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Tuning sodium nucleation and stripping by the mixed surface of carbon nanotube-sodium composite electrodes for improved reversibility

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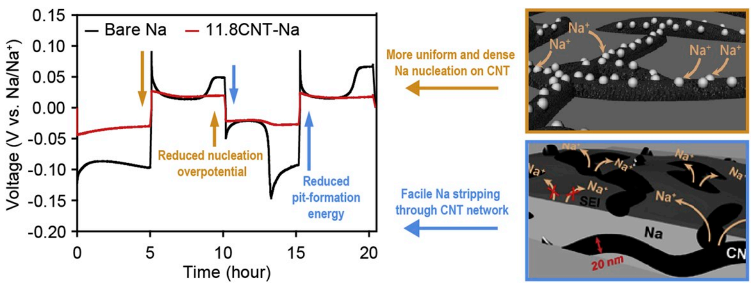
HIGHLIGHTS

- Carbon nanotube(CNT) is introduced to Na metal anode by a rolling and folding method.
- Electrically conductive CNT network induces more uniform and dense Na nucleation.
- Embedded CNT helps Na stripping by providing a facile channels for Na ion transport.
- CNT-Na composite electrode exhibits a 5-times improved cycling stability.

GRAPHICAL ABSTRACT



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ABSTRACT

Metallic sodium is regarded as a promising anode material for sodium rechargeable batteries. However, sodium dendrite growth and exhaustive electrolyte decomposition cause the poor reversibility of the sodium metal electrode. Here, we present that, by forming a mixed surface of carbon and sodium metal, the sodium electrodeposition mode and stripping mechanism can be tuned. In order to systematically investigate sodium plating/stripping behavior on a mixed surface of carbon and sodium, we fabricate a carbon nanotube-sodium composite electrode with a simple rolling and folding method. As the carbon nanotube content is increased, the overpotentials for sodium nucleation and pit-formation are remarkably reduced. Postmortem and chronoamperometry analysis elucidate that sodium and sodiated carbon nanotube have a different sodium nucleation mode, and sodium nucleation is preferred on the sodiated carbon nanotube surface with lower nucleation energy, inducing a more uniform sodium deposition. Furthermore, the embedded carbon nanotube appears to help sodium stripping by providing a channel for a more facile sodium ion transport. As a result, the carbon nanotube-sodium composite electrode exhibits a 5 times higher cycling stability. The tuning of the nucleation and stripping behaviors by forming a mixed surface can be a viable approach for enhancing the reversibility of metal electrode.

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