

Supplementary information

Tertiary butyl hydroquinone as a novel additive for SEI film formation in lithium-ion batteries

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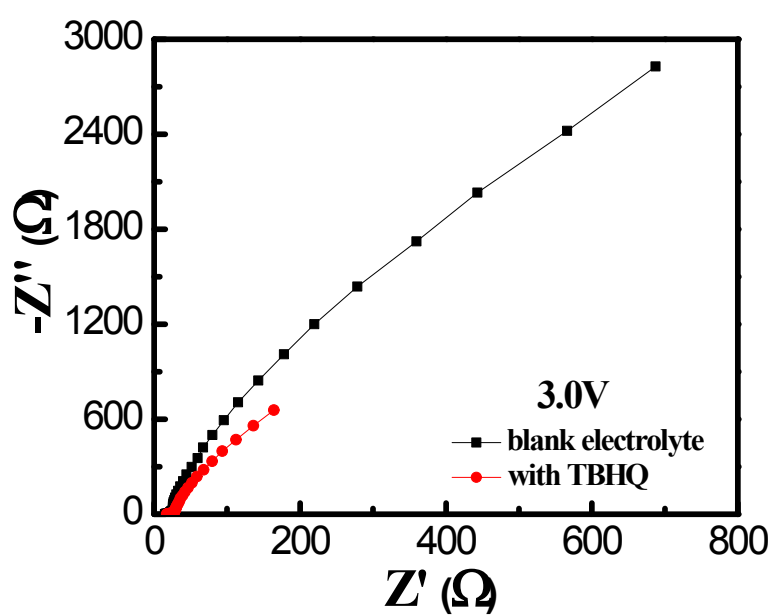


Fig. S1. Nyquist plots of the graphite electrodes at 3.0 V in the first discharge process in the 1.0 M LiPF_6 -EC: DMC: DEC (1:1:1, v/v/v) electrolyte without and with TBHQ.

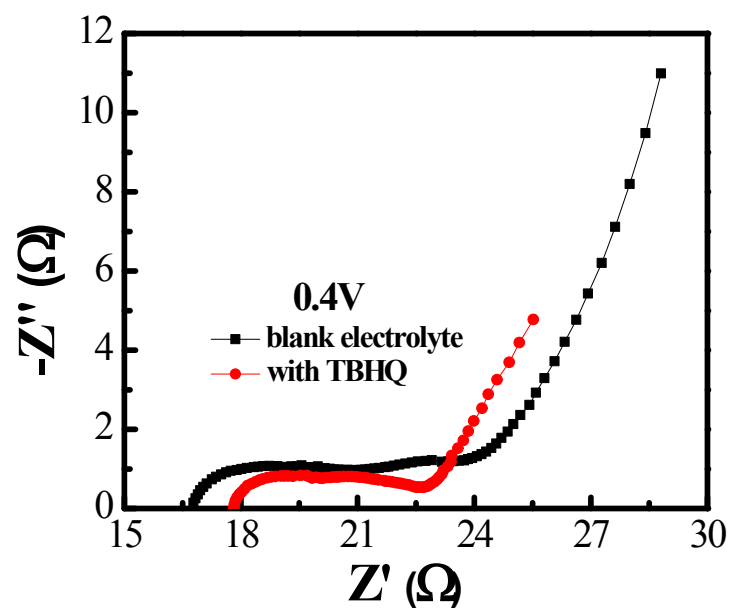


Fig. S2. Nyquist plots of the graphite electrodes at 0.4V in the first discharge process in the 1.0 M LiPF₆-EC: DMC: DEC (1:1:1, v/v/v) electrolyte without and with TBHQ.

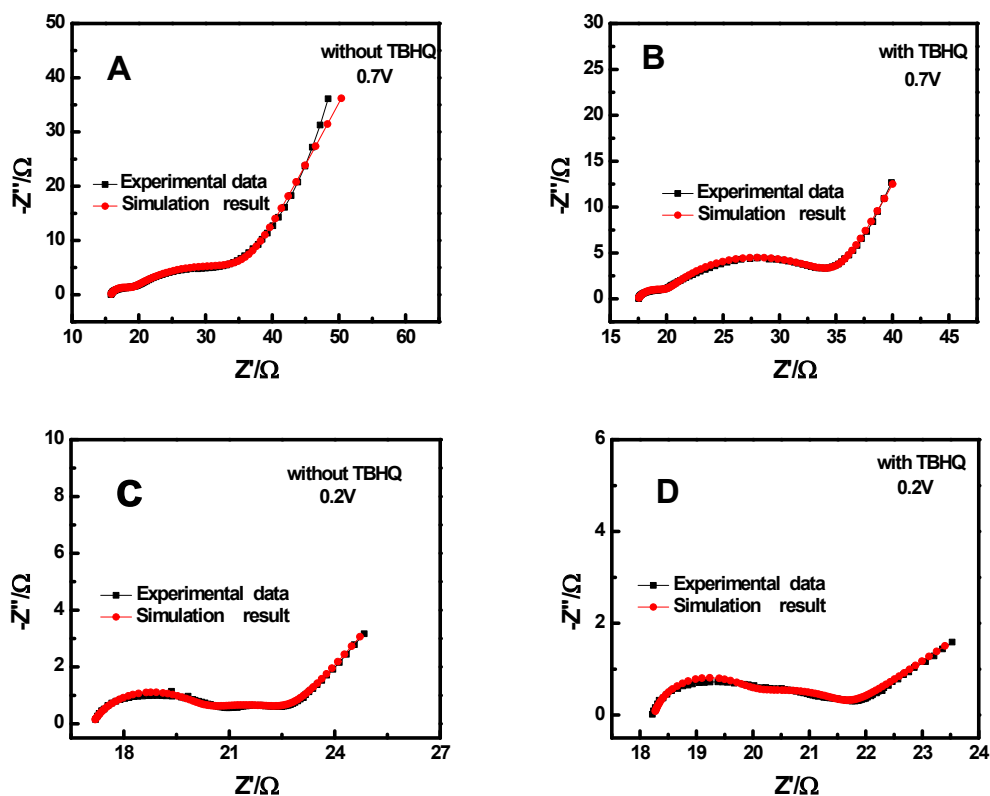


Fig. S3. Comparisons of EIS experimental data recorded at 0.7 V and 0.2V during discharge process with the simulation result obtained from the proposed equivalent circuit in the 1.0 M LiPF₆-EC: DMC: DEC (1:1:1, v/v/v) electrolyte without and with TBHQ.

Table S1

Equivalent circuit parameters at 0.7 V in the discharge process in the 1.0 M LiPF₆-EC:

DMC: DEC (1:1:1, v/v/v) electrolyte without and with TBHQ.

parameters	Without TBHQ		With TBHQ	
	value	Uncertainty(%)	value	Uncertainty (%)
$R_s (\Omega)$	15.83	0.34459	17.5	0.41333
$R_{SEI} (\Omega)$	8.552	9.9809	3.252	0.13218
$Q_{SEI} - n$	2.4653×10^{-4}	14.145	4.3702×10^{-4}	13.655
$Q_{SEI} - Y_0$	0.80492	6.3603	0.75998	4.9021
$R_{ct} (\Omega)$	22.4	4.3061	18.3	1.6547
$Q_{dl} - n$	0.013865	5.1693	0.011008	2.6914
$Q_{dl} - Y_0$	0.54074	3.598	0.64036	1.6392
$Q_D - n$	0.18343	1.8816	0.57154	3.2999
$Q_D - Y_0$	0.76753	1.4483	0.64975	1.7027

Table S2

Equivalent circuit parameters at 0.2 V in the discharge process in the 1.0 M LiPF₆-EC:

DMC: DEC (1:1:1, v/v/v) electrolyte without and with TBHQ

parameters	Without TBHQ		With TBHQ	
	value	Uncertainty (%)	value	Uncertainty (%)
$R_s (\Omega)$	17.11	0.27663	18.24	0.17332
$R_{SEI} (\Omega)$	4.445	12.759	2.216	10.917
$Q_{SEI} - n$	5.8335×10^{-2}	14.842	1.8474×10^{-2}	14.39
$Q_{SEI} - Y_0$	0.49221	13.137	0.5639	13.92
$R_{ct} (\Omega)$	4.29	13.017	3.472	10.724
$Q_{dl} - n$	3.1874×10^{-4}	14.833	8.4384×10^{-5}	14.194
$Q_{dl} - Y_0$	0.75824	5.9823	0.92734	7.0895
$Q_D - n$	1.576	12.438	1.474	11.13
$Q_D - Y_0$	0.62624	6.98686	0.4452	6.427

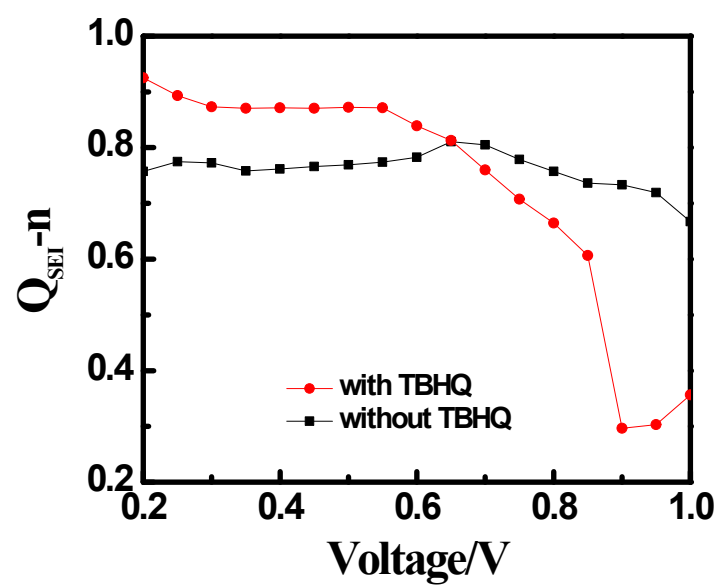


Fig. S4. Variations of Q_{SEI-n} with the electrode potential in electrolytes without and with TBHQ.

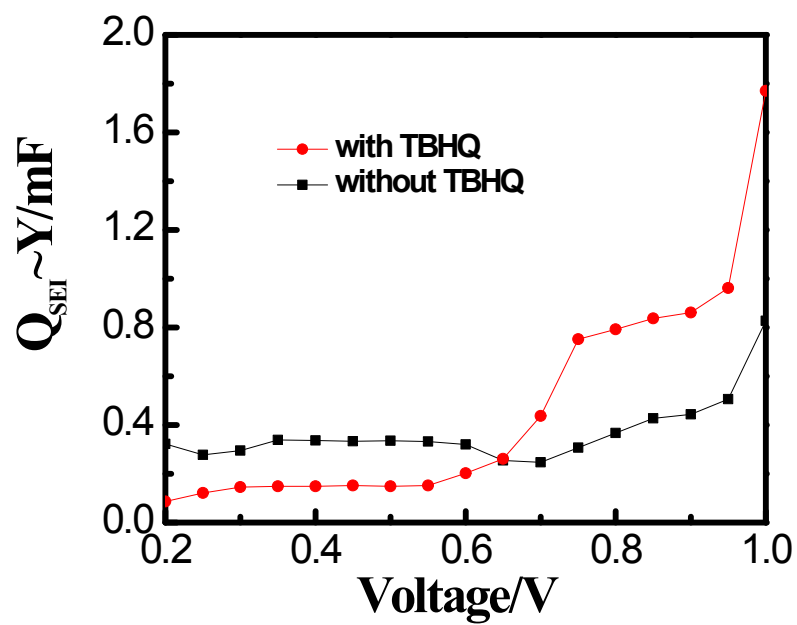


Fig. S5. Variations of Q_{SEI} -Y with the electrode potential in electrolytes without and with TBHQ.

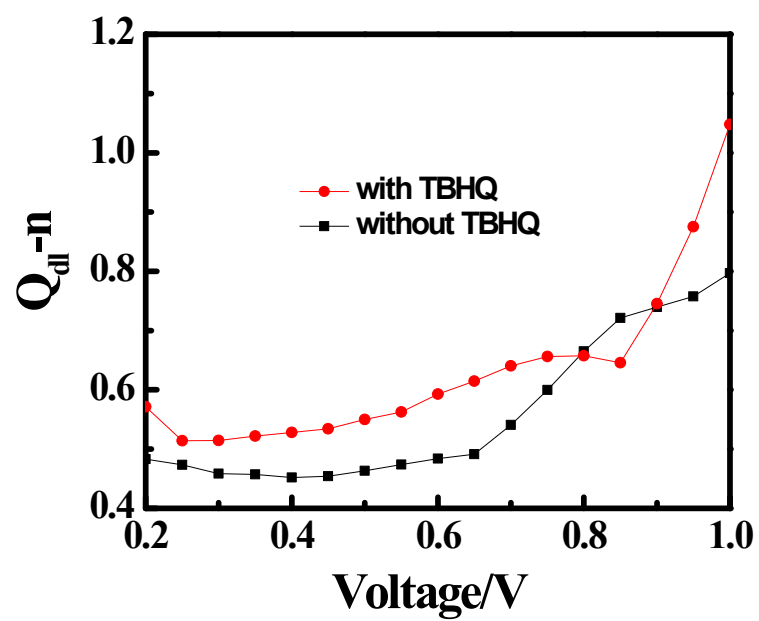


Fig. S6. Variations of Q_{dl-n} with the electrode potential in electrolytes without and with TBHQ.

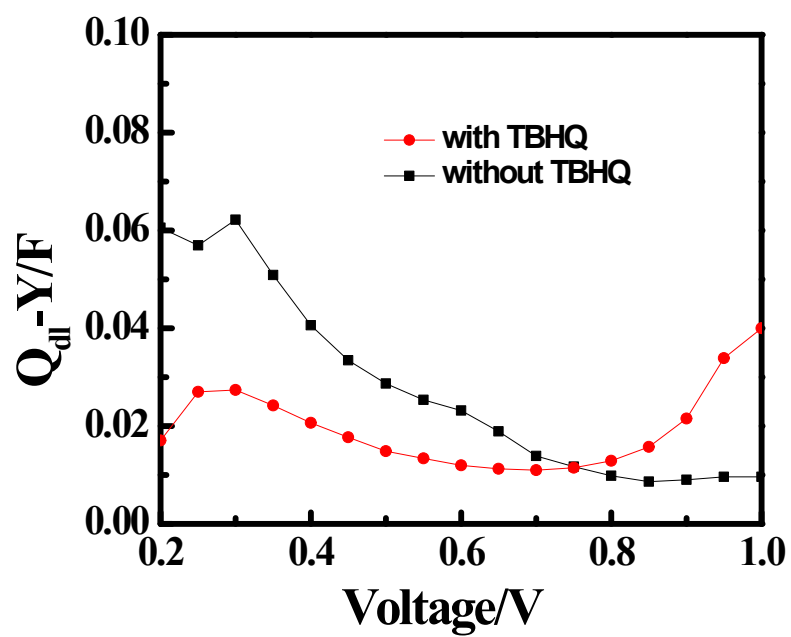


Fig. S7. Variations of $Q_{dl} - Y$ with the electrode potential in electrolytes without and with TBHQ.

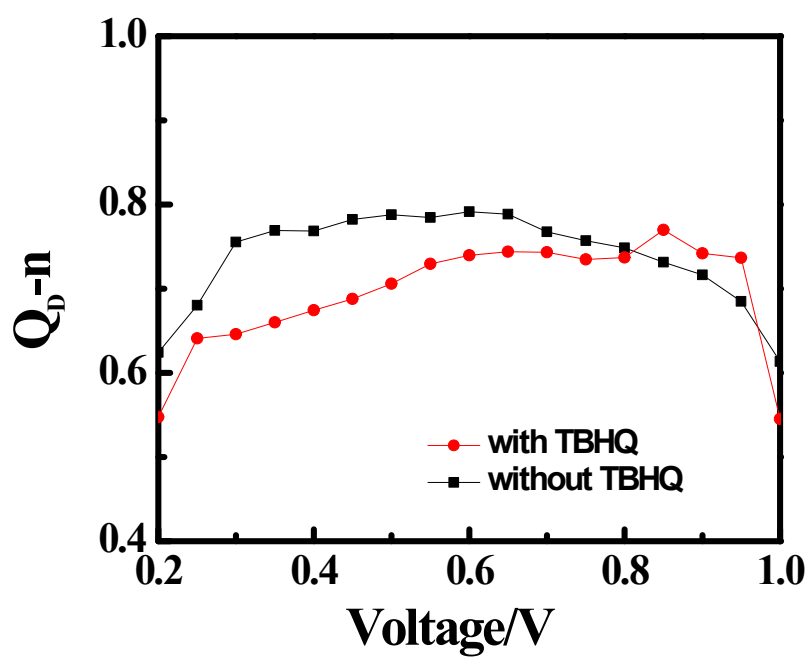


Fig. S8. Variations of $Q_D - n$ with the electrode potential in electrolytes without and with TBHQ.

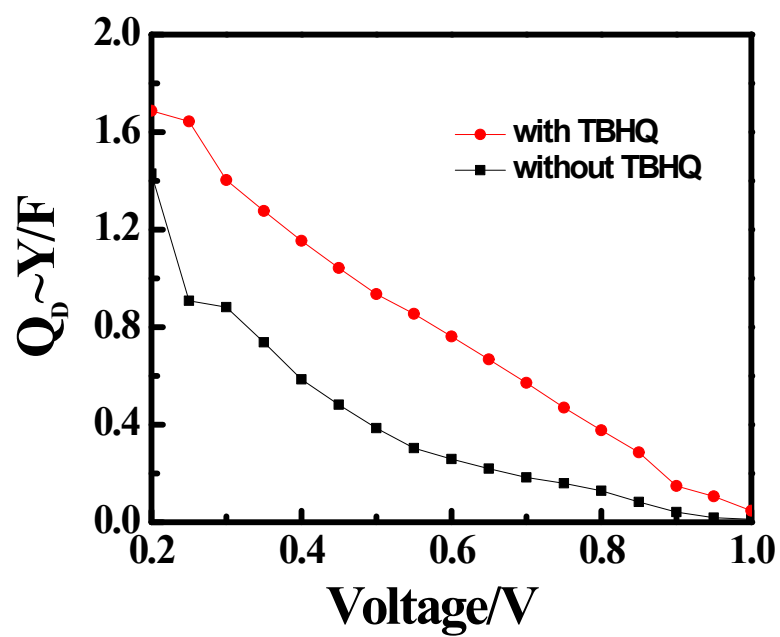


Fig. S9. Variations of $Q_D - Y$ with the electrode potential in electrolytes without and with TBHQ.