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Editorial

Selective dissolution for stabilizing solid electrolyte interphase

With pursuing high energy density batteries, traditional graphite anode could be unable to meet current needs [1–4]. The high-capacity anodes have attracted increasing attention, such as lithium anodes and alloy-type anodes [5–8]. Silicon anode, as a high-capacity alloy-type anode (3579 mAh/g), has attracted great attention [9]. However, due to its unique electrochemical mechanism, significant changes in volume and morphology during charge/discharge process could lead to the decrease in cycling stability [9,10]. Therefore, it is still challenging for silicon anode in tackling volume expansion and unstable interfaces.

Guo's group recently proposed a high donor number (DN) solvent-induced selective dissolution strategy to construct a stable solid electrolyte interface (SEI) for mitigating volume expansion during charge/discharge process [11]. As shown in Fig. 1a, a high-donor-number γ-butyrolactone (GBL) could selectively dissolve low-modulus components in the SEI (*e.g.*, lithium ethylene dicarbonate (LEDC), lithium ethyl carbonate (LEC), lithium fluorophosphate (Li_xPF_yOz), and other oligomers), while high-modulus LiF and polyethylene carbonate were left. This process forms a robust SEI, labeled as selective dissolution SEI (SD-SEI), primarily composed of resilient inorganic polymer components (Fig. 1b). It could accommodate the volume changes of micrometer-sized silicon anodes for stable cycling.

The atomic force microscope (Figs. 1c-e) revealed the SD-SEI and the F-SEI with high LiF content had an average modulus of 1.5 GPa and 2.6 GPa, respectively, while the impurity-rich c-SEI has a much lower average modulus of 0.7 GPa. Compared to F-SEI and c-SEI, the selective dissolution of GBL helped SEI to exhibit opti-

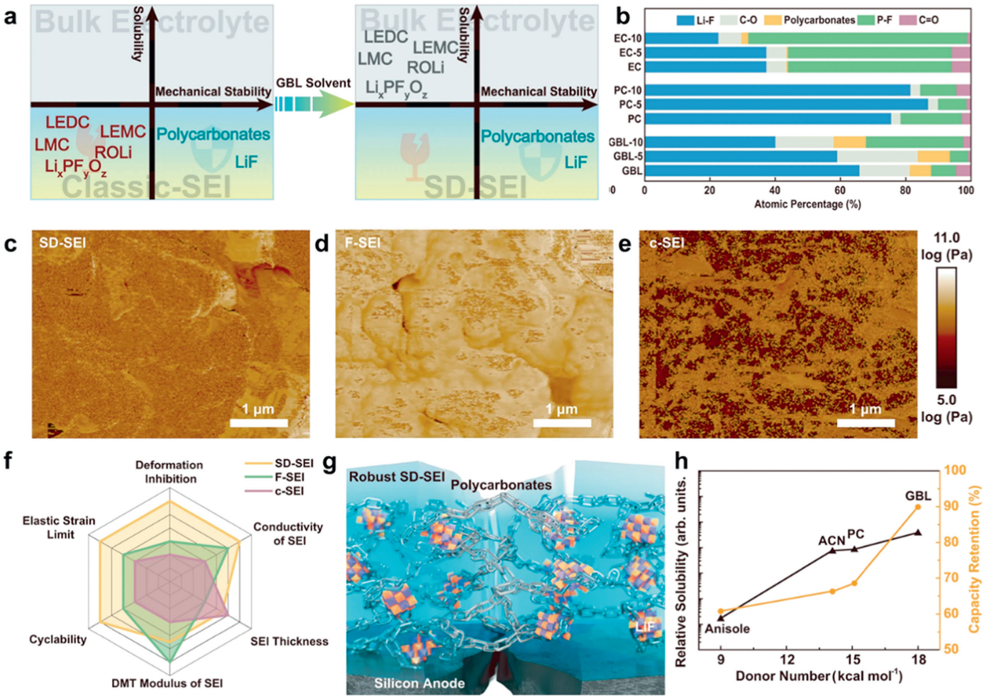

Fig. 1. (a) Schematic selective dissolution of GBL for SEI. (b) SEI component content in various electrolytes. (c-e) Derjaguin–Muller–Toporov (DMT) modulus mappings of SD-SEI, F-SEI and c-SEI. (f) Property comparison of different SEI. (g) Schematic SD-SEI. (h) The relationship of DN, relative solubility and capacity retention. Reproduced and adapted with permission [11]. Copyright 2023, Springer Nature.

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mized mechanical parameters (Fig. 1f, *e.g.*, elastic strain limit, deformation suppression capability). As illustrated in Fig. 1g, the SD-SEI anchored by tough LiF and connected by elastic polyethylene carbonate could well buffer volume changes for enhancing battery stability. In addition, they also studied the relationship between establishing DN and loop stability (Fig. 1h). Due to the selective dissolution effect, stable cycling of silicon-based anodes can be achieved when using high DN solvents in the electrolyte.

In conclusion, Guo's work improved the cycling stability of micron-scale silicon anode by selectively dissolving unfavorable components within the SEI using a high DN solvents. The work not only addressed the challenge of significant volume changes in silicon-based anodes, but also revealed the relationship between the physicochemical properties of solvents and electrochemical performance.

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References

[1] H.M. Wu, P.B. Gao, J.L. Mu, et al., Chin. Chem. Lett. 33 (2022) 3236–3240.
[2] Y. Cai, Q. Jin, K.X. Zhao, X.Z. Ma, X.T. Zhang, Chin. Chem. Lett. 33 (2022) 457–461.
[3] H.Y. Chen, M.X. Li, C.P. Li, et al., Chin. Chem. Lett. 33 (2022) 141–152.
[4] S.J. Yang, X. Shen, X.B. Cheng, et al., J. Energy Chem. 69 (2022) 70–75.
[5] Z.P. Li, L.H. Sun, L.P. Zhai, et al., Angew. Chem. Int. Ed. 62 (2023) e202307459.
[6] Q. Li, J.F. Ruan, S.T. Weng, et al., Angew. Chem. Int. Ed. 62 (2023) e202310297.
[7] Z.P. Wang, S.Y. Xie, X.J. Gao, et al., Chin. Chem. Lett. 34 (2023) 108151.
[8] X.H. Liu, X.J. Qian, W.Q. Tang, et al., J. Energy Chem. 52 (2021) 385–392.
[9] J. Chen, X. Fan, Q. Li, et al., Nat. Energy 5 (2020) 386.
[10] H. Jia, L. Zou, P. Gao, et al., Adv. Energy Mater. 9 (2019) 1900784.
[11] Y.F. Tian, S.J. Tan, C. Yang, et al., Nat. Commun. 14 (2023) 7247.