Enhanced charge storage capacity and high rate capabilities of Ni_2Co-layered double hydroxides/expanded graphite composites as an anode for Li-ion batteries

Ramesh Chandra Sahoo [a,b]
Sreejesh Moolayadukkam,[a] Jun Ho Seok,[c] Sang Uck Lee,[c]† and H.S.S. Ramakrishna Matte [a,b]†
a. Energy Materials Laboratory, Centre for Nano and Soft Matter Sciences, Bangalore 562162, India.
b. Manipal Academy of Higher Education (MAHE), Manipal 576104, India.
c. School of Chemical Engineering, Sungkyunkwan University, Suwon 16149, Republic of Korea.
Email: rameshchasahoo94@gmail.com, ramesh@cens.res.in

Abstract
Layered double hydroxides (LDH) have been on the forefront due to their multi-faceted advantages towards Lithium-ion batteries (LIB). However, the low electronic conductivity, huge volume change during the lithiation and delithiation process, and slow ion diffusion hamper their cycling stability as well as rate capabilities, limiting their usage for LIB. [1] To address the above mentioned issues, expanded graphite (EG) has been used as a conductive additive using in-situ methods, which helped in anchoring Ni_2Co-LDH on the surface of EG. Upon using the Ni_2Co-LDH/EG composites as an anode for LIB showed an enhanced charge storage capacity of 1880 and 919 mAh g^{-1} compared to 1028 and 92 mAh g^{-1} for Ni_2Co-LDH at 0.05 A g^{-1} and 1 A g^{-1} respectively. Along with that, staircase potentio-electrochemical impedance spectroscopy (SPEIS) studies indicated that the charge storage dynamics of Ni_2Co-LDH/EG composites could be attributed to the battery like behaviour. [2, 3] Further, to understand the significant enhancement in charge storage capabilities of Ni_2Co-LDH/EG composites, Density functional theory (DFT) calculations have been carried out. The calculations suggest that the relatively large lithium interaction energy of the Ni_2Co-LDH/EG and the PDOS overlapping of lithium and carbon in the valence band region gives rise to a stable Li-ion intercalation process. [4]

References

[1] Q. Wang and D. O'Hare, Chem. Rev., 112 (2012) 4124–4155.
[2] N. Kurra, S. Uzun, G. Valurouthu and Y. Gogotsi, Energy Storage Mater., 39 (2021) 347–353.
[3] J. S. Ko, C.-H. Lai, J. W. Long, D. R. Rolison, B. Dunn and J. Nelson Weker, ACS Appl. Mater. Interfaces, 12 (2020) 14071–14078.
[4] R. Zhang, Z. Xue, J. Qin, M. Sawangphruk, X. Zhang and R. Liu, J. Energy Chem., 50 (2020) 143–153.

Figures

Figure 1 The expanded graphite has been used as a matrix to grow Ni_2Co-LDH and this enabled to obtain stability and fast charging capabilities when used as anode for Li-ion batteries. The experimental findings are supported by DFT calculations.