigated. In a bottom-gate device structure with benzocyclobutene gate dielectric, n-type behavior with electron mobility of $1.1 \times 10^{-2}$ cm$^2$ V$^{-1}$ s$^{-1}$ has been observed after thermal annealing. When applied in the top-gate structure with a polycyclohexylethylene-based gate dielectric, TDI devices exhibit ambipolar transport with electron and hole mobility of $7.2 \times 10^{-3}$ cm$^2$ V$^{-1}$ s$^{-1}$ and $2.2 \times 10^{-3}$ cm$^2$ V$^{-1}$ s$^{-1}$ respectively. The correlation between morphology and field-effect mobility was investigated by atomic force microscopy (AFM) and X-ray diffraction (XRD) studies. Spin-coated, annealed TDI film crystallize in a terrace structure, and the molecules are packed in an “edge-on” structure, thus forming a favorable packing arrangement for charge transport in the plane of the film.

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