Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Supporting Information

Ultralow-Threshold Up-Converted Lasing in Oligofluorenes with Tailored Strong Nonlinear Absorption

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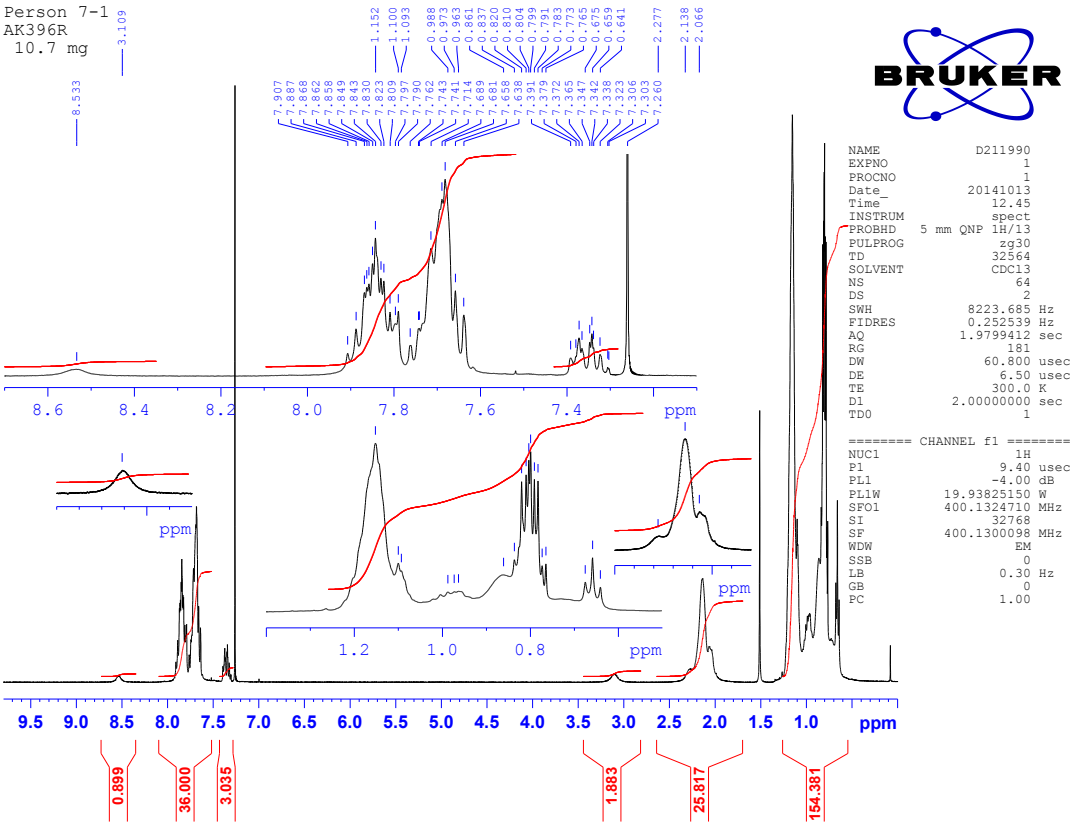

Figure S1. ^{1}H NMR of T6

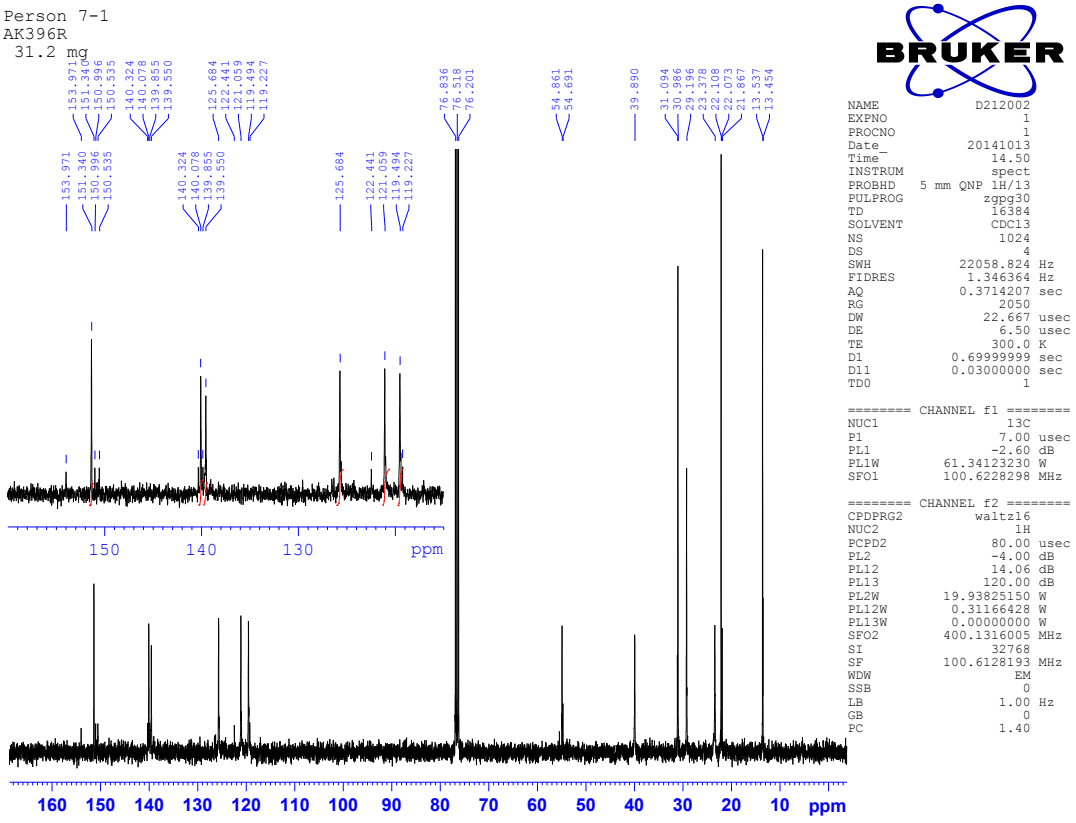

Figure S2. ^{13}C NMR of T6

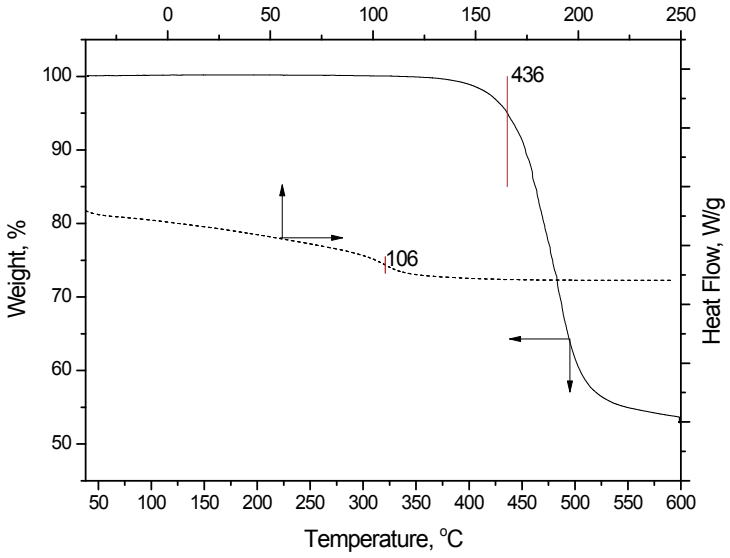

Figure S3. Thermogravimetric (solid line) and DSC (dashed line) analyses of T6 measured at 10 °C/min. The temperature corresponding to 5% mass loss and the glass transition are shown.

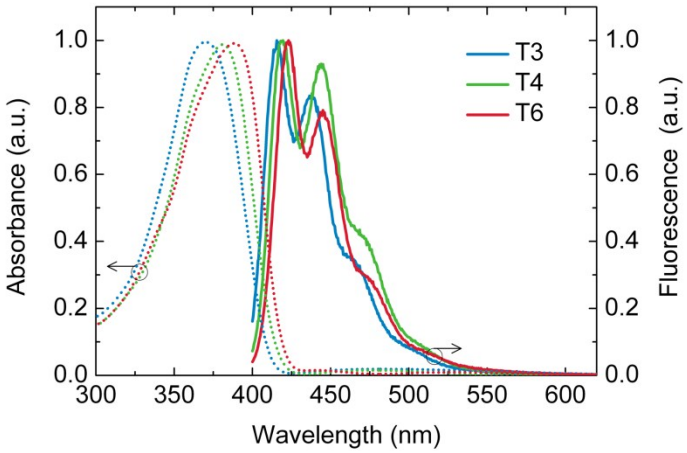

Figure S4. PL and absorbance spectra of T3, T4 and T6 molecules in their solid-films.

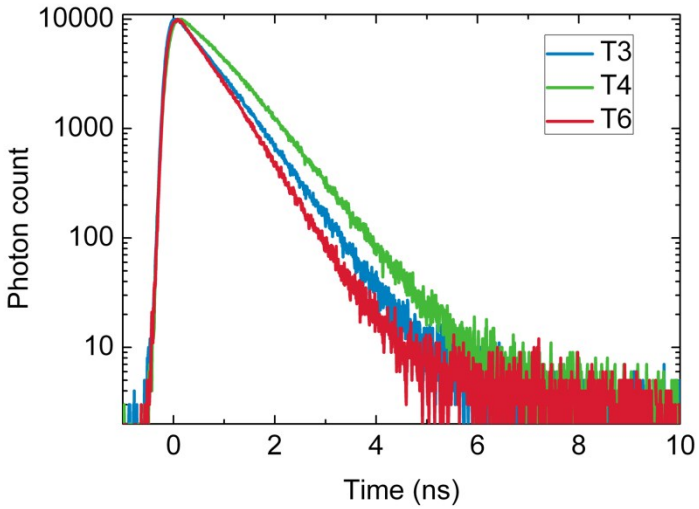

Figure S5. PL decay curves of the T3, T4 and T6 measured at the 0-0 transition peak with 1/e lifetimes of 0.85, 1.14 and 0.78 ns, respectively.

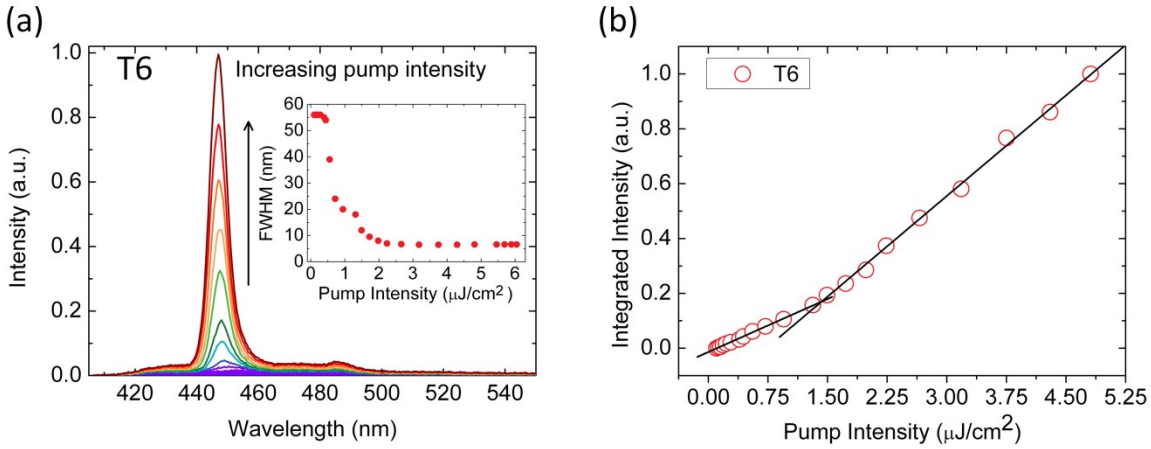

Figure S6. (a) Emission spectra on quartz of the T6 molecules as the pump intensity is increased. 1PA pumped ASE in T6 is clearly visible with an emerging narrow peak at 448 nm. The inset shows the change of the FWHM emission as a function of the pump intensity. (b) Pump intensity vs integrated emission intensity measurement under 1PA pumping in T6 molecules giving 1.43 μJ/cm^2 threshold.

We have measured the extinction coefficients of the truxene oligomers at their peak absorption wavelengths as follows:

$\varepsilon = 411000$ l mol^{-1} cm^{-1} for T3 (Ref. [1])
$\varepsilon = 473000$ l mol^{-1} cm^{-1} for T4 (Ref. [1])
$\varepsilon = 680000$ l mol^{-1} cm^{-1} for T6

For this, we used T3, T4 and T6 solutions (in toluene) at 3.76 10^{-6}, 6.52 10^{-7} and 2.63 10^{-6} mol/L concentrations, respectively.

Table S1. Comparison of the experimental conditions for the frequency up-converted laser thresholds in the organic semiconductors.

Reference	Material	Threshold	Pulse duration	Repetition rate	Excitation geometry	Spot size	Medium	Threshold
This work	Truxene based star-shaped oligofluorenes with 6 fluorene units per arm (T6)	**3.1 mJ/cm²**	**120 fs**	**1 kHz**	**spot**	**1.48 mm**	**1 bar (ambient)**	**3.1 mJ/cm²**
Ref. [2]	Ladder-type poly(p-phenylene) (MeLPPP)	>200 mJ/cm²	150 fs	1 kHz	spot	NA	10^{-4} mbar	>200 mJ/cm²
Ref. [3]	Polyfluorene (PFO)	42 mJ/cm²	100 fs	NA	NA	NA	NA	42 mJ/cm²
Ref. [4]	Bisfluorene dendrimer (BPCz)	4.9 mJ/cm²	100 fs	5 kHz	spot	85 µm	10^{-4} mbar	4.9 mJ/cm²
Ref. [5]	1,4-bis[2-[4-[N,N-di(p-totyl)amino]phenyl]vinyl]benzene (DADSB)	4.5 mJ/cm²	150 fs	1 kHz	spot	1 mm	1 bar (ambient)	4.5 mJ/cm²

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