

Facile synthesis of multi-phase (Si+SiO₂) @C anode materials for Lithium-ion batteries

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The D_{Li^+} coefficient can be determined by the Warburg coefficient (S1)¹:

$$D_{Li^+} = R^2 T^2 / (2 A^2 n^4 F^4 C^2 \sigma_\omega^2) \quad (S1)$$

Where R is the gas constant of 8.314J (mol/K), T is the temperature at which the sample was tested, A is the electrode area immersed in the electrolyte, n is the number of transferred electrons, F is the Faraday constant (96500 C/mol), and C is the molar concentration of Li⁺ in the electrode.

It is apparent that the D_{Li^+} are only related to the Warburg coefficients (ω), which were determined from a linear fit to the low-frequency region:

$$Z' = R_e + R_{ct} + \sigma_\omega * \omega^{-0.5} \quad (S2)$$

The current response at a certain scan rate is evaluated by Eq. S3²:

$$i = a v^b \quad (S3)$$

Where a is a constant. b could be obtained by linear fitting the logarithm of the peak current and the logarithm of the corresponding scanning rate. According to the Conway theoretical equations (S3),

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Values a and b are the regulation parameters, and the value of b is determined by a series of logarithmic fits of the peak currents, and when $b = 0.5$, the storage mechanism of lithium ions is the diffusion contribution, and when $b = 1$, it indicates that the storage mechanism of lithium ions is all capacity contribution

Table 1. Comparison of electrochemical performance for various Si/SiO₂-based anode materials reported recently.

Si anode materials	Synthesis method	current density (mA/g)	N/capacity retention(%)	ICE(%)	Ref.
Si/SiO ₂ @C composites	ball milling+ magnesiothermic reduction+ C coating	50	50/59.6%	56.7	3
Si@SiO ₂ @ amorphous-C	ball milling+ magnesiothermic reduction	1000	200/93.1%	54%	4
Si/SiO ₂ coated with lignin-derived carbon (Si/SiO ₂ @ALC)	magnesiothermic reduction	200	150/87.1%	73.1	5
Si-SiO ₂ /carbon nanospheres composite	magnesiothermic reduction+template method + carbonthermal vapor deposition	150	200/96%	64%	6
Si@C@SiO ₂	template method+ liquid phase synthesis+coating	200	300/89.4%	73.2	7
Si@SiO ₂ /C composite	wet chemistry+liquid phase coating	420	200/70%	61%	8
Porous Si/SiO ₂ /C	Dealloying+ solid state reaction	100	100/51.2%	53.4	9
SS50-900C	Ball milling+carbonthermal vapor deposition	100 200	130/96.6% 280/79.5%	62.5%	This work

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