我校樊小勇教授科研成果荣登《Advanced Energy Materials》封面

发布时间：2019-08-02 作者：樊小勇 来源：材料学院 字体：小 中 大

近日，材料学院樊小勇教授和李东林教授课题组在三维铜纳米阵列的构筑及其作为钠离子电池集流体研究方面取得重大进展，相关成果（3D Nanowire Arrayed Cu Current Collector toward Homogeneous Alloying Anode Deposition for Enhanced Sodium Storage）以封面文章全文发表于材料科学领域国际顶级期刊《Advanced EnergyMaterials》（影响因子IF=24.884）。

合金类电极具有多电子反应容量、适中的电压平台和高电子导电性，被认为是一类理想的锂/钠储能负极。然而，Sb电极在储锂/钠过程中的巨大体积变化导致活性成分在传统集流体上发生剥离，失去电接触，最终导致容量的快速衰减。课题组通过在三维多孔铜的孔壁上生长一维纳米线阵列制备出一种独特的三维纳米线集流体，并在其表面电沉积Sb膜获得核-壳结构3D Cu@Sb 纳米线阵列电极。该3DSb电极具有大量相互贯穿的微米孔和丰富的纳米线阵列间隙，不仅可有效缓解Sb电极循环过程中的结构应力，且确保了电极稳定性，还提供均衡电子/离子分布，显示出优异的长循环寿命和快速充放电性能。本工作将为设计和制备先进的锂/钠储能电极提供了一种理想、可行的方法。

本论文由我校与湖南大学、加拿大滑铁卢大学等国内外知名高校共同合作完成。长安大学为第一通讯单位，樊小勇教授为论文第一作者，硕士生韩家兴同学为第二作者；樊小勇教授、李东林教授、湖南大学丁元力教授和加拿大滑铁卢大学Chen Zhongwei教授（加拿大工程院院士）为共同通讯作者。课题组苟蕾教授也为工作提出了宝贵意见，蒋震和曾祥天同学（现就读于清华大学深圳研究院）、加拿大滑铁卢大学Deng Ya-ping和LuoDan博士也参与了部分工作。

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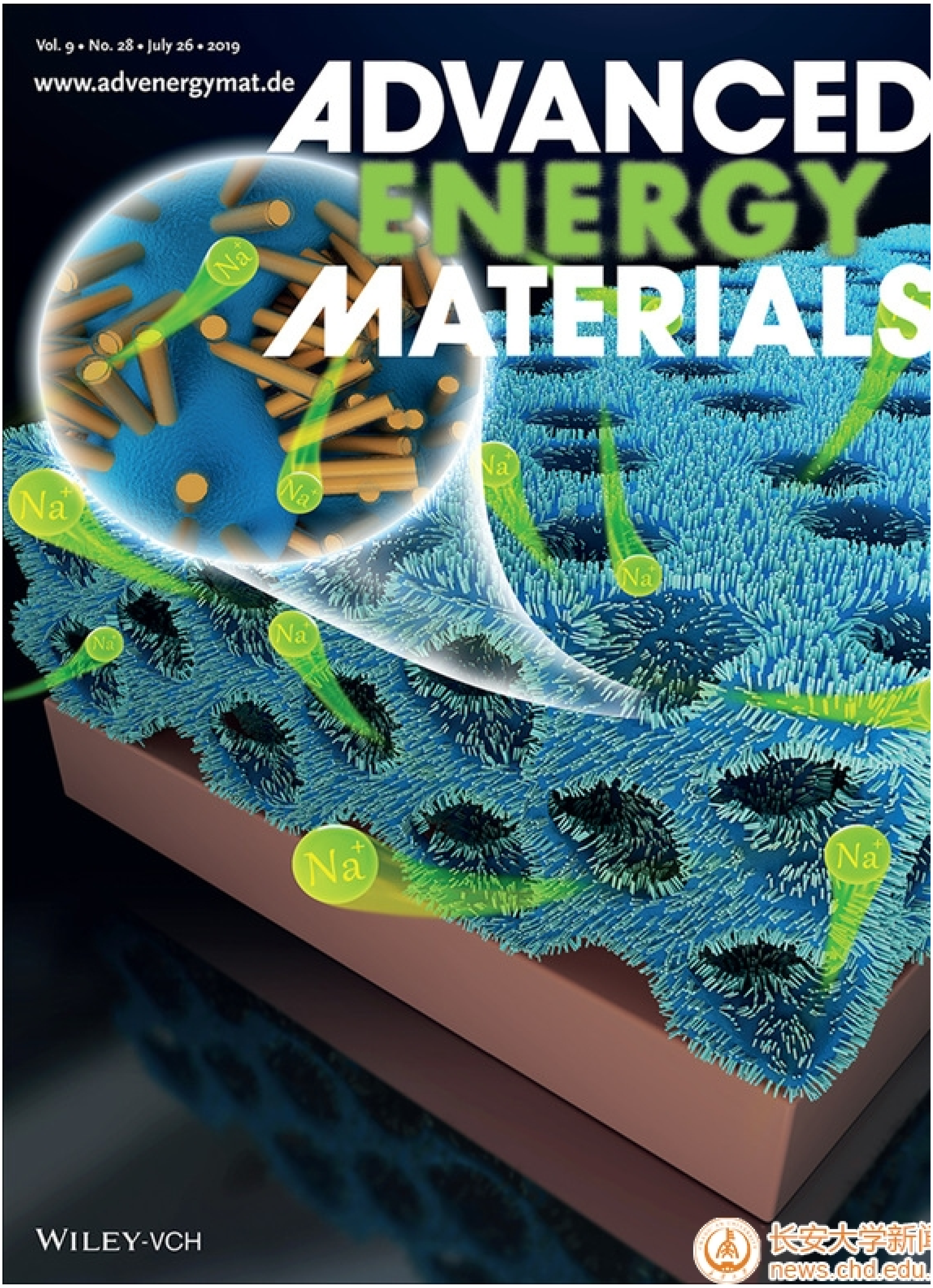
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3D Nanowire Arrayed Cu Current Collector toward Homogeneous Alloying Anode Deposition for Enhanced Sodium Storage

Xiao-Yong Fan, Jiaxing Han, Yuan-Li Ding,* Ya-Ping Deng, Dan Luo, Xiangtian Zeng Zhen Jiang, Lei Gou, Dong-Lin Li,* and Zhongwei Chen**

Alloying electrodes are regarded as promising anodes for lithium/sodium storage thanks to their multielectron reaction capacity, moderate voltage plateau, and high electrical conductivity. However, huge volume change upon cycling, especially for sodium storage, usually causes the loss of electrical connection between active components and their delaminations from traditional current collectors, thus leading to rapid capacity decay. Herein, a unique 3D current collector is assembled from 1D nanowire arrays anchored on 3D porous Cu foams for constructing core-shelled Cu@Sb nanowires as advanced sodium-ion battery (SIB) anodes. The so-formed hierarchical 3D anode with interconnected 3D micrometer sized pores and abundant voids between nanowires not only effectively accommodates the structural strains during repeated cycling but also ensures the structural integrity and contributes to a uniform ion/electron scattered distribution throughout the whole surface. When employed as anodes for SIBs, the obtained electrode shows a high capacity of 605.3 mAh g^{-1} at 330 mA g^{-1}, and demonstrates a high capacity retention of 84.8% even at a high current density of 3300 mA g^{-1}. The 3D nanowire arrayed Cu current collector in this work can offer a promising strategy for designing and building advanced alloy anodes for lithium/sodium storage.

1. Introduction

With the development of modern i tries, the energy crisis is becoming c the most urgent issues which need resolved in our life.[1] Therefore, ex tion of sustainable and renewable e from solar, wind, biomass power, e considered to be the top priority.[2] Eff utilization of these energy demands l efficient energy storage systems. A these potential candidates, sodiu batteries (SIBs) have drawn much tion and gained fast development tl to rich sodium resources and its lov ($135–165 per ton for Na_2CO_3, wh only ≈3% of that of Li_2CO_3).[1d,2c,3] ever, SIBs usually display lower c ties and shorter cycle life compared lithium-ion batteries (LIBs) due to l structural strain and volume ch upon sodiation/desodiation, especial alloying anode.[4] Thus, it is highly essary to probe efficient electrode rials those can well accommodat large volume expansion/contraction cycling. To effectively address these is several strategies are generally employed, including 1) syn of special architectures, such as 3D porous structure, to r ion diffusion distance and accommodate volume chan 2) alloying with active or inactive elements to partially l volume changes,[6] 3) designing and building alloy/C posites to alleviate volume changes and structure stab 4) surface engineering to maintain structure stability th preventing the reaction between active materials and el lyte during the repeated sodiation/desodiation process,[6d, 5) synthesis of self-supported nanoarchitectured array tures to reduce electron and ion transfer distance mean accommodate volume changes.[5b,8b,9]

Although the above various nanostructures can effe mitigate the volume expansion effect of alloying anode material level, it is difficult for avoiding the delaminati active components from traditional flat Cu current col owing to a large volume variation, which strongly rely o uniform mixing process of the active materials, cond

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