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

Supporting Information for

Novel n-Type Organic Semiconductor Comprising 1,5-naphthyridine-2,6-dione Unit †

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† Electronic Supplementary Information (ESI) available: *Supporting data (Fig. S1-S11 and Tables S1-S3) and NMR Spectra.*

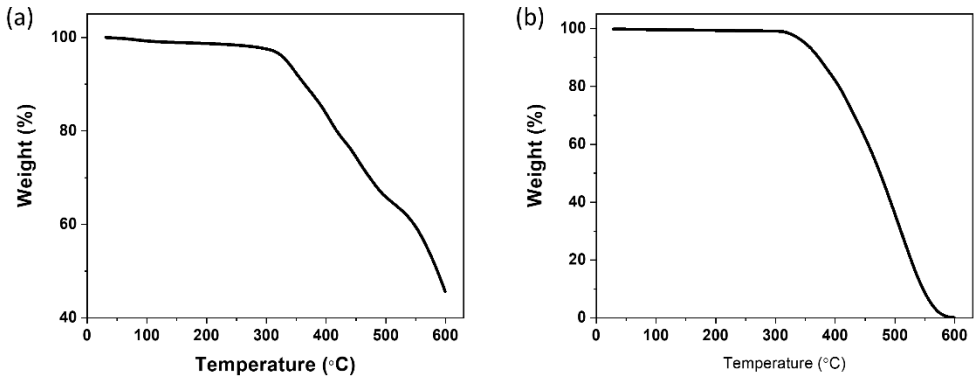


Figure S1. TGA curves for (a) **NTDT-DCV** and (b) **NTDP-DCV.**

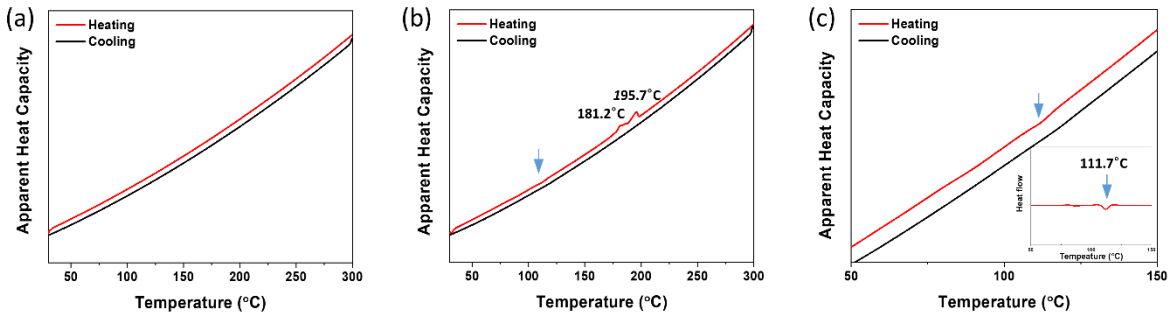


Figure S2. Second cycle DSC curves for (a) **NTDT-DCV** and (b) **NTDP-DCV**. (c) The DSC curves range from 50 to 150℃ and baseline corrected curve (bottom right) of **NTDP-DCV** (blue arrow indicated the cold crystallization).

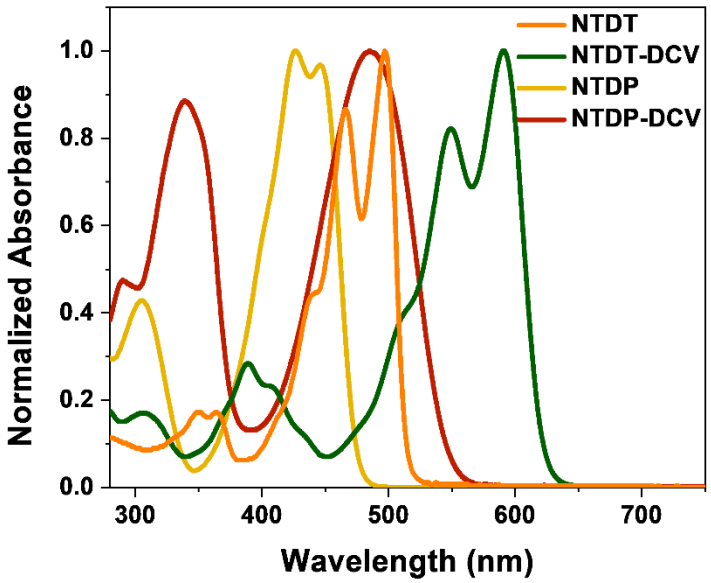


Figure S3. Normalized UV-vis absorption spectra of NTD-DCV derivatives in the in the 1.0×10^{-5} M L^{-1} $CHCl_3$ solutions.

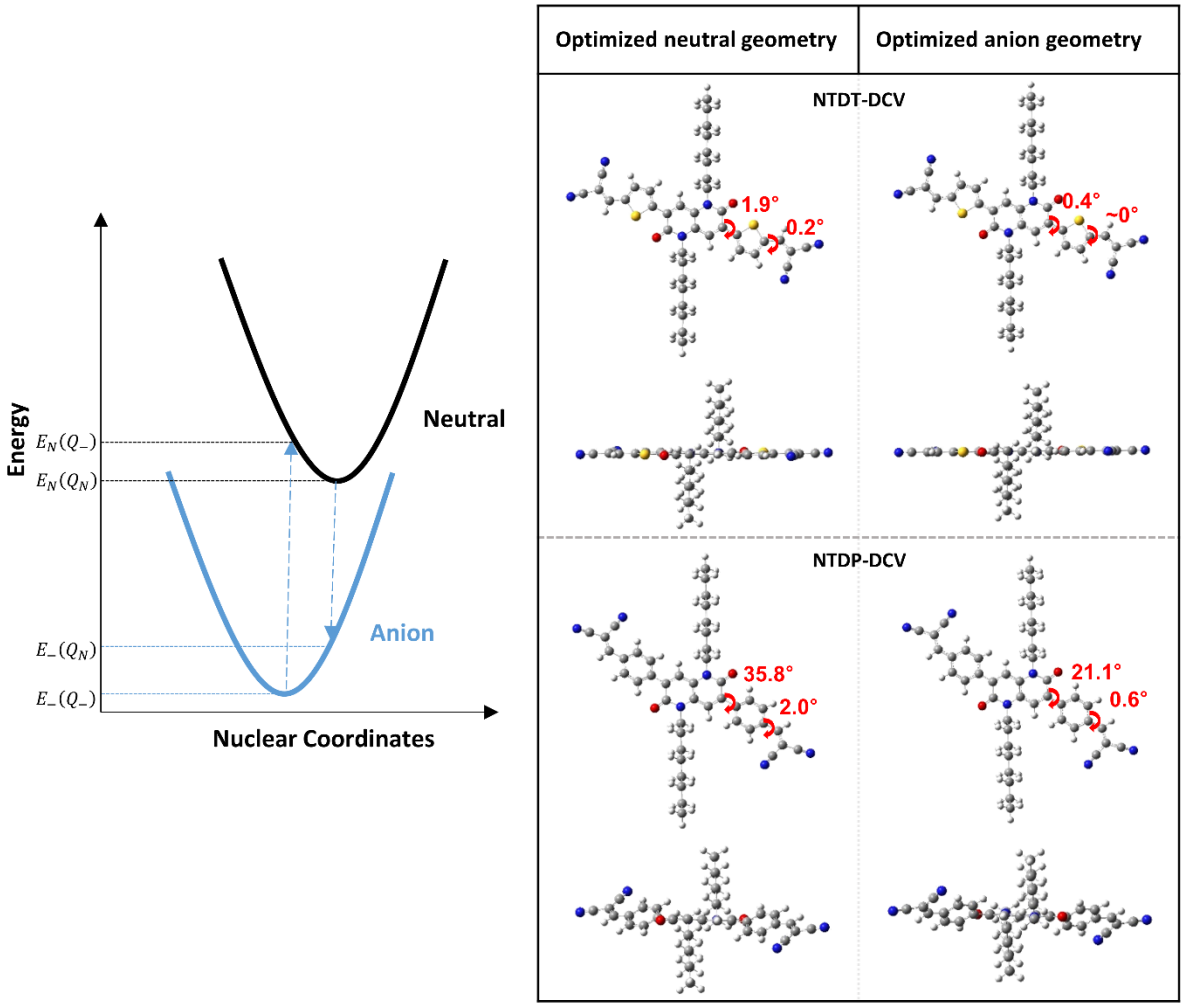


Figure S4. Schematic description of the electron reorganization energy diagram and the optimized neutral and anion geometries of **NTDT-DCV** and **NTDP-DCV**.

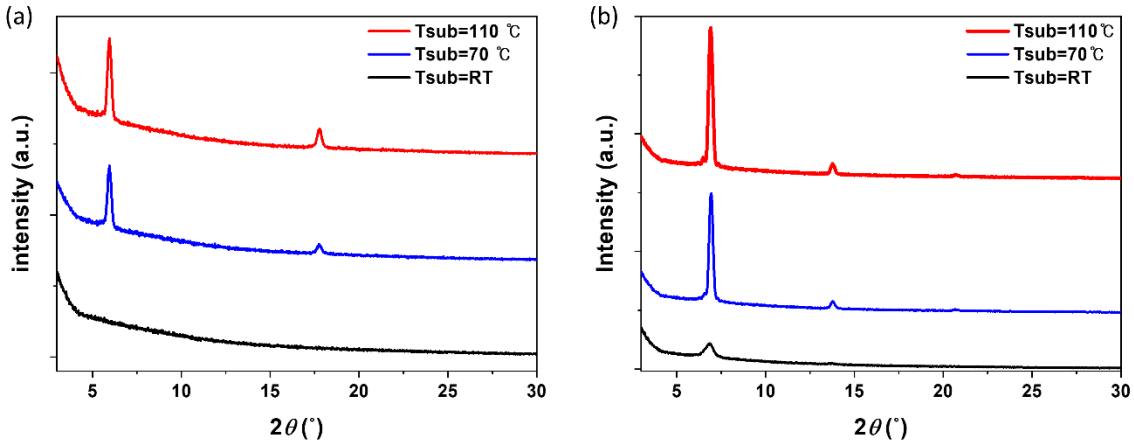


Figure S5. Out-of-plane XRD results of (a) **NTDT-DCV** and (b) **NTDP-DCV** vacuum-deposited thin films.

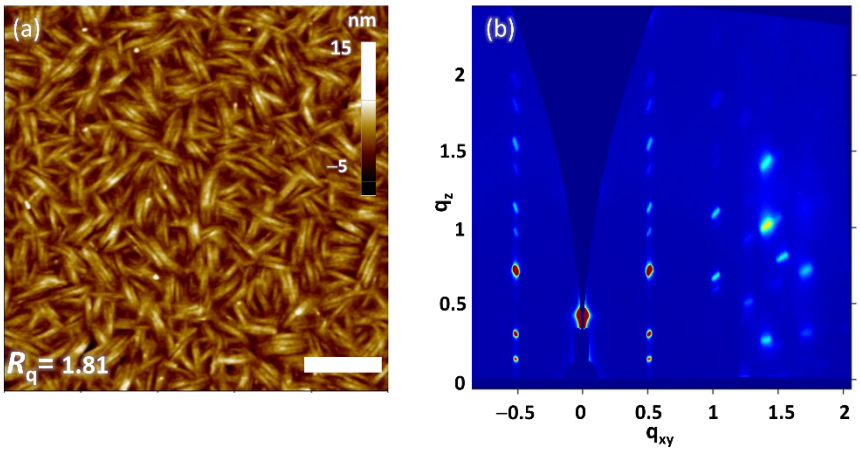


Figure S6. (a) AFM images (scale bar: 1 μm) and (b) 2D-GIWAXS patterns of the vacuum-deposited thin films for **NTDT-DCV** at T_{sub} = 70℃.

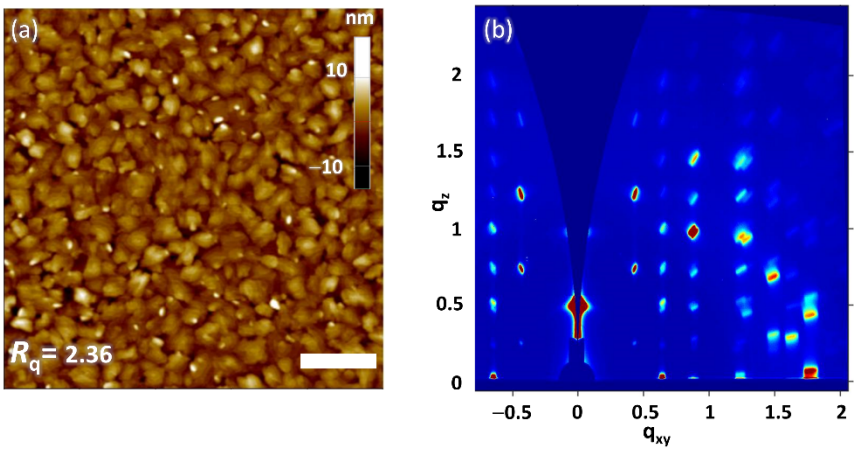


Figure S7. (a) AFM images (scale bar: 1 μm) and (b) 2D-GIWAXS patterns of the vacuum-deposited thin films for **NTDP-DCV** at T_{sub} = 70℃.

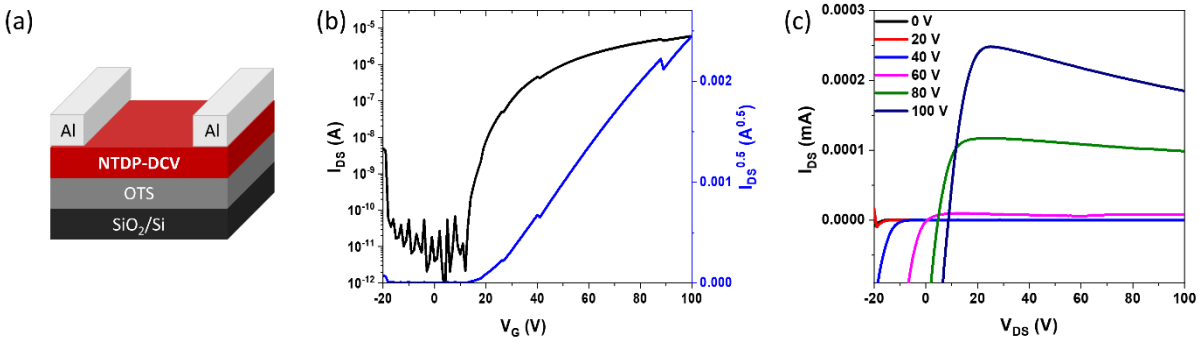


Figure S8. Schematic structure of OFETs for (a) **NTDP-DCV**, representative (b) transfer, and (c) output curve of solution processed **NTDP-DCV** OFETs at T_{ann}=140℃.

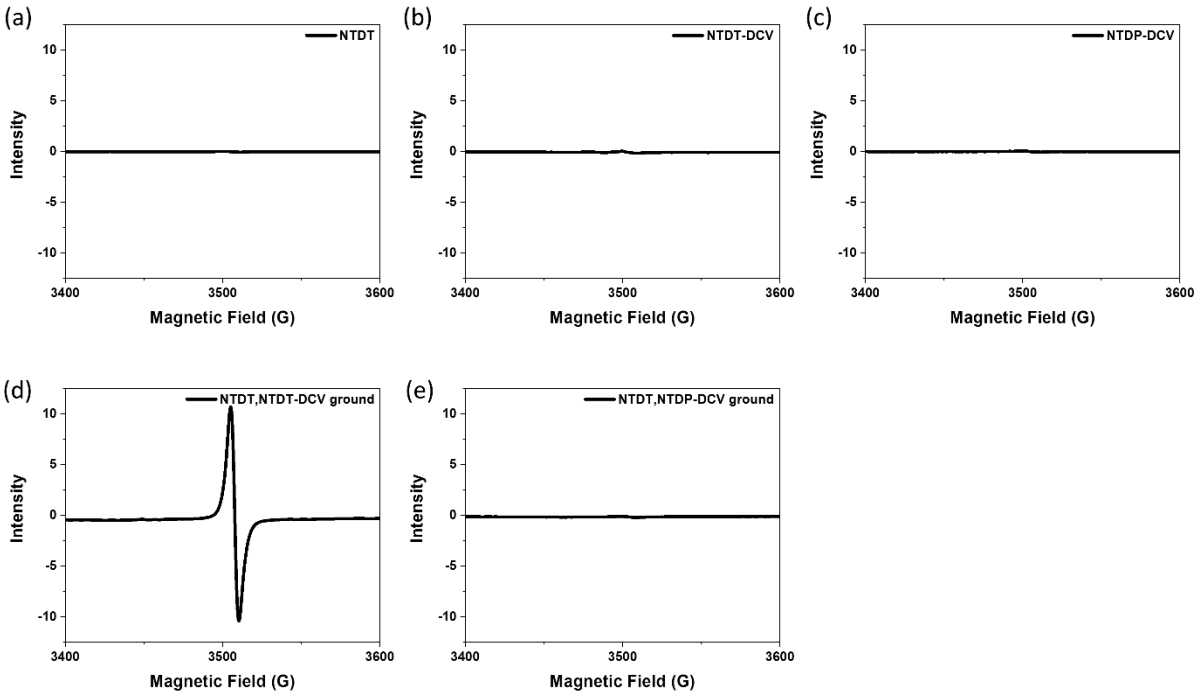


Figure S9. ESR spectra of the (a) **NTDT**, (b) **NTDT-DCV**, (c) **NTDP-DCV**, (d), **NTDT**/**NTDT-DCV** ground and (e) **NTDT**/**NTDP-DCV** ground samples.

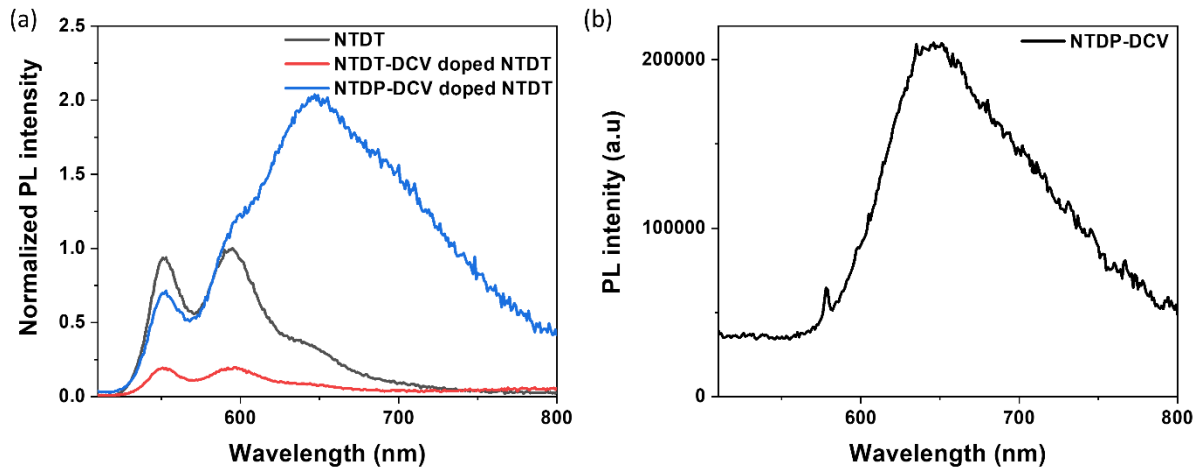


Figure S10. PL spectra of (a) pristine **NTDT** (black line), **NTDT-DCV** doped **NTDT** (red line), and **NTDP-DCV** doped **NTDT** (blue line), and (b) pristine **NTDP-DCV** thin film. The emission at 600–800 nm in **NTDP-DCV** doped **NTDT** film arose from **NTDP-DCV** PL characteristic.

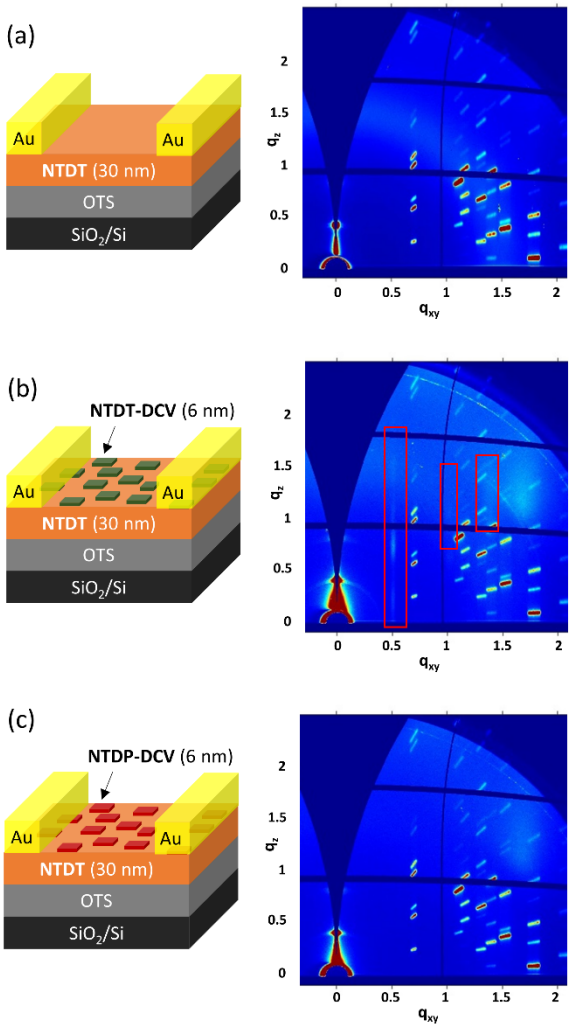


Figure S11. Schematic structure of OFETs and the corresponding 2D-GIWAXS images of (a) pristine **NTDT**, (b) **NTDT-DCV** doped **NTDT**, and (c) **NTDP-DCV** doped **NTDT** films. 2D-GIWAXS were measured at 3C SAXS-I beamline.

Table S1. Optical and electrochemical properties of **NTDT** and **NTDP**.

Compound	Solution			Film			Experimental E_{HOMO}/E_{LUMO} (eV)[b]
	λ_{max} (nm)	λ_{onset} (nm)	E_g^{opt} (eV)[a]	λ_{max} (nm)	λ_{onset} (nm)	E_g^{opt} (eV)[a]	
NTDT	497	515	2.50	533	559	2.22	−5.42/−3.13
NTDP	427	473	2.62	458	512	2.42	−5.58/−2.96

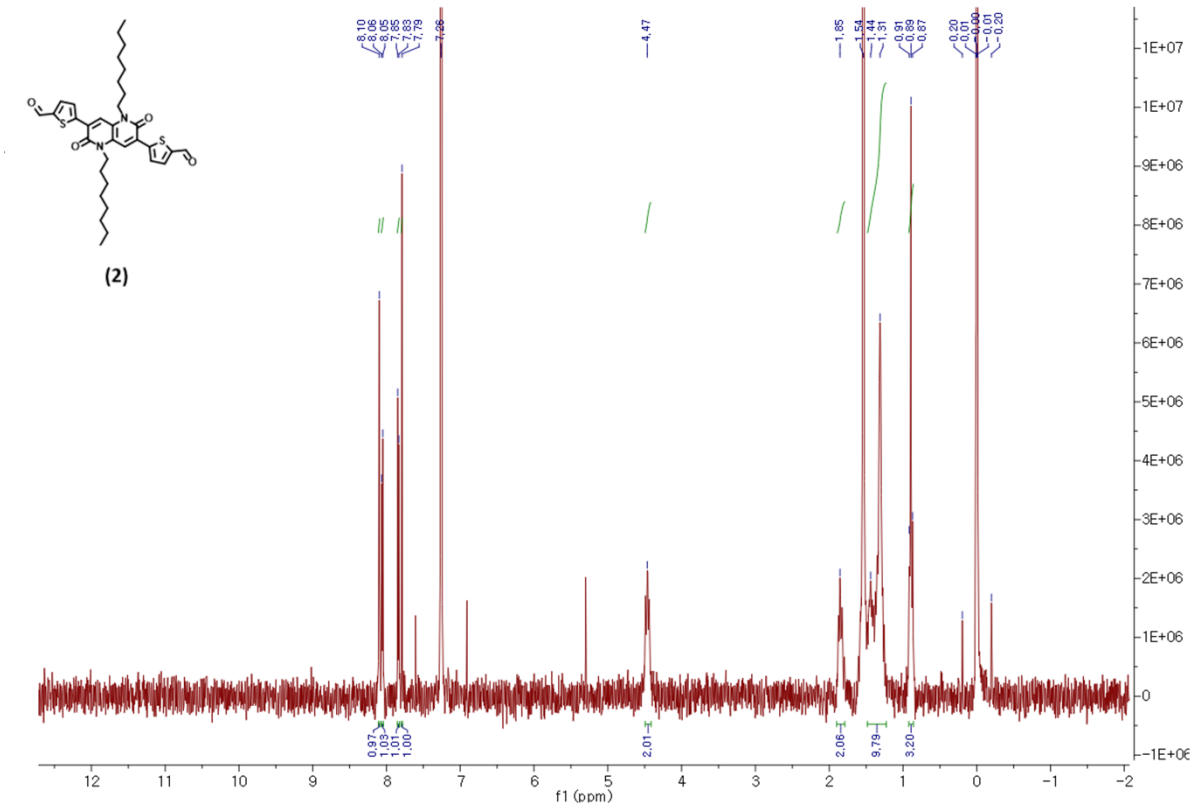
[a] Determined from the onset of absorption spectra (E_g^{opt} = 1240/ λ_{onsset}). [b] Measured by cyclic voltammetry in thin film states.

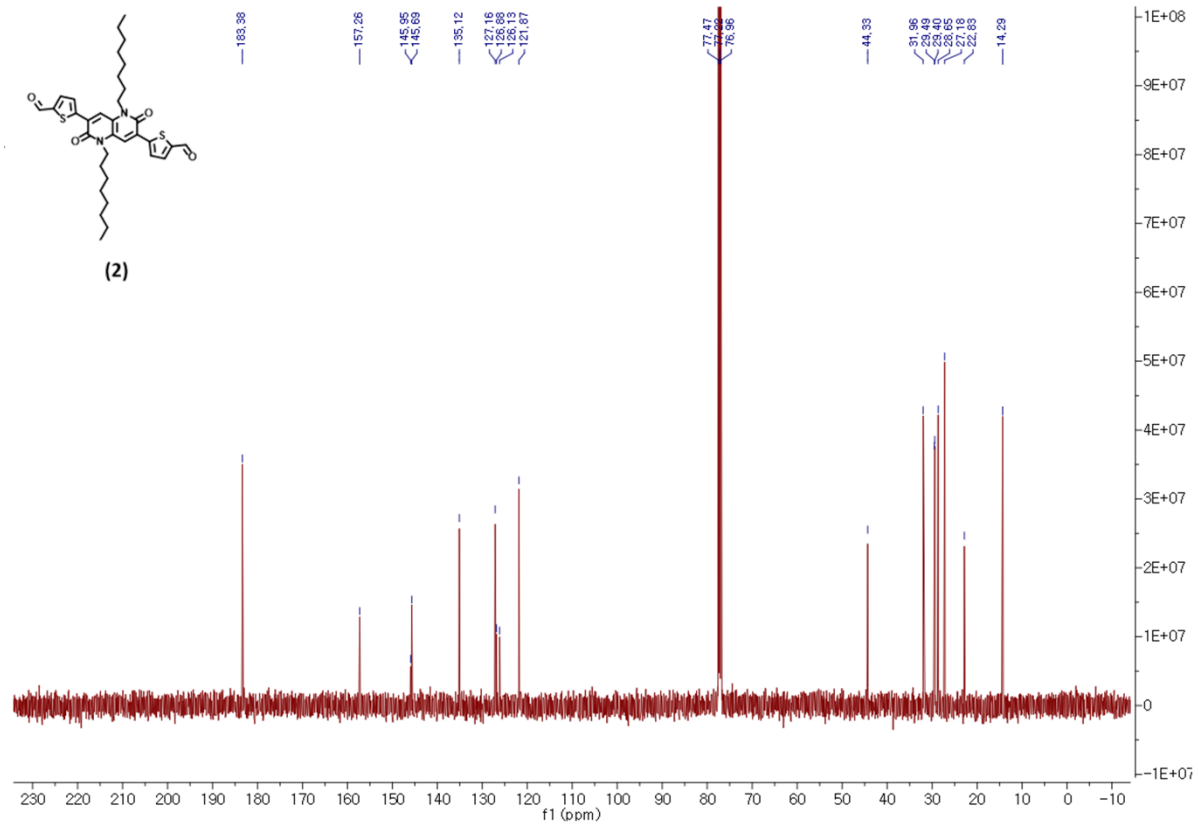
Table S2. [kl] Planes deduced from in-plane reflection along the q_{xy}-direction in the vacuum deposited thin-film at T_{sub} = 110℃.

	q_{xy} (Å^{-1})	hkl
NTDT-DCV	0.52	(h01)
	1.04	(h02)
	1.25	(h10)
	1.28	(h1−1)
	1.42	(h11)
	1.51	(h1−2)
	1.56	(h03)
	1.73	(h12)
NTDP-DCV	0.44	(h01)
	0.64	(h10)
	0.67	(h1−1)
	0.87	(h11)
	0.88	(h02)
	1.22	(h12)
	1.27	(h20)
	1.32	(h03)
	1.46	(h21)
	1.62	(h13)
	1.74	(h22)
	1.94	(h30)

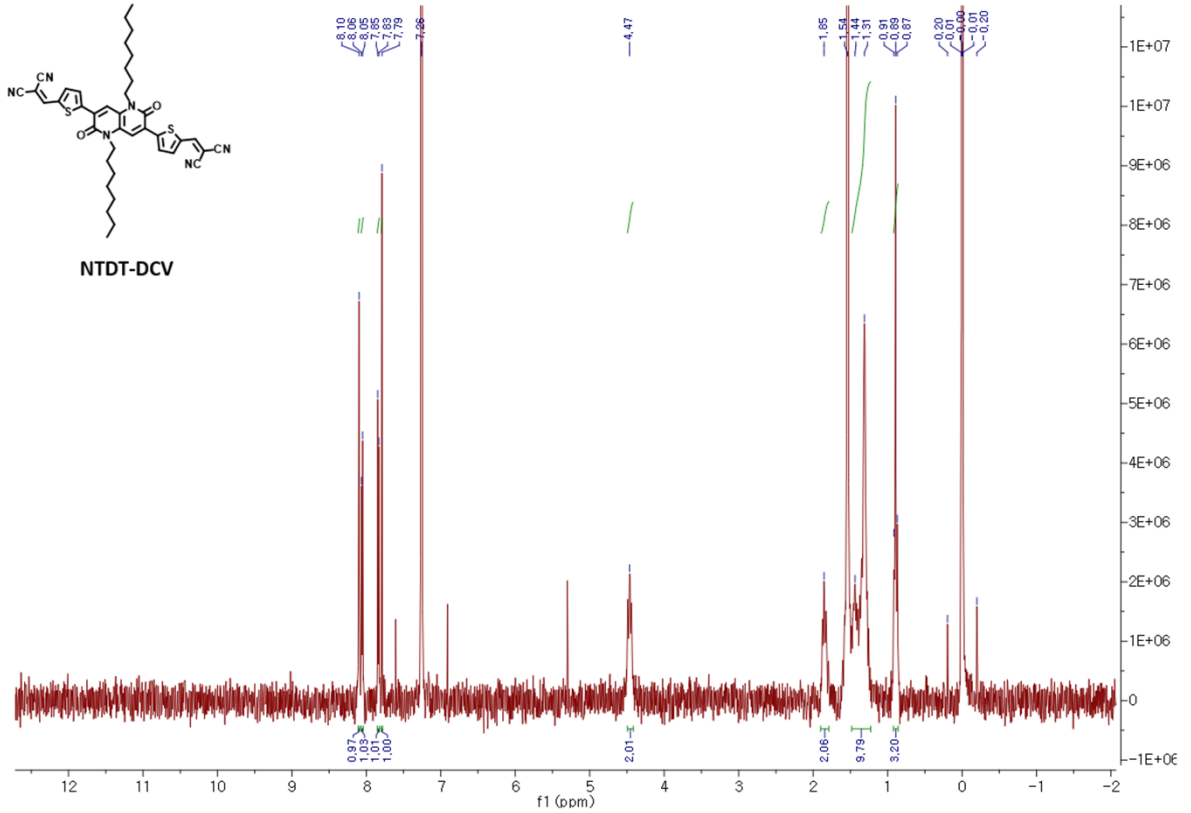
Table S3. Solution-processed OFET characteristics of **NTDP-DCV**

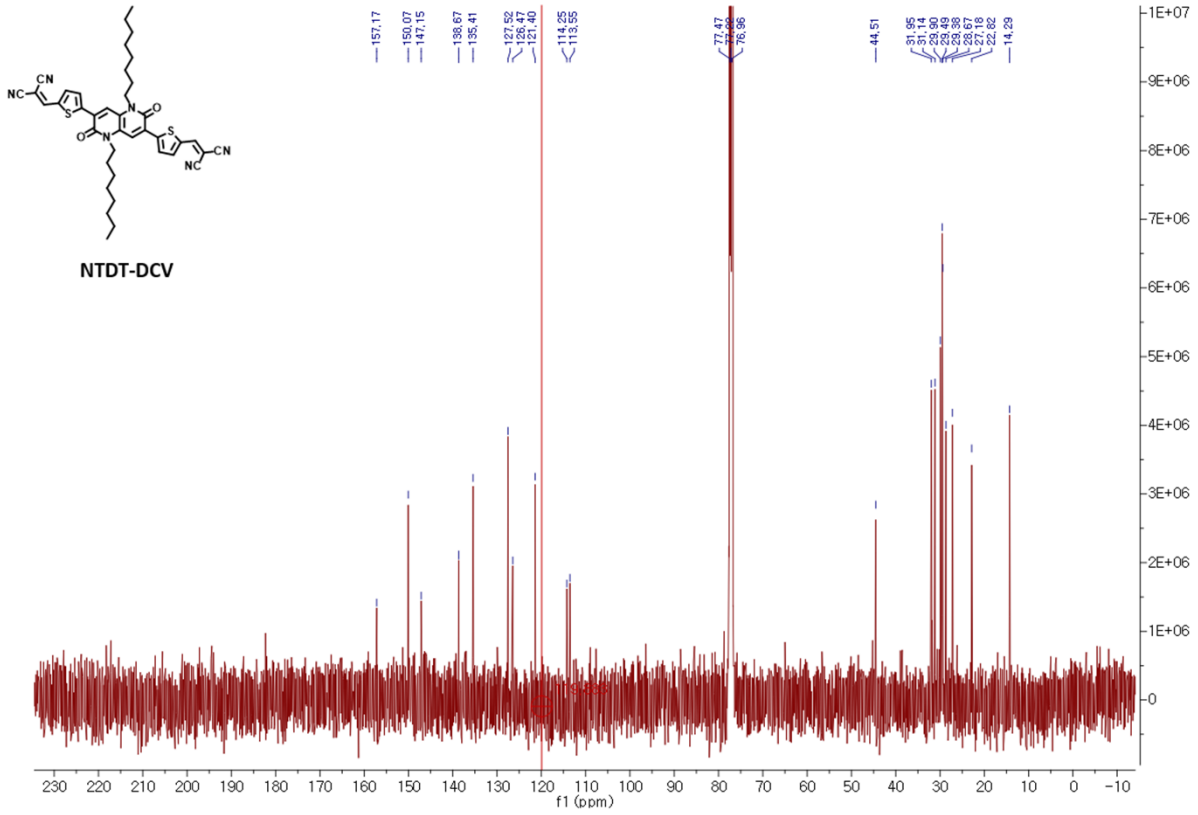
compound	T_{ann} (℃)	$\mu_{e,\ avg}$ ($cm^2\ V^{-1}\ s^{-1}$)[a]	$\mu_{e,\ max}$ ($cm^2\ V^{-1}\ s^{-1}$)[b]	V_{th} (V)[c]	I_{on}/I_{off}
NTDP-DCV	140	$(1.96 \pm 0.57) \times 10^{-2}$	0.021	20.8 ± 4.0	~10^6



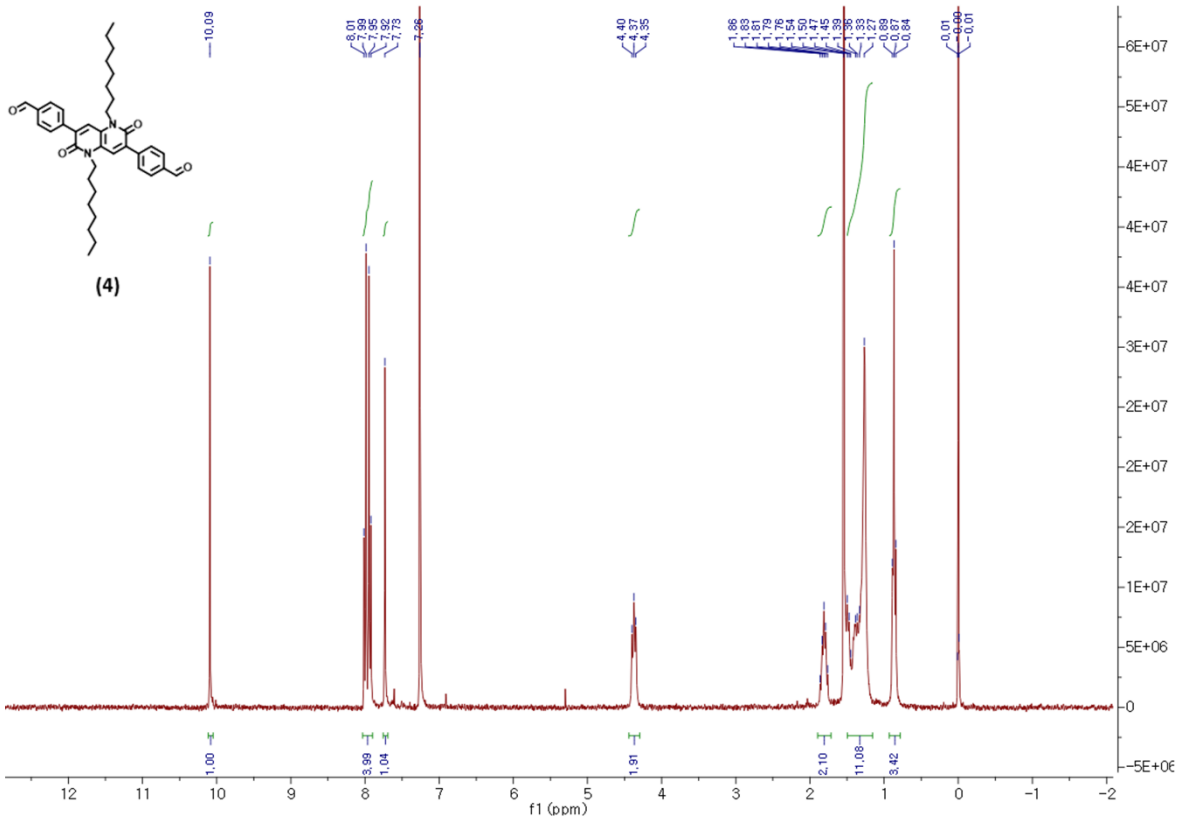


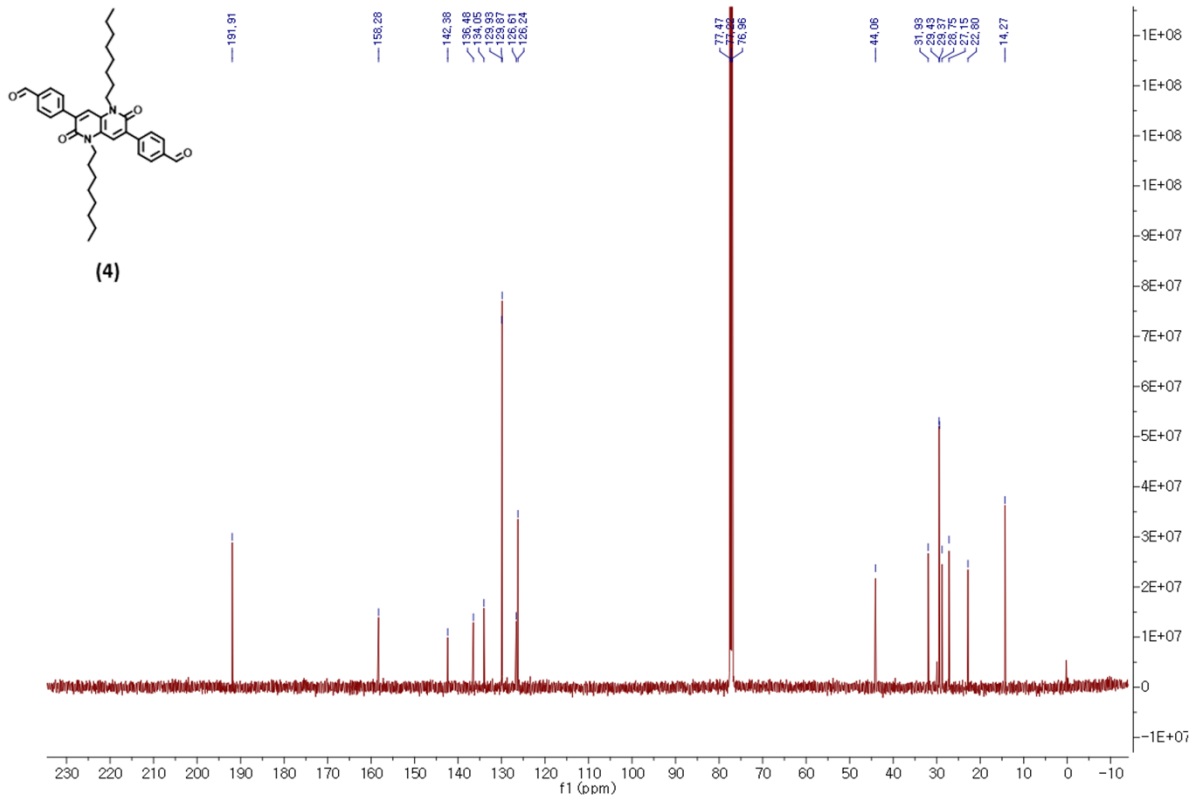
^{1}H-NMR and ^{13}C-NMR Spectra of. **5,5'-(1,5-dioctyl-2,6-dioxo-1,2,5,6-tetrahydro-1,5-naphthyridine-3,7-diyl)bis(thiophene-2-carbaldehyde) (2)**.



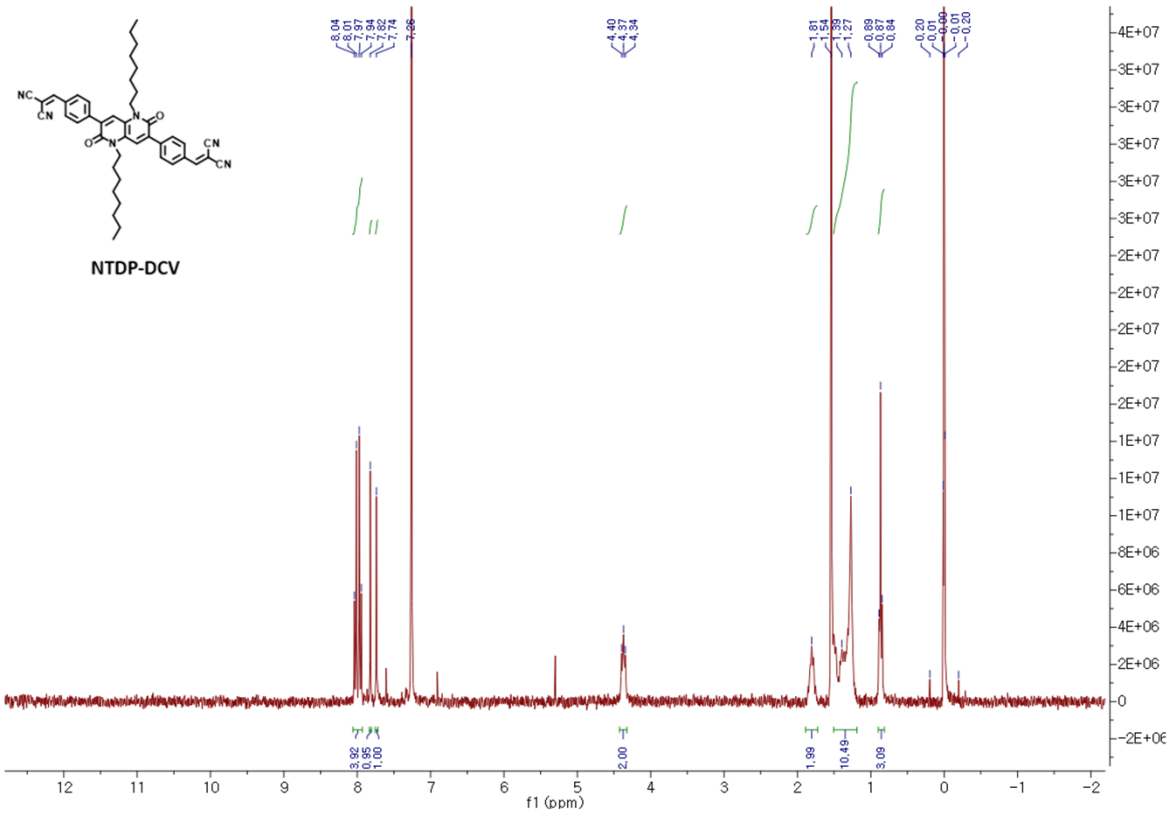


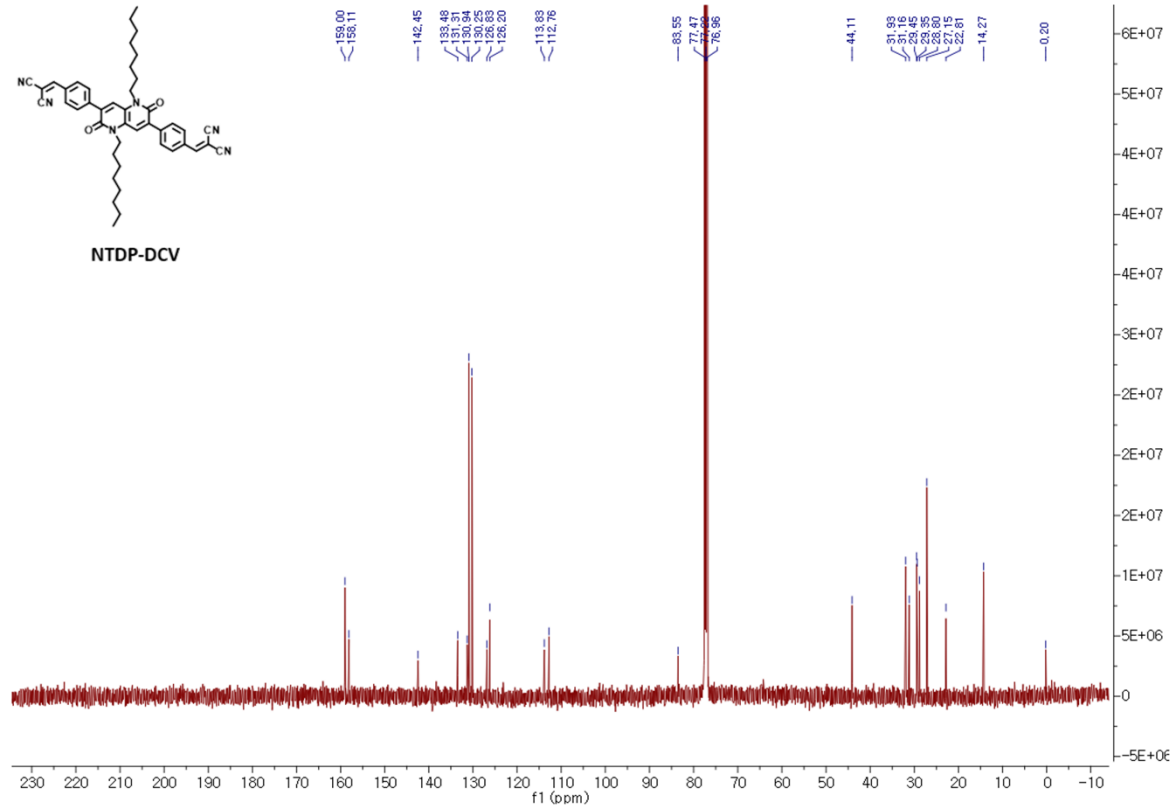
^{1}H-NMR and ^{13}C-NMR Spectra of. **NTDT-DCV**.





^{1}H-NMR and ^{13}C-NMR Spectra of. **4,4'-(1,5-dioctyl-2,6-dioxo-1,2,5,6-tetrahydro-1,5-naphthyridine-3,7-diyl)dibenzaldehyde (4)**.





^{1}H-NMR and ^{13}C-NMR Spectra of. **NTDP-DCV**.