Supplementary Materials

Magnetic field-governed kinetics in silicon dioxide-based anode towards high performing lithium-ion magneto-batteries

Rizwan Ur Rehman Sagar [a], Srikanth Mateti [a], Nasir Mahmood [b], Muhammad Waqas Khan [b], Ying (Ian) Chen [a]*, Md Mokhlesur Rahman [a]*

[a]Institute for Frontier Materials, Deakin University, Waurn Ponds, VIC, 3216, Australia

[b]School of Engineering, RMIT University, Melbourne, VIC 3001, Australia

Corresponding authors:

E-mail addresses: MokhlesDeakin@gmail.com (M.M. Rahman); ian.chen@deakin.edu.au (Y. Chen)

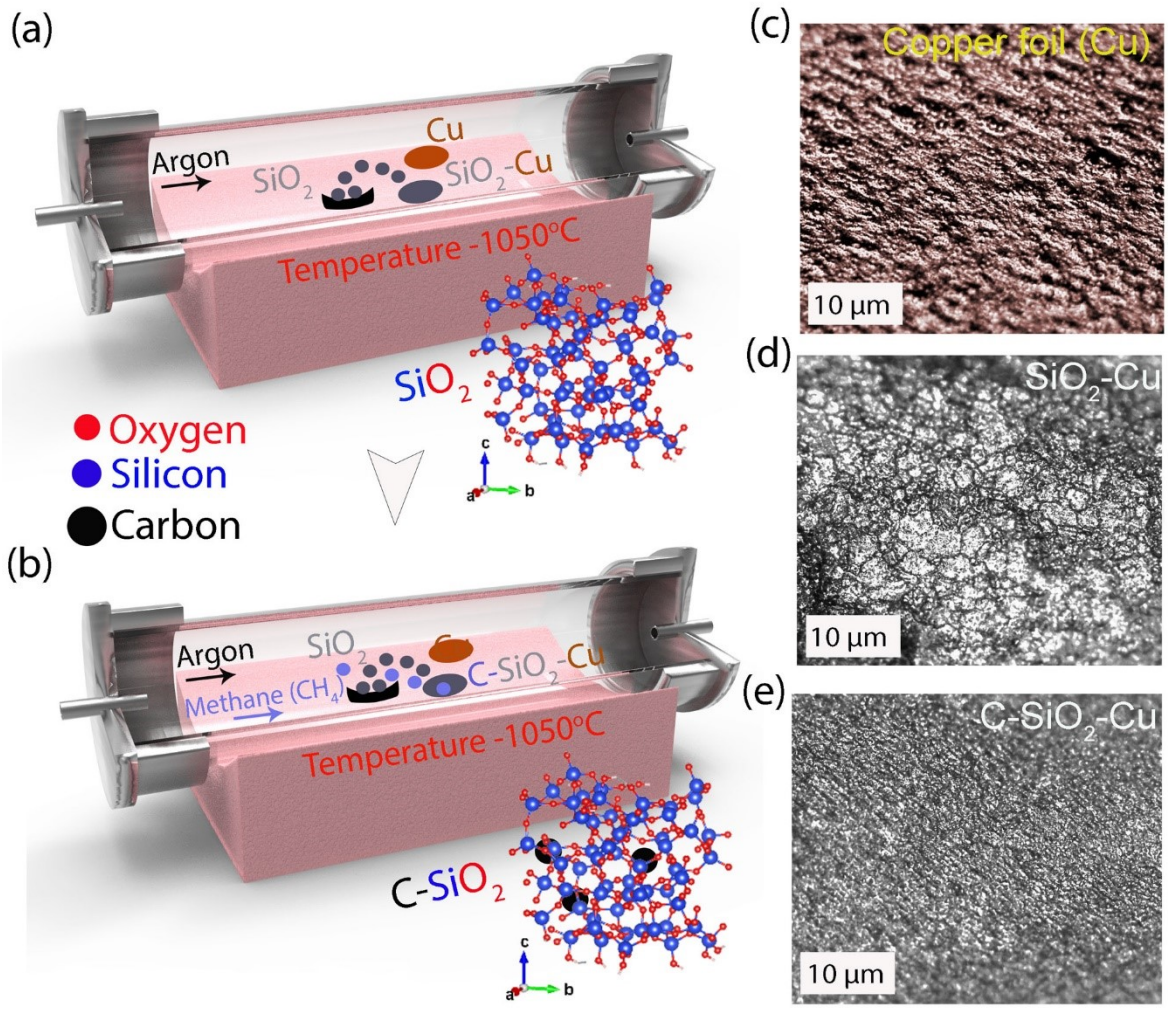

Fig. S1. Schematic presentation of the deposition of SiO_2 and carbon on the surface of Cu foil using CVD technique: (a) direct deposition of SiO_2 on the surface of copper (SiO_2/Cu sample) and (b) direct deposition of SiO_2 and carbon (CH_4 is used as a source of carbon) on the surface of copper (C-SiO_2/Cu sample). (c-e) surface analysis by optical microscope: (c) Cu-foil surface, (e) surface of SiO_2 particles deposited on Cu foil (SiO_2 shows shinny surface), and (e) carbon incorporated SiO_2 particles deposited on Cu foil (reduces the shiny surface and trends to darker due to carbon deposition).

Fig. S2. (a-c) Optical microscopy images: (a) Cu-foil surface (inset digital image), (b) surface of SiO_2 particles deposited on Cu foil (inset digital image), and (c) carbon incorporated SiO_2 particles deposited on Cu foil (inset digital image). A significant surface color changes after deposition of SiO_2 and carbon.

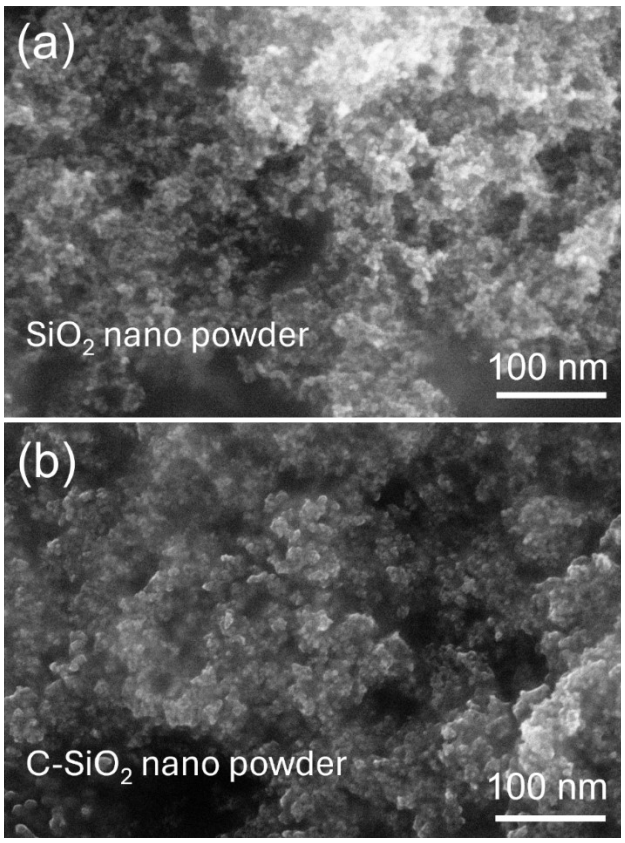

Fig. S3. SEM images of the SiO_2 and C-SiO_2 nano powders before deposition on the copper surface.

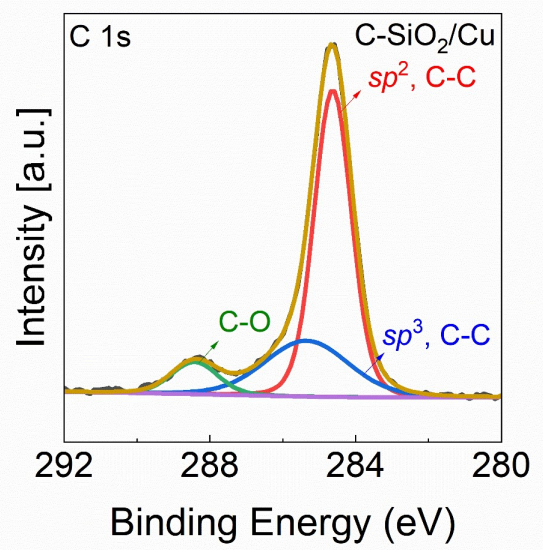

Fig. S4. C 1s spectra of the C-SiO_2/Cu sample.

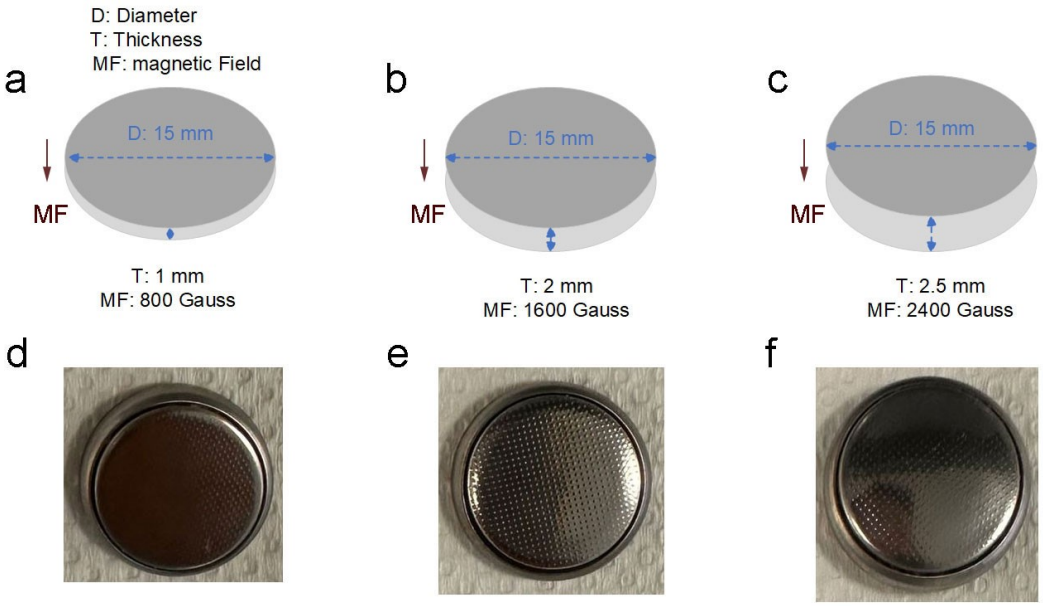

Fig. S5. Different magnetic spacers: (a) 15 × 1 mm- 800 Gauss, (b) 15 × 2 mm- 1600 Gauss and (c) 15 × 2.5 mm- 2400 Gauss used to assemble CR-2032-coin cells (d, e, f), respectively.

Table S1. Comparison of the battery performance of the SiO_x based materials with present results.

Materials	**Initial discharge -charge capacity**	**Initial Coulombic efficiency**	**Cycling performance**	**Rate performance**	**Ref.**
SiO_x-graphene/C	896/607 mAh g^{-1}	67.7 %	630 mAh g^{-1} at 100 mA g^{-1} after 250 cycles	408 mAh g^{-1} at 600 mA g^{-1}	[44]
SiO_x/C	1475/1015 mAh g^{-1}	68.8 %	817 mAh g^{-1} at 100 mA g^{-1} after 100 cycles	650 mAh g^{-1} at 800 mA g^{-1}	[45]
SiO_x/C	1324/906 mAh g^{-1}	68.4 %	720 mAh g^{-1} at 100 mA g^{-1} after 350 cycles	410 mAh g^{-1} at 800 mA g^{-1}	[46]
SiO_x/MWCNT/C	1093/720 mAh g^{-1}	66 %	620 mAh g^{-1} at 100 mA g^{-1} after 450 cycles	388 mAh g^{-1} at 800 mA g^{-1}	[47]
SiO_2/C	880/530 mAh g^{-1}	68 %	441 mAh g^{-1} at 500 mA g^{-1} after 500 cycles	231 mAh g^{-1} at 2A g^{-1}	[48]
SiO_x/Graphite	785/645 mAh g^{-1}	82.2 %	580 mAh g^{-1} at 325 mA g^{-1} after 500 cycles	549 mAh g^{-1} at 3A g^{-1}	[49]
Carbon coating lemon-like SiO_2 hollow spheres	451/203 mAh g^{-1}	< 50 %	786 mAh g^{-1} at 1 Ag^{-1} after 500 cycles	681 mAh g^{-1} at 2A g^{-1}	[50]
Nanotubular SiO_2@C composite	-	50.5 %	526 mAh g^{-1} at 1 A g^{-1} after 500 cycles	~ 600 mAh g^{-1} at 2A g^{-1}	[51]
Rice Husk-Derived SiO_2/C Composites	-	60 %	730 mAh g^{-1} at 100 mA g^{-1} after 100 cycles	480 mAh g^{-1} at 1A g^{-1}	[52]
3D PAA-TA/SiO_x	2328/1550	66.7%.	1025 mAh g^{-1} at 500 mA g^{-1}after 250cycles	670 mAh g^{-1} at 2A g^{-1}	[53]
Porous carbon rich SiO_x/C	718/650	90%	533 at 200 mA g^{-1} 200 cycles	299 mAh g^{-1} at 1A g^{-1}	[54]
SiOx/G/C anode	790/660	83%	487 mAh g^{-1} at 300 mA g^{-1} after 500 cycles	650 mAh g^{-1} at 1.2 A g^{-1}	[55]
Carbon coated C-SiO_2 (under magnetic field)	1757/1686	96%	2020 mAh g^{-1} at 100 mA g^{-1} after 750 cycles	891 mAh g^{-1} at 2A g^{-1}.	This Work

References

44. M. Li, Y. Yu, J. Li, B. Chen, A. Konarov and P. Chen, *Journal of Power Sources*, 2015, **293**, 976-982.

45. P. Lv, H. Zhao, C. Gao, T. Zhang and X. Liu, *Electrochimica Acta*, 2015, **152**, 345-351.
46. Y. Ren and M. Li, *Journal of Power Sources*, 2016, **306**, 459-466.
47. Y. Ren, X. Wu and M. Li, *Electrochimica Acta*, 2016, **206**, 328-336.
48. W. An, J. Fu, J. Su, L. Wang, X. Peng, K. Wu, Q. Chen, Y. Bi, B. Gao and X. Zhang, *Journal of Power Sources*, 2017, **345**, 227-236.
49. Q. Xu, J.-K. Sun, Y.-X. Yin and Y.-G. Guo, *Advanced Functional Materials*, 2018, **28**, 1705235.
50. K. Chen, Y. Tan, K. Wang, J. Niu and Z. Y. Chen, *Electrochimica Acta*, 2022, **401**, 139497.
51. C. Shi, J. Chen, T. Guo, G. Luo, H. Shi, Z. Shi, G. Qin, L. Zhang and X. He, *Batteries*, 2023, **9**, 107.
52. X. Cui, L. Liu, X. Liu, Y. Li, Y. Feng, L. Ma, L. Liu, Y. Xue, Y. Zhu and X. Wang, *Journal of Electronic Materials*, 2022, **51**, 68-76.
53. W. Tang, L. Feng, X. Wei, G. Lai, H. Chen, Z. Li, X. Huang, S. Wu and Z. Lin, *ACS Applied Materials & Interfaces*, 2022, **14**, 56910-56918.
54. Q. Aini, Y. Irmawati, J. Karunawan, M. H. R. Pasha, A. Alni, F. Iskandar and A. Sumboja, *Energy & Fuels*, 2023, **37**, 11397-11405.
55. G. Li, J.-Y. Li, F.-S. Yue, Q. Xu, T.-T. Zuo, Y.-X. Yin and Y.-G. Guo, *Nano Energy*, 2019, **60**, 485-492.