Electronic Supplementary Information

Molecular Engineering of Covalent Organic Nanosheets toward High-Performance Sodium-Ion Batteries

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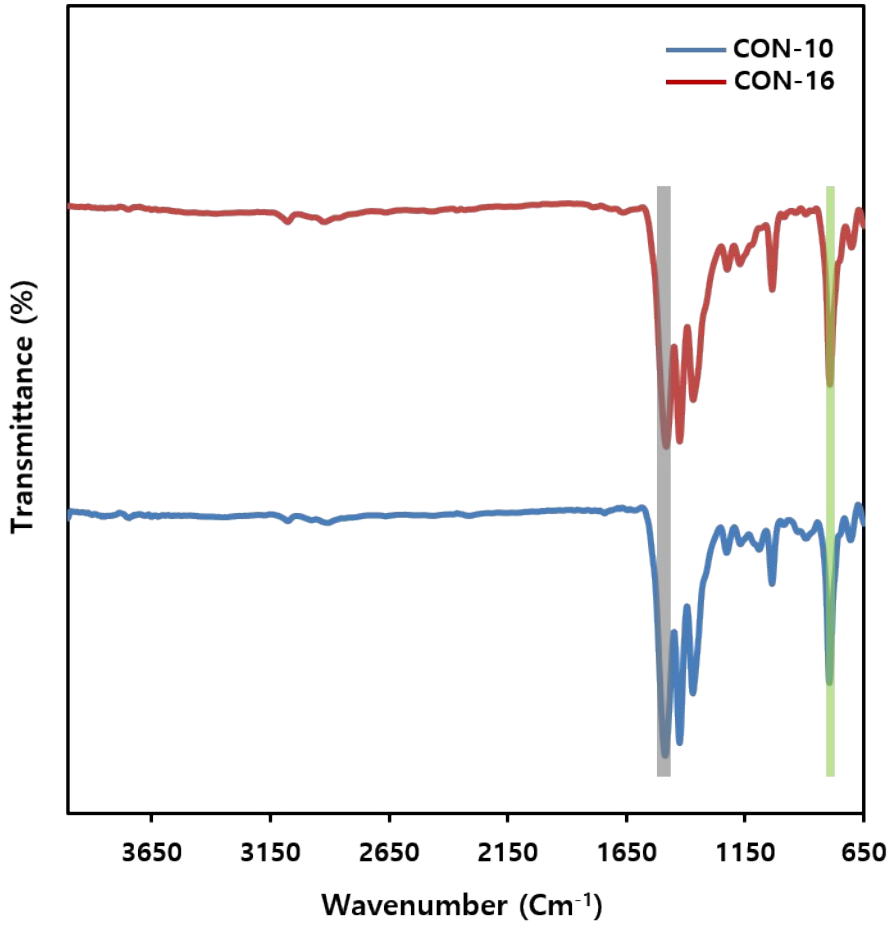

Figure S1. Fourier transform infrared spectra of CON-10 and CON-16, showing the peaks of the C=N stretching vibration of the tris-s-triazine moieties and benzenoid at ~1498 cm^{-1}, the C–N stretching vibration of the tris-s-triazine moieties at ~1421 and 1361 cm^{-1}, and the C_{β}–H out-of-plane and in-plane vibrations of the thiophene units at ~802−788 and 1030 cm^{-1}.

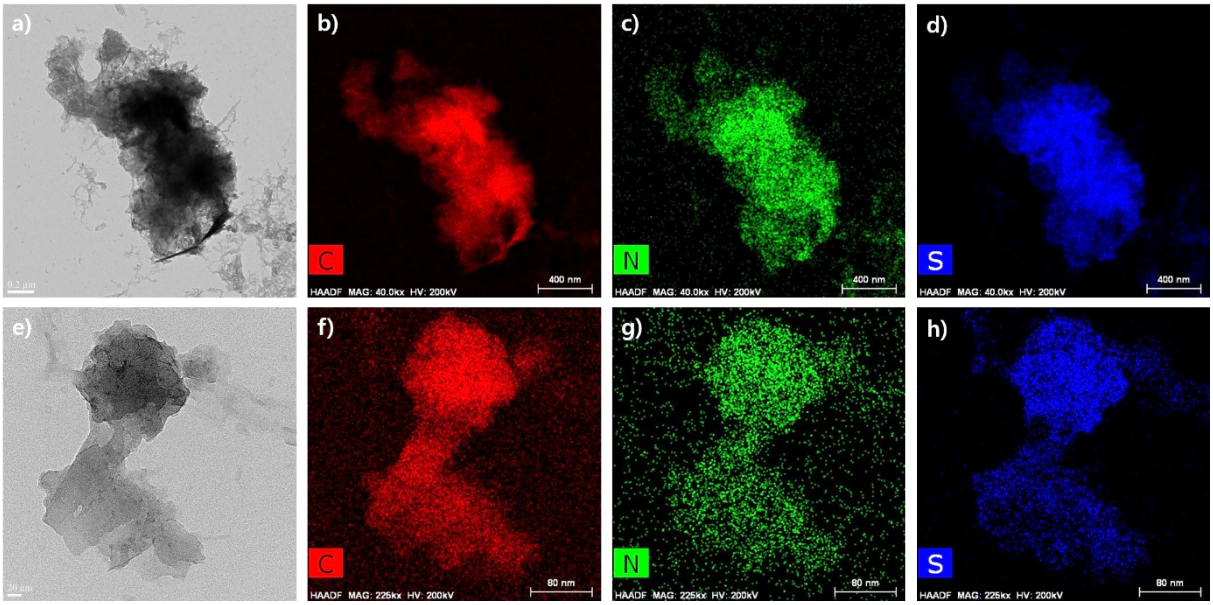

Figure S2. TEM images of (a) D/A-CON-10 and (e) D/A-CON-16 for EDS mapping; (b), (c), (d) for D/A-CON-10 and (f), (g), (h) for D/A-CON-16

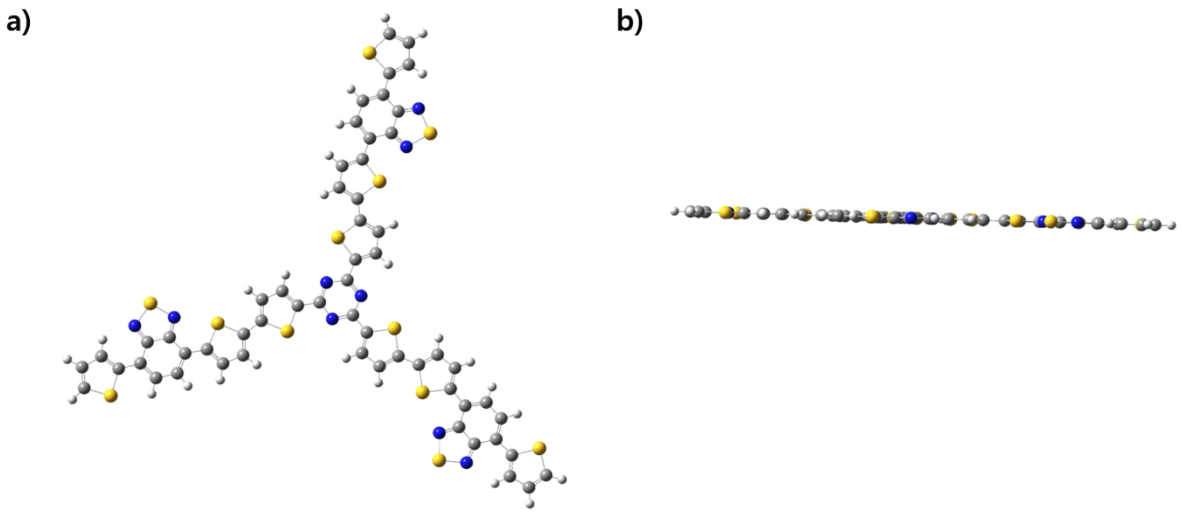

Figure S3. Density function theory (DFT) calculation at B3LPY/6-31G level to highlight the planarity of D/A-CON-10 and 16 with basic unit structure; (a) and (b) are top view and side view of basic structure from DFT cacuslation respectively.

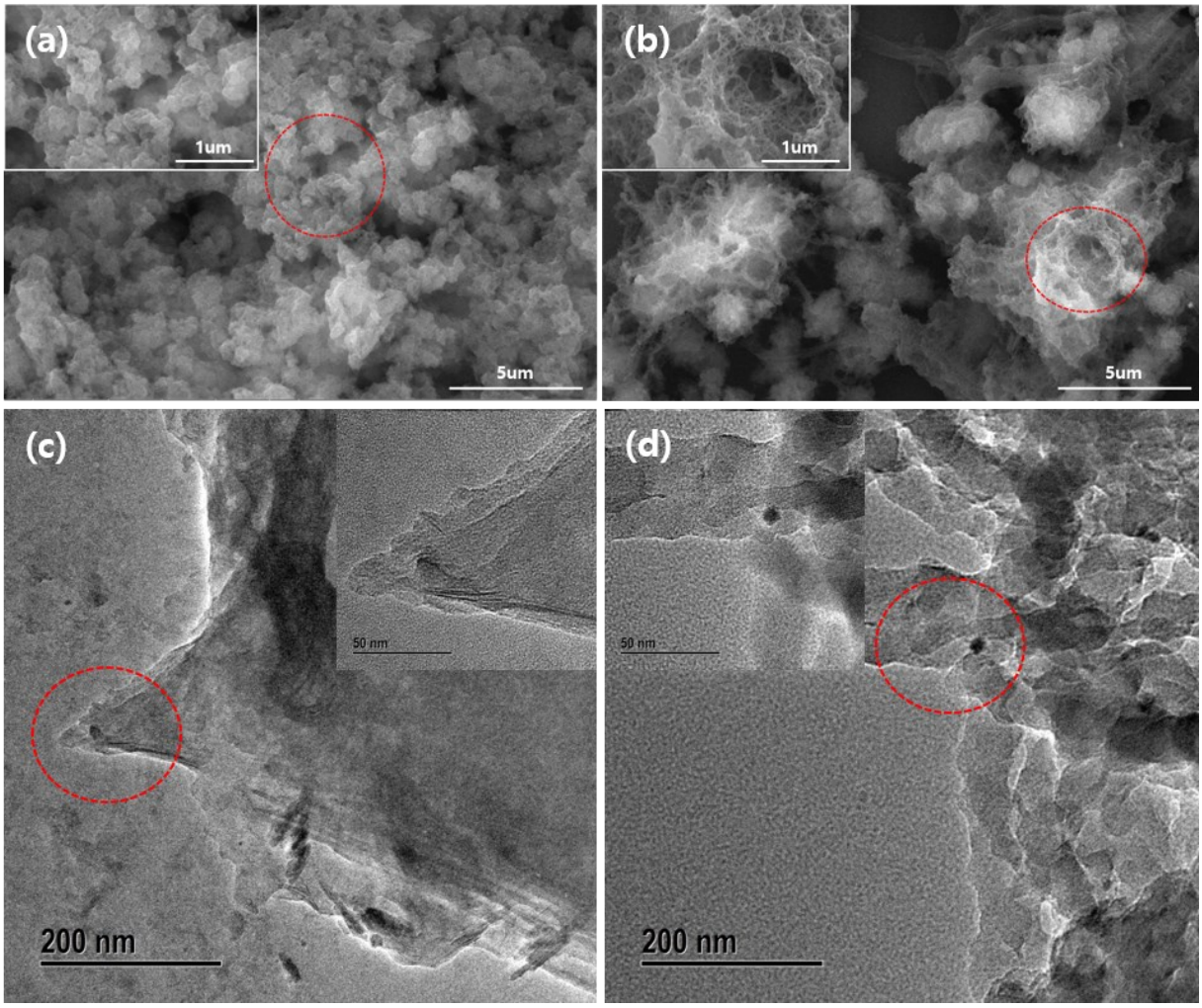

Figure S4. (a,b) Scanning electron microscopy and (c,d) transmission electron microscopy images of CON-10 (a,c) and CON-16 (b,d).

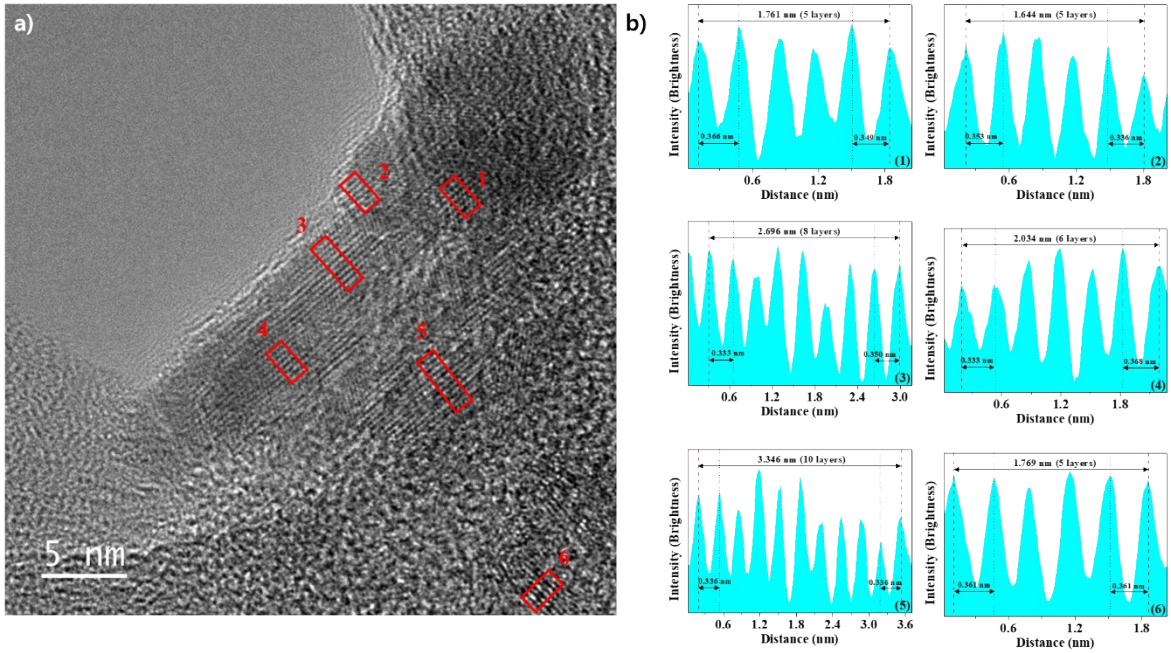

Figure S5. (a) Magnified TEM image of D/A-CON-10 showing the stacked morphology of 2D D/A-CON-10 and (b) brightness profiles in the red-lined regions in (a).

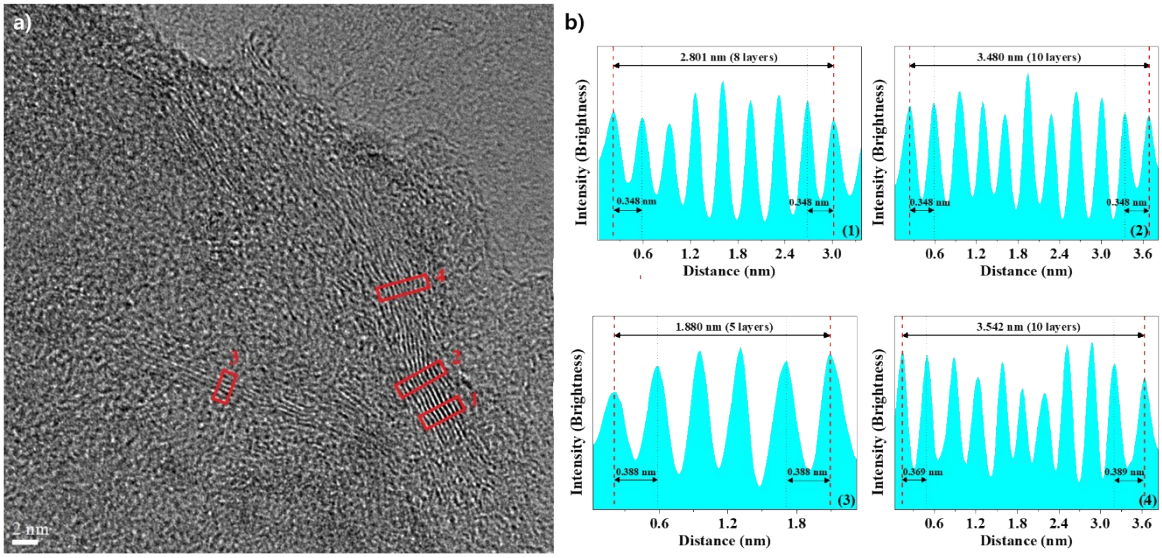

Figure S6. (a) Magnified TEM image of D/A-CON-16 showing the stacked morphology of 2D D/A-CON-10 and (b) brightness profiles in the red-lined regions in (a).

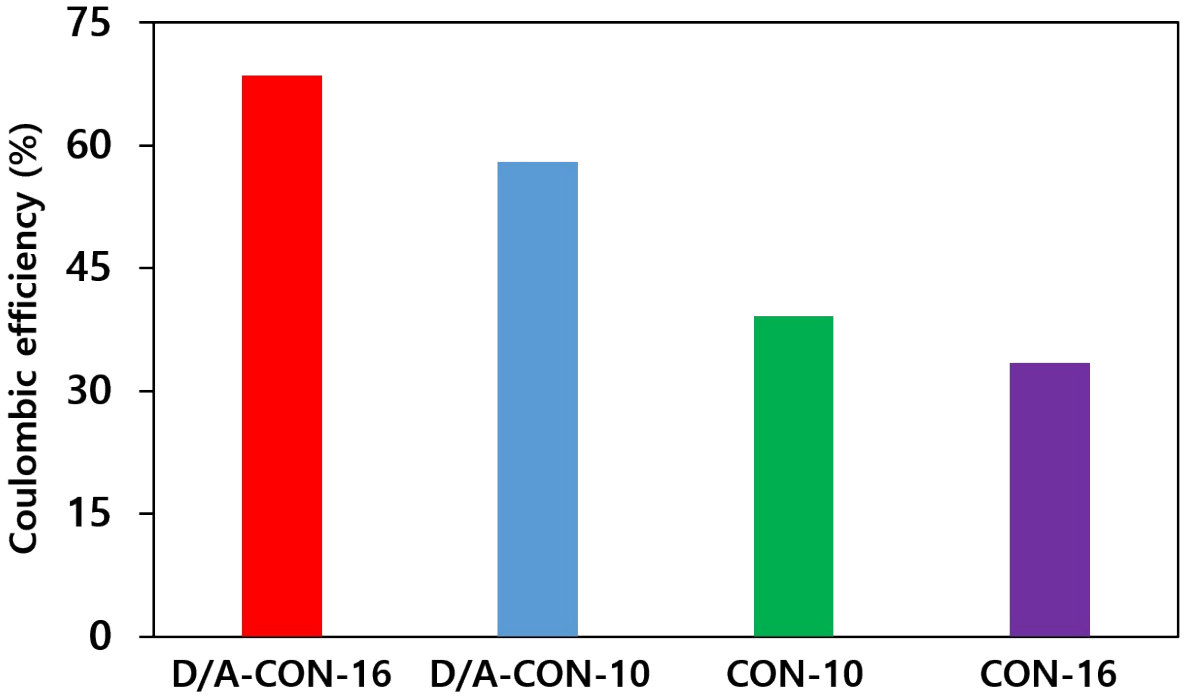

Figure S7. Coulombic efficiency of the first charge/discharge for various CONs.

Table S1. Summary of recent works for the various organic anode materials used in sodium ion batteries; [a]capacity (mA h/g); [b]current density (mA/g); [c]mass ratio (active material : conductive carbon : binder).

Anode materials	Capacity (Capacity[a]/Current density[b]/Cycle number)	Voltage range (vs. Na/Na^+)	Mass loading of the electrodes	Mass ratio[c]	Ref.
NPC-1	215/50/100	0.005–3.0 V		7 : 2 : 1	[1]
NPC-2	238/50/100	0.005–3.0 V	0.9 mg	7 : 2 : 1	[1]
CTF	225/100/10	0.01–2.5 V		7 : 2 : 1	[2]
2DP	262/100/10	0.01–2.5 V		7 : 2 : 1	[2]
TFPB-TAPT COF	170/100/15	0.05–1.6 V	1.65 mg/cm^2		[3]
DAAQ - COFs	420/100/100	0.05–3.0 V		6 : 3 : 1	[4]
TSAQ	315/100/100	0.05–3.0 V		6 : 3 : 1	[4]
PDCzBT	145/20/100	0.05–3.0 V	1.8 mg/cm^2	6 : 3 : 1	[5]
PI-1	331/100/20	0.05–2.5 V		5 : 3 : 2	[6]
PI-2	95/500/100	0.05–2.5 V		5 : 3 : 2	[6]
PTTE	370/50/5	0.0–3.0 V	0.8 mg/cm^2	5 : 4 : 1	[7]
CON-10	192/300/100	0.01–2.5 V	1.2 mg/cm^2	7 : 2 : 1	[8]
CON-16	195/300/100	0.01–2.5 V	1.2 mg/cm^2	7 : 2 : 1	[8]
D/A-CON-10	380/100/100	0.01–2.5 V	1.2 mg/cm^2	7 : 2 : 1	This work
D/A-CON-16	440/100/100	0.01–2.5 V	1.2 mg/cm^2	7 : 2 : 1	This work

References

1. X. Zhang, G. Zhu, M. Wang, J. Li, T. Lu, L. Pan, *Carbon,* 2017, **116**, 686.
2. J. Liu, P. Lyu, Y. Zhang, P. Nachtigall, Y. Xu, *Adv. Mater.* 2018, **30**, 1705401.
3. B. C. Patra, S. K. Das, A. Ghosh, A. R. K, P. Moitra, M. Addicoat, S. Mitra, A. Bhaumik, S. Bhattacharya, A. Pradhan, *J. Mater. Chem. A* 2018, **6**, 16655.
4. S. Gu, S. Wu, L. Cao, M, Li, N. Qin, J. Zhu, Z. Wang, Y. Li, Z. Li, J. Chen, Z. Lu, *J. Am. Chem. Soc.* 2019, **141**, 24, 9623.
5. S. Zhang, W. Huang, P. Hu, C. Huang, C. Shang, C. Zhang, R. Yang, G. Cui, *J. Mater. Chem. A*, 2015, **3**, 1896.
6. Z. Li, J. Zhou, R. Xu, S. Liu, Y. Wang, P. Li, W. Wu, M. Wu, *Chemical Engineering Journal*, 2016, **287**, 516.
7. X. Wang, C. Zhang, Y. Xu, Q. He, P. Mu, Prof. Y. Chen, J. Zeng, J.-X. Jiang, *Macromol. Chem. Phys*, 2018, **219**, 1700524.
8. M.-S. Kim, W.-J. Lee, S.-M. Paek, J. K. Park, *ACS Appl. Mater. Interfaces* 2018, **10**, 38, 32102-32111