Nitrogen enriched mesoporous carbon as high capacity cathode in Li-O2 batteries
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Lithium-oxygen batteries with nonaqueous electrolyte are attracting more and more interests because of their extremely high energy density. Ogasawara et al. predicted that the specific energy density of a lithium-oxygen battery could be more than 10 times higher than that of current Li-ion batteries. Among all the components that make up a lithium-oxygen battery, the carbon cathode plays a key role on the cell performance. Previous studies have proved that both optimized pore structure and N doping could help improve discharge performance. The motivation of this work is to construct a novel carbon material to combine the two factors together to get excellent discharge performance in lithium-oxygen batteries.

In this work, we develop a novel nitrogen enriched mesoporous carbon material (N-MCS) for lithium-oxygen battery electrodes through a facile one-step hard template method. Nitrogen-containing polymer (melamine-formaldehyde resin) is employed as carbon source to achieve the in-situ doping of nitrogen. Colloidal silica is used as hard template. The obtained carbon powder contains great amount of nitrogen with homogeneous distribution (Figure 1), combined with ultra-large pore volume at appropriate size (Table 1) for solid deposition. And by changing the size of the template, the pore size of N-MCS can be exactly adjusted.

When used as cathode materials for lithium-oxygen batteries, it exhibits the discharge capacity of 4500 mAh g⁻¹, which is 1.73 times that of BP2000 (Figure 2). The high discharge capacity of N-MCS is attributed to the combined effect of pore structure and the introduction of nitrogen. The large mesopore volume with appropriate size could hold more solid products. Meanwhile, the pore utilization rate has been improved due to the interconnected macropore channels and lower affinity to organic electrolytes of N-MCS cathode, which facilitate O2 diffusion. In addition, the cathode made of N-MCS also demonstrated the faster charge-transfer kinetics. Therefore, N-MCS should be a promising material for the cathode of lithium-oxygen batteries.

<table>
<thead>
<tr>
<th></th>
<th>S_BET (m² g⁻¹)</th>
<th>V_0-10 nm (cm³ g⁻¹)</th>
<th>V_10-100 nm (cm³ g⁻¹)</th>
<th>V_10-400 nm (cm³ g⁻¹)</th>
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<tr>
<td>N-MCS</td>
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<td>3.06</td>
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Reference