**Sodium-ion batteries: biomass-derived hard carbon materials for anode**

Sodium-ion batteries (SIBs or NIBs) are currently receiving attention and are predicted to be used to complement or replace lithium-ion batteries in the near future. This is because they offer the advantage of being abundant in nature and ranks as the sixth most element in the Earth's crust, at approximately 23,600 parts per million, making them cost-effective. Additionally, sodium-ion batteries exhibit electrochemical reactions similar to lithium-ion batteries. Therefore, they can be prepared and manufactured using the same production processes as lithium-ion batteries. This significant advantage allows for scalability of production to industrial levels.

The development of both anode and cathode materials for sodium-ion batteries poses a significant challenge in achieving high performance and long-cycle life. Among potential candidates, hard carbon stands out as the most promising material for SIB anodes due to its suitable d-spacing, enabling the accommodation of Na+ ions with high reversible capacity and exceptional long-cycle performance. Moreover, a primary source of hard carbon is waste biomass, which is abundant and cost-effective. Transforming waste biomass into high-quality hard carbon for use as SIB anodes not only enhances the value-added application of solid waste but also promotes resource efficiency and contributes to a circular economy.

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