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Towards next generation batteries based on sulfur cathodes

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Lithium-sulfur batteries (LSBs) have emerged as an exciting alternative to Li-ion batteries. However, the practical application of LSBs requires overcoming several challenges, including the electrical insulating character of sulfur and lithium sulfides, the severe volumetric variation during charge/discharge processes, the diffusion of soluble lithium polysulfides (LiPS) intermediates, and the slow redox kinetics of the LiPS conversion reaction. Several strategies have been developed to improve the performance of LSBs. In terms of materials, one effective approach is to host sulfur at the cathode in carbon-based materials with high conductivity. Polar materials are also used to strongly bind LiPS and efficiently confine them within the cathode, achieving notable improvements in the cycling stability. In terms of structure, porous nanomaterials have been demonstrated advantageous in LSBs, to mitigate the detrimental effect of the volume expansion and provide physical confinement for LiPS. Besides, the use of electrocatalysts to enhance LiPS redox kinetics has been demonstrated effective to improve LSB performance. We will present our recent advances in the design and engineering of promising sulfur hosts, using materials with high electrical conductivity, significant polarity to ensure a strong polysulfide affinity, highly porous nanostructures and having high catalytic activity toward sulfide redox reactions.

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