

Nanostructure-Surface Modified Cu Thin Film for Lithium-ion Negative Electrode Application

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Thin Cu film is widely used as a current collector for the negative electrode in lithium ion batteries. However, a major cause of battery failure results from the delamination between the current collector and the graphite anode¹⁻². When Si and Sn are used as the active material, delamination becomes a key issue due to the large volume changes of Si and Sn during lithiation and delithiation processes³⁻⁴. In the microscale, adhesion is dominated by Van der Waals forces, which are proportional to the surface area of contact⁵. We present a new approach that improves adhesion between the laminate and the Cu surface by introducing Cu(OH)₂ nanofibers that increase the surface area of the current collector.

We report the successful chemical modification of the Cu surface to generate Cu(OH)₂ nanofibers, shown in Figure 1. Regular Cu current collector (17 μ m thick) was treated with base to form the Cu(OH)₂ nanofibers layer (less than 100 nm) on the surface. At x1000 magnification, the roughness of clean Cu and modified copper is very similar (Figure 1a,1b). However, at x100000 (Figure 1c), the treated Cu surface displays a carpet of nanofibers. Calculation based on the SEM surface feature indicated at least x40 area increase.

Introducing the Cu(OH)₂ did not affect the initial electrode performance (Figure 3). Test cells were made with the modified current collector using the same formation process⁶, with the control cell using the regular current collector. The most typical electrode composition of 90% graphite (CGP-G8), 4% AB, and 6% PVDF⁷ was used in all cells. The cells were EIS tested (Figure 2).

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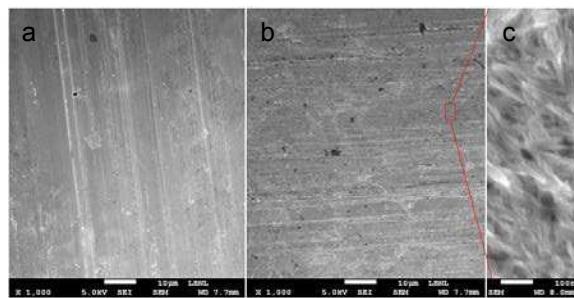


Figure 1: Surface SEM of (a) clean Cu, (b) chemically modified Cu at x10 μ m (c) chemically modified Cu shows nanofiber structure at x100 μ m.

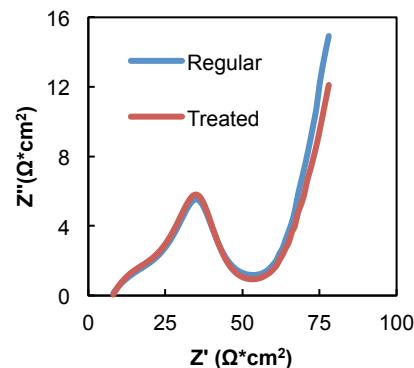


Figure 2: Impedance testing: large similarity between the treated and regular Cu were observed.

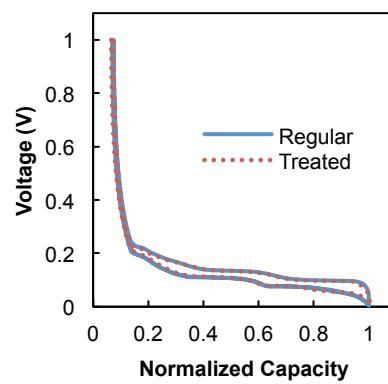


Figure 3: Initial cycling: the capacity was normalized to better compare the cycling trend, shown to be identical.

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