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Editorial

Iodized polyacrylonitrile as fast-charging anode for lithium-ion battery

In recent years, the fast-charging capability of the batteries is highly required, especially used for electric vehicles [1–4]. Thus, the commercialized lithium-ion batteries (LIBs) which can be rapidly charged and stably cycled have a huge market prospect [5–7]. However, the Li^+ transmission rate inside the electrode material/interface is sluggish in fast-charge condition, which usually leads to battery impedance increase, Li metal deposition, and electrolyte decomposition, which seriously affects both battery cycling stability and safety [8–12]. Therefore, it is of great significance to design fast Li^+ transport anode in bulk/interphase for fast-charging LIBs.

Recently, Li's group proposed an iodized polyacrylonitrile (I-PAN) as novel anode with fast Li^+ transport in bulk/interphase and easily Li^+ desolvation for fast-charging LIBs [13]. This is mainly attributed to the C-I bond in I-PAN expanding Li^+ transport channel and providing rich Li^+ adsorption sites (Fig. 1a)

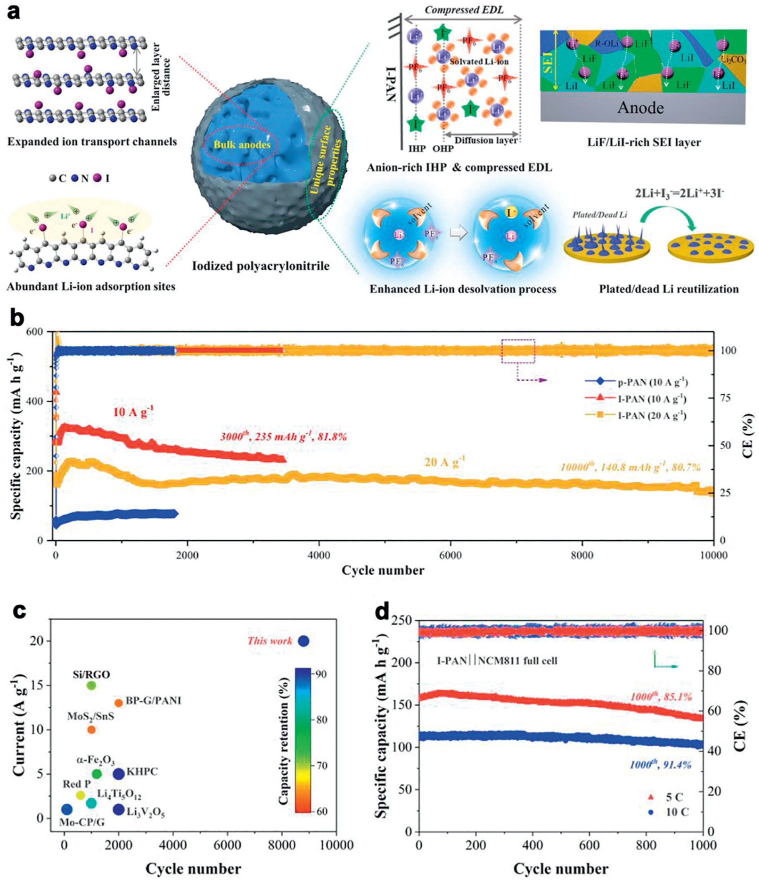

Fig. 1. (a) Illustrative scheme of I-PAN anodes. (b) Cycling performance of I-PAN anode at 10 and 20 A/g. (c) Corresponded comparison with other anode materials. (d) Cycling performance of I-PAN||NCM811 battery. Reprinted with permission [13]. Copyright 2023, Wiley-VCH.

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for improving both the Li^+ diffusion kinetics and storage capacity. Moreover, Raman spectra, nuclear magnetic resonance (NMR) measurement and Molecular dynamics (MD) simulations consistently demonstrated that the I^- released from I-PAN could be involved in the Li^+ solvation structure and weaken the coordination number of Li^+-solvents and anions for accelerating the Li^+ desolvation. In addition, the iodine groups affected the inner Helmholtz plane (IHP) and the structure of the electric double layer (EDL) on anode surface by increasing surface charge density, leading to the generation of LiF/LiI-rich SEI layer. Such SEI also improves the mechanical strength/ionic conductivity for facilitating the battery with the fast charge ability and cycle stability. Notedly, the inactive Li formed in the anode could be revived by a reversible I^-/I^{3-} redox reaction. As expected, the I-PAN anode realized fast-charging capacity with the capacity retention of 81.8% and 80.7% after 3000 and 10,000 cycles at 10 A/g and 20 A/g (Fig. 1b), respectively. Such exceptional fast-charging performance is greatly better than other advanced anode materials (Fig. 1c). The I-PAN anode further exhibited low-capacity decay at 0.1 A/g over 600 cycles. When I-PAN||$LiNi_{0.8}Co_{0.1}Mn_{0.1}O_2$ (NCM811) battery (Fig. 1d) was assembled, it could achieve high-capacity retention of 85.1%/91.4% after 1000 cycles at 5/10 C (1 C = 180 mA/g), respectively.

In summary, Li's group developed I-PAN as the anode for fast-charging LIBs. Such excellent fast-charging capacity is attributed to that the iodine groups in I-PAN with expanded ion transport channel for accelerating ion transport kinetics, promoting Li^+ desolvation process and changing the IHP and EDL of anode surface to form a highly mechanical/conductive SEI. This work not only presents a novel design strategy for fast-charging anode materials, but also opens the way for fast-charging batteries. Moreover, this will inspire us to explore more fast-charging materials for LIBs.

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Haixia Wu*
Kailu Guo
College of Chemistry and Chemical Engineering, Henan Key Laboratory of Function-Oriented Porous Materials, Luoyang Normal University, Luoyang 471934, China

*Corresponding author.
E-mail address: haixiawu@lynu.edu.cn (H. Wu).

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References

[1] Y. Na, Z. Chen, Z.K. Xu, et al., Chin. Chem. Lett. 33 (2022) 4037–4042.
[2] W.J. Cheng, Q. Feng, Z.L. Guo, et al., Chin. Chem. Lett. 33 (2022) 4776–4780.
[3] D.X. Wu, J. He, J.D. Liu, et al., Adv. Energy Mater. 12 (2022) 2200337.
[4] Y. Liu, H. Shi, Z.S. Wu, Energy Environ. Sci. 16 (2023) 4834–4871.
[5] X. Zhu, Y.B. Mo, J.W. Chen, et al., Chin. Chem. Lett. 35 (2024) 109146.
[6] C.Y. Wang, T. Liu, X.G. Yang, et al., Nature 611 (2022) 485–490.
[7] Y. Sun, L. Wang, Y. Li, Y. Li, H. Lee, Joule 3 (2019) 1080–1093.
[8] L. Yang, X. Xiong, G. Liang, et al., Adv. Mater. 34 (2022) 2200914.
[9] J. An, H. Zhang, L. Qi, G. Li, Y. Li, Angew. Chem. Int. Ed. 61 (2021) e202113313.
[10] X. Han, T.T. Wu, L.H. Gu, et al., Chin. Chem. Lett. 34 (2023) 107594.
[11] A. Tomaszewska, Z.Y. Chu, X.N. Feng, et al., eTransportation 1 (2019) 100011.
[12] W.L. Cai, Y.X. Yao, G.L. Zhu, et al., Chem. Soc. Rev. 49 (2020) 3806–3833.
[13] S. Ma, J. Zhao, Q. Gao, et al., Angew. Chem. Int. Ed. 62 (2023) e202315564.