# Incorporating Graphene-Quantum-Dots into Lithium-Sulfur Batteries for Enhanced Electrochemical Performance with Optimized Sulfur Nucleation

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Graphene Quantum Dots (GQDs) are 0D materials fragmented into a few nanometer sized particles from larger graphitic materials. GQDs contain a mixture of sp2 and sp3 carbon bonds with various chemical functional groups, exhibiting unique properties such as characteristic fluorescence, quantum confinement effect, amphiphilicity, biocompatibility, *etc.*, which have been utilized to LEDs, photocatalysts, bioimaging and sensing agents, therapeutic agents, and energy applications.[1] Recently, GQDs have been widely used in batteries for their large surface areas and more active sites, resulting in faster charge transfer and ion diffusion. GQDs were also used to address the shuttle effect, a common problem in Li-S batteries, due to their abundant sulfiphilic oxygen functional groups.[2] On the other hand, the failure of Li-S batteries often depends on the sulfur deposition morphology in the cathode,[3] so organic solvents have been introduced to solve this issue, which still limits the performance of the Li-S batteries. [4]

In this study, GQDs with abundant oxygen functional groups were introduced into the cathode of a Li-S battery to solve the above mentioned shuttle effect and the sulfur morphology problem, simultaneously. As a result, we confirmed that the overpotential and resistance of the Li-S battery are reduced, and the faster reaction kinetics are observed, indicating that GQDs suppress the shuttle effect and promote the faster charge or mass transfer. Furthermore, we observed minimized capacity fade even after 200 cycles of charge and discharge. In addition, the particle-like morphology of lithium sulfide deposition was obtained, which is advantageous to prevent the formation of sulfur films that degrade the performance of Li-S batteries.

## References

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## Figures

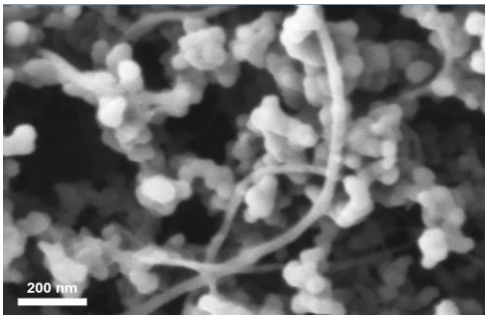


**Figure 1:** SEM image of the GQD-incorporated cathode of Li-S battery after full discharge.