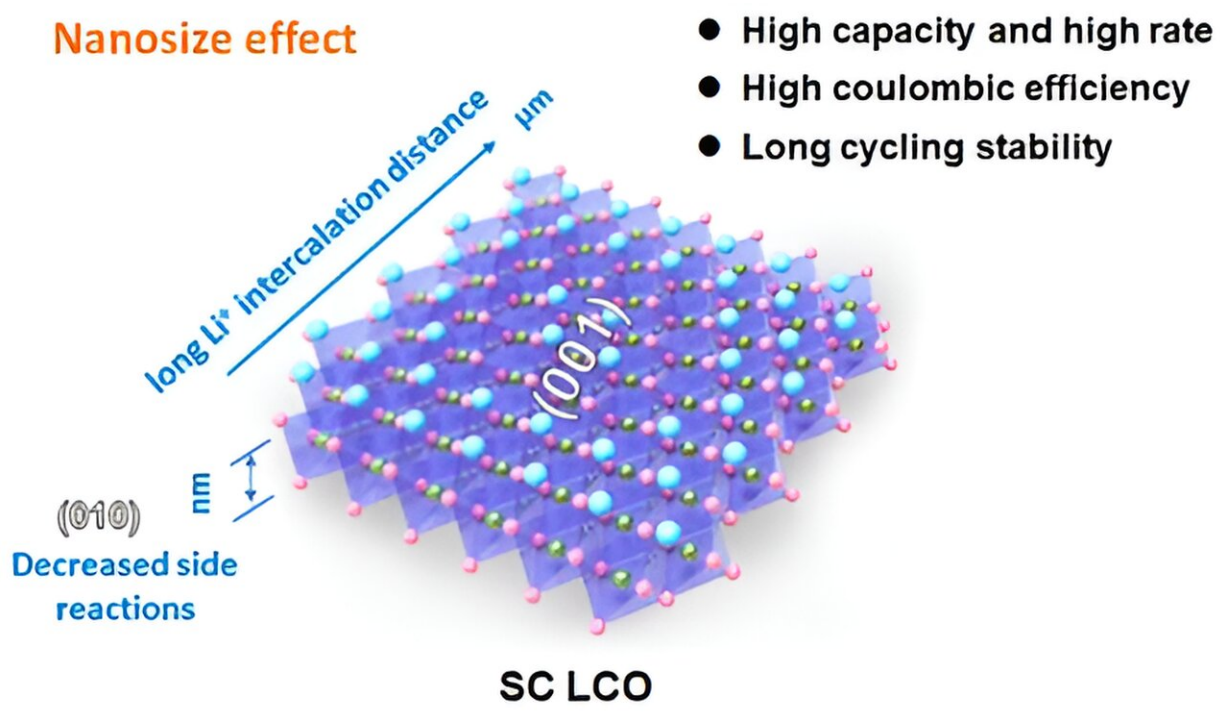
2D single-crystalline $LiCoO_2$ nanosheets developed for high-performance battery-supercapacitor hybrid devices

February 1 2024, by Liu Jia



Graphical abstract. Credit: *ACS Energy Letters* (2024). DOI: 10.1021/acsenergylett.3c02196

A team led by Prof. Wu Zhongshuai has developed novel 2D atomically thin (001)-oriented single-crystalline $LiCoO_2$ nanosheets with longer Li^+ intercalation distance and (001) planes dominated surface for high-

performance battery-supercapacitor hybrid devices. This study was published in *ACS Energy Letters*.

Shorter Li^+ intercalation distance or lower intercalation energy barrier enables fast diffusion in Li^+ intercalation process. However, it has been found that nanosize effect in nanocrystalline $LiCoO_2$ affects surface-redox and Li^+ intercalation processes simultaneously.

As the crystallite size decreases, more Li^+ intercalation processes are replaced by surface-redox processes, which brings about decreased platform capacity, low initial coulombic efficiency, and poor cycle performance. Therefore, the nanosize effect restricts the application of nanostructured $LiCoO_2$ in "double high" battery-supercapacitor hybrid devices.

To solve this problem, Prof. Wu's team attempted to regulate the nanosize effect by precisely controlling the Li^+ intercalation process and surface-redox process.

The team synthesized micro-sized atomically thin single-crystalline LCO nanosheets (SC-LCO) and nanocrystalline LCO nanosheets (NC-LCO).

Compared with NC-LCO, SC-LCO presented longer Li^+ intercalation distance and decreased side reactions. Both coulombic efficiency and discharge capacity of SC-LCO at 1C (194 mAh g^{-1}, 92%) were higher than those of NC-LCO (173 mAh g^{-1}, 86%).

The specific capacity of SC-LCO maintained 151 mAh g^{-1} (83%) after cycling for 500 cycles, which preceded NC-LCO (84 mAh g^{-1}, 63%).

Moreover, the team fabricated a battery-supercapacitor hybrid device with SC-LCO, which achieved high-energy and high-power, demonstrating the practical applicability of this nanosheets.

More information: Feifei Xing et al, Regulating the Nanosize Effect of LiCoO2 for High-Performance Battery-Supercapacitor Hybrid Devices, *ACS Energy Letters* (2024). DOI: 10.1021/acsenergylett.3c02196

Provided by Chinese Academy of Sciences

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