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FEATURE TOPIC: ADVANCED MATERIALS - SUPERCAPACITORS, CATALYSTS



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Review Articles

[Fabrication, modification and application of \(BiO\)\(2\)CO3-based photocatalysts: A review \(China\) 2016](#)

Ni, ZL (Ni, Zilin); Sun, YJ (Sun, Yanjuan); Zhang, YX (Zhang, Yuxin); Dong, F (Dong, Fan)

Source: APPLIED SURFACE SCIENCE Volume: 365 Pages: 314-335 DOI: 10.1016/j.apsusc.2015.12.231 Published: MAR 1 2016

ABSTRACT: In this review, we first give a detailed description of the strategies to fabricate various BOC micro/nano structures. Next, the mechanisms of photocatalytic activity enhancement are elaborated in three parts, including BOC-based nanocomposites, nonmetal doping and formation of oxygen vacancy. The enhanced photocatalytic activity of BOC-based systems can be attributed to the unique interaction of the p-n junction (semiconductor/semiconductor heterostructures), the Schottky junction (metal/semiconductor heterostructures), the surface plasmon resonance (SPR) effect, the surface scattering and reflecting (SSR) effect, the well-matched band structures, tunable electronic band structure, photosensitization and excellent electronic conductivity. Besides, multi-functional applications of BOC based materials are presented. Finally, prospective about the rational design, mechanistic understanding and application of BOC based materials is demonstrated, aiming to broaden the perspective and provide guidelines for future work. (C) 2016 Elsevier B.V. All rights reserved.

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Times Cited: 13

Number of references: 152

Tags: Advanced materials - Review article, Advanced materials - Photocatalyst

[Hierarchical photocatalysts \(China\) 2016](#)

Li, X (Li, Xin); Yu, JG (Yu, Jiaguo); Jaroniec, M (Jaroniec, Mietek)

Source: CHEMICAL SOCIETY REVIEWS Volume: 45 Issue: 9 Pages: 2603-2636 DOI: 10.1039/c5cs00838g Published: 2016

ABSTRACT: This review presents a critical appraisal of fabrication methods, growth mechanisms and applications of advanced hierarchical photocatalysts. Especially, the different synthesis strategies such as two-step templating, in situ template-sacrificial dissolution, self-templating method, in situ template-free assembly, chemically induced self-transformation and post-synthesis treatment are highlighted. Finally, some important applications including photocatalytic degradation of pollutants, photocatalytic H₂ production and photocatalytic CO₂ reduction are reviewed. A thorough assessment of the progress made in photocatalysis may open new opportunities in designing highly effective hierarchical photocatalysts for advanced applications ranging from thermal catalysis, separation and purification processes to solar cells.

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Times Cited: 90

Number of references: 445

Tags: Advanced materials - Review article, Advanced materials - Photocatalyst

Highly densified carbon electrode materials towards practical supercapacitor devices (China) 2017

Wu, SL (Wu, Shuilin); Zhu, YW (Zhu, Yanwu)

Source: SCIENCE CHINA-MATERIALS Volume: 60 Issue: 1 Pages: 25-38 DOI: 10.1007/s40843-016-5109-4 Published: JAN 2017

ABSTRACT: A wide range of novel materials such as novel carbons have been investigated to increase the energy density of the electrodes and the volumetric merits of the materials need to be specifically considered and evaluated, towards the practical application of these novel materials. In observation of the intense research activity to improve the volumetric performance of carbon electrodes, the density or mass loading is particularly important and shall be further optimized, both for commercially applied activated carbons and in novel carbon electrode materials such as graphene. In this review, we presented a brief overview of the recent progress in improving the volumetric performance of carbon-based supercapacitor electrodes, particularly highlighting the development of densified electrodes by various technical strategies including the controlled assembly of carbon building blocks, developing carbon based hybrid composites and constructing micro-supercapacitors.

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Number of references: 79

Tags: Advanced materials - Review article, Advanced materials - Supercapacitors

A mini review on nickel-based electrocatalysts for alkaline hydrogen evolution reaction (USA) 2016

Author(s): Gong, M (Gong, Ming); Wang, DY (Wang, Di-Yan); Chen, CC (Chen, Chia-Chun); Hwang, BJ (Hwang, Bing-Joe); Dai, HJ (Dai, Hongjie)

Source: NANO RESEARCH Volume: 9 Issue: 1 Pages: 28-46 DOI: 10.1007/s12274-015-0965-x Published: JAN 2016

ABSTRACT: In this review, we summarize earlier studies of HER activity and mechanism on Ni surfaces, along with recent progress in the optimization of the Ni-based catalysts using various modern techniques. Recently developed Ni-based HER catalysts are categorized according to their chemical nature, and the advantages as well as limitations of each category are discussed. Among all Ni-based catalysts, Ni-based alloys and Ni-based hetero-structure exhibit the most promising electrocatalytic activity and stability owing to the fine-tuning of their surface adsorption properties via a synergistic nearby element or domain. Finally, selected applications of the developed Ni-based HER catalysts are highlighted, such as water splitting, the chloralkali process, and microbial electrolysis cell.

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Times Cited: 15

Number of references: 104

Tags: Advanced materials- Review article, Advanced materials - Electocatalysts

Multi-component electrocatalyst for low-temperature fuel cells synthesized via sonochemical reactions (South Korea) 2016

Author(s): Lee, E (Lee, Eunjik); Kwon, YU (Kwon, Young-Uk)

Source: ULTRASONICS SONOCHEMISTRY Volume: 29 Pages: 401-412 DOI: 10.1016/j.ultsonch.2015.10.013 Published: MAR 2016

ABSTRACT: This review presents recent advances in multi-component electrocatalysts for low-temperature fuel cells (FCs) synthesized via sonochemical reactions. As a feasible approach to develop novel electrocatalysts that can overcome the many problems of the prevailing Pt electrocatalysts, Pt- or Pd-based alloy and core shell M@Pt nanoparticles (NPs) have been pursued. Synthesizing NPs with desirable properties often turn out to be challenging. Sonochemistry generates extreme conditions via acoustic cavitation, which have been utilized in the syntheses of various Pt and Pd NPs and Pt- and Pd-based alloy NPs. Especially, it has been reported that several M@Pt core shell NPs can be synthesized by sonochemistry, which is hard to achieve by other methods. The principles of sonochemistry are presented with examples. Also alloy NPs and core shell NPs synthesized by sonochemistry and those

continued

by other methods are compared. (C) 2015 Elsevier B.V. All rights reserved.

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Times Cited: 1

Number of references: 121

Tags: Advanced materials- Review article, Advanced materials - Electocatalysts

Nanomaterials and Technologies for Lithium-Ion Hybrid Supercapacitors (China) 2016

Gu, HC (Gu, Haichen); Zhu, YE (Zhu, Yuan-En); Yang, JQ (Yang, Jiqian); Wei, JP (Wei, Jinping); Zhou, Z (Zhou, Zhen)

Source: CHEMNANOMAT Volume: 2 Issue: 7 Special Issue: SI Pages: 578-587 DOI: 10.1002/cnma.201600068 Published: JUL 2016

ABSTRACT: For developing energy storage devices with both high energy and power density, lithium-ion hybrid supercapacitors (LIHs) are the optimal candidate to bridge the gap between lithium-ion batteries (LIBs) and conventional supercapacitors. A LIHs consists of a capacitor-type cathode and a LIB-type anode. However, the particle size of LIB-type anode materials should be within approximate to 10 nm to overcome the sluggish ion diffusion in the bulk. In addition, capacitor-type cathode materials are required to possess high capacitance to match with LIB-type anodes. Meanwhile, pre-lithiation proves an effective strategy to achieve high cell voltages and high energy density accordingly. In this review we first summarize the requirement on electrode materials for LIHs, and then propose two levels of LIHs with the clarification of true LIHs according to the energy and power density. Finally, we give an outlook for future LIHs.

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Times Cited: 2

Number of references: 64

Tags: Advanced materials - Review article, Advanced materials - Hybrid supercapacitors

Photocatalytic Water Splitting The Untamed Dream: A Review of Recent Advances (USA) 2016

Jafari, T (Jafari, Tahereh); Moharreri, E (Moharreri, Ehsan); Amin, AS (Amin, Alireza Shirazi); Miao, R (Miao, Ran); Song, WQ (Song, Wenqiao); Suib, SL (Suib, Steven L.)

Source: MOLECULES Volume: 21 Issue: 7 Article Number: 900 DOI: 10.3390/molecules21070900 Published: JUL 2016

ABSTRACT: Photocatalytic water splitting using sunlight is a promising technology capable of providing high energy yield without pollutant byproducts. Herein, we review various aspects of this technology including chemical reactions, physiochemical conditions and photocatalyst types such as metal oxides, sulfides, nitrides, nanocomposites, and doped materials followed by recent advances in computational modeling of photoactive materials. As the best-known catalyst for photocatalytic hydrogen and oxygen evolution, TiO₂ is discussed in a separate section, along with its challenges such as the wide band gap, large overpotential for hydrogen evolution, and rapid recombination of produced electron-hole pairs. Various approaches are addressed to overcome these shortcomings, such as doping with different elements, heterojunction catalysts, noble metal deposition, and surface modification. Development of a photocatalytic corrosion resistant, visible light absorbing, defect-tuned material with small particle size is the key to complete the sunlight to hydrogen cycle efficiently. Computational studies have opened new avenues to understand and predict the electronic density of states and band structure of advanced materials and could pave the way for the rational design of efficient photocatalysts for water splitting. Future directions are focused on developing innovative junction architectures, novel synthesis methods and optimizing the existing active materials to enhance charge transfer, visible light absorption, reducing the gas evolution overpotential and maintaining chemical and physical stability.

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Number of references: 266

Tags: Advanced materials - Review article, Advanced materials - Photocatalyst

continued

Recent Advances in Electrocatalysts for Oxygen Reduction Reaction (China) 2016

Author(s): Shao, MH (Shao, Minhua); Chang, QW (Chang, Qiaowan); Dodelet, JP (Dodelet, Jean-Pol); Chenitz, R (Chenitz, Regis)

Source: CHEMICAL REVIEWS Volume: 116 Issue: 6 Pages: 3594-3657 DOI: 10.1021/acs.chemrev.5b00462 Published: MAR 23 2016

ABSTRACT: This comprehensive review focuses on the low- and non-platinum electrocatalysts including advanced platinum alloys, core shell structures, palladium-based catalysts, metal oxides and chalcogenides, carbon-based non-noble metal catalysts, and metal-free catalysts. The recent development of ORR electrocatalysts with novel structures and compositions is highlighted. The understandings of the correlation between the activity and the shape, size, composition, and synthesis method are summarized. For the carbon based materials, their performance and stability in fuel cells and comparisons with those of platinum are documented. The research directions as well as perspectives on the further development of more active and less expensive electrocatalysts are provided.

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Times Cited: 96

Number of references: 748

Tags: Advanced materials- Review article, Advanced materials - Electrocatalysts

A review on g-C₃N₄-based photocatalysts (China) 2017

Wen, JQ (Wen, Jiuqing); Xie, J (Xie, Jun); Chen, XB (Chen, Xiaobo); Li, X (Li, Xin)

Source: APPLIED SURFACE SCIENCE Volume: 391 Special Issue: SI Pages: 72-123 DOI: 10.1016/j.apsusc.2016.07.030 Part: B Published: JAN 1 2017

ABSTRACT: In this review, we have systematically summarized the photocatalytic fundamentals of g-C₃N₄-based photocatalysts, including fundamental mechanism of heterogeneous photocatalysis, advantages, challenges and the design considerations of g-C₃N₄-based photocatalysts. The versatile properties of g-C₃N₄-based photocatalysts are highlighted, including their crystal structural, surface physicochemical, stability, optical, adsorption, electrochemical, photoelectrochemical and electronic properties. Various design strategies are also thoroughly reviewed, including band-gap engineering, defect control, dimensionality tuning, pore texture tailoring, surface sensitization, heterojunction construction, co-catalyst and nanocarbon loading. Many important applications are also addressed, such as photocatalytic water splitting (H₂ evolution and overall water splitting), degradation of pollutants, carbon dioxide reduction, selective organic transformations and disinfection. Through reviewing the important state-of-the-art advances on this topic, it may provide new opportunities for designing and constructing highly effective g-C(3)N(4-) based photocatalysts for various applications in photocatalysis and other related fields, such as solar cell, photoelectrocatalysis, electrocatalysis, lithium battery, supercapacitor, fuel cell and separation and purification. (C) 2016 Elsevier B.V. All rights reserved.

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Times Cited: 5

Number of references: 933

Tags: Advanced materials - Review article, Advanced materials - Photocatalyst

Supercapacitors - Double-Layer Capacitors**Characterization of asymmetric ultracapacitors as hybrid pulse power devices for efficient energy storage and power delivery applications (USA) 2016**

Zhu, WHH (Zhu, Wenhua H.); Tatarchuk, BJ (Tatarchuk, Bruce J.)

Source: APPLIED ENERGY Volume: 169 Pages: 460-468 DOI: 10.1016/j.apenergy.2016.02.020 Published: MAY 1 2016

ABSTRACT: The ultracapacitor combines advantages including long cycle life and high power density of a conventional capacitor with enhanced energy storage capability due to high electrode surface area and low internal resistance. A hybrid ultracapacitor

can be designed by using both a double-layer capacitor electrode and a battery electrode. This hybrid structure increases energy conservation and capacitance. It is also recognized as an asymmetric ultracapacitor. A power module consisting of 10 asymmetric ultracapacitors with 300 F at an operating window from 4.0 V to 14.5 V was tested for studying of these unique features. These 10 electrochemical capacitors were connected in series and performed electrical characterizations including Ragone plots, self-discharge, features at high current loads, working voltage, and related energy storage performance. The ultracapacitor module was then operated together with a Pb-acid battery as a hybrid power device. Performance of the hybrid power system was characterized by using an adjusted cold cranking and a modified hybrid pulse power profile. The irreplaceable structures on energy storage and power delivery serve as a potential to further reduce the cyclic burden and thermal stress in advanced battery packs for onboard energy storage applications. (C) 2016 Elsevier Ltd. All rights reserved.

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Times Cited: 3

Number of references: 40

Tags: Advanced materials - Double-layer capacitors

Effects of different electrolytes on the electrochemical and dynamic behavior of electric double layer capacitors based on a porous silicon carbide electrode (South Korea) 2015

Kim, M (Kim, Myeongjin); Oh, I (Oh, Ilgeun); Kim, J (Kim, Jooheon)

Source: PHYSICAL CHEMISTRY CHEMICAL PHYSICS Volume: 17 Issue: 25 Pages: 16367-16374 DOI: 10.1039/c5cp01728a Published: 2015

ABSTRACT: Controlling the structure and morphology of porous electrode materials is an effective strategy for realizing a high surface area and efficient paths for ion diffusion. Moreover, excellent electrical conductivity can significantly decrease the internal resistance of an electrode by the formation of a conductive network and facilitate the application of electrostatic charges, which favors the accumulation of an electrical double layer. In light of these facts, we demonstrate the fabrication of beta-polytype porous silicon carbide spheres (PSiCS) with a hierarchical pore structure in which micro- and mesopores are interconnected with a mesoporous network. Further, to investigate the effects of the electrolyte on the electrochemical and dynamic behavior, two-electrode symmetrical supercapacitors based on the PSiCS electrode with an aqueous electrolyte (1 M potassium chloride, KCl) or an organic electrolyte (1 M tetraethylammonium tetrafluoroborate in acetonitrile, TEABF(4)/AN) were assembled. The symmetrical supercapacitor based on the PSiCS electrode with the aqueous electrolyte exhibited a high charge storage capacity with a specific capacitance of 82.9 F g⁻¹ at a scan rate of 5 mV s⁻¹, which is much higher than that obtained using the organic electrolyte (60.3 F g⁻¹ at a scan rate of 5 mV s⁻¹). However, the energy density of the organic electrolyte system was 102.59 Wh kg⁻¹ at a scan rate of 5 mV s⁻¹, which is greatly superior to that of the aqueous electrolyte system (energy density: 29.47 Wh kg⁻¹) owing to the wide cell operating voltage range.

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Times Cited: 6

Number of references: 53

Tags: Advanced materials - Double-layer capacitors

Electrostatic-Induced Assembly of Graphene-Encapsulated Carbon@Nickel-Aluminum Layered Double Hydroxide Core-Shell Spheres Hybrid Structure for High-Energy and High-Power-Density Asymmetric Supercapacitor (South Korea) 2017

Wu, SX (Wu, Shuxing); Hui, KS (Hui, Kwan San); Hui, KN (Hui, Kwun Nam); Kim, KH (Kim, Kwang Ho)

Source: ACS APPLIED MATERIALS & INTERFACES Volume: 9 Issue: 2 Pages: 1395-1406 DOI: 10.1021/acsami.6b09355 Published: JAN 18 2017

ABSTRACT: Achieving high energy density while retaining high power density is difficult in electrical double-layer capacitors and in pseudocapacitors considering the Origin of different charge storage mechanisms. Rational structural design became an appealing strategy in circumventing these tradeoffs between energy and power densities. A hybrid:structure consists of chemically converted graphene-encapsulated carbon@nickel-aluminum layered double hydroxide core shell spheres as spacers among graphene layers (G-CLS) used as an advanced electrode to achieve high energy density while retaining high power density for high-performance supercapacitors. The merits of the proposed architecture are as follows: (1) CLS act as spacers to avoid the close restacking

of graphene; (2)-highly conductive carbon sphere and graphene preserve the mechanical integrity and improve the electrical Conductivity of LDHs hybrid. the proposed hybrid structure can simultaneously achieve high electrical-double-layer capacitance and pseudocapacitance resulting in the overall highly active electrode. The G-CLS electrode exhibited high specific capacitance (1710.5 F g⁻¹) at 1 A g⁻¹) under three-electrode tests. An ASC fabricated using the G-CLS as positive electrode and reduced graphite oxide as negative electrode demonstrated remarkable electrochemical performance. The ASC device operated at 1.4 V and delivered a high energy density of 35.5 Wh kg⁻¹) at a 670.7 W kg⁻¹) power density at 1 A g⁻¹) with an excellent rate capability as well as a robust long-term cycling stability of up to 10 000 cycles.

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Times Cited: 0

Number of references: 63

Tags: Advanced materials - Double-layer capacitors

Finite field methods for the supercell modeling of charged insulator/electrolyte interfaces (England) 2016

Zhang, C (Zhang, Chao); Sprik, M (Sprik, Michiel)

Source: PHYSICAL REVIEW B Volume: 94 Issue: 24 Article Number: 245309 DOI: 10.1103/PhysRevB.94.245309 Published: DEC 15 2016

ABSTRACT: Surfaces of ionic solids interacting with an ionic solution can build up charge by exchange of ions. The surface charge is compensated by a strip of excess charge at the border of the electrolyte forming an electric double layer. These electric double layers are very hard to model using the supercell's methods of computational condensed phase science. The problem arises when the solid is an electric insulator (as most ionic solids are) permitting a finite interior electric field over the width of the slab representing the solid in the supercell. The slab acts as a capacitor. The stored charge is a deficit in the solution failing to compensate fully for the solid surface charge. Here, we show how these problems can be overcome using the finite field methods developed by Stengel, Spaldin, and Vanderbilt [Nat. Phys. 5, 304 (2009)]. We also show how the capacitance of the double layer can be computed once overall electric neutrality of the double layer is restored by application of a finite macroscopic field E or alternatively by zero electric displacement D . The method is validated for a classical model of a solid-electrolyte interface using the finite-temperature molecular dynamics adaptation of the constant field method presented previously [C. Zhang and M. Sprik, Phys. Rev. B 93, 144201 (2016)]. Because ions in electrolytes can diffuse across supercell boundaries, this application turns out to be a critical illustration of the multivaluedness of polarization in periodic systems.

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Times Cited: 0

Number of references: 85

Tags: Advanced materials - Double-layer capacitors

High-Performance PEDOT:PSS/Single-Walled Carbon Nanotube/Ionic Liquid Actuators Combining Electrostatic Double-Layer and Faradaic Capacitors (Japan) 2016

Terasawa, N (Terasawa, Naohiro); Asaka, K (Asaka, Kinji)

Source: LANGMUIR Volume: 32 Issue: 28 Pages: 7210-7218 DOI: 10.1021/acs.langmuir.6b01148 Published: JUL 19 2016

ABSTRACT: New hybrid-type poly(3,4-ethylenedioxythiophene) (PEDOT) actuators produced by the film-casting method, in which both electrostatic double-layer (EDLC) and faradaic capacitors (FCs) occur simultaneously, have been developed. The electrochemical and electromechanical properties of PEDOT:poly(4-styrenesulfonate) (PSS), PEDOT:PSS/ionic liquid (IL), and PEDOT:PSS/single-walled carbon nanotubes (SWCNTs)/IL actuators are compared with those of a conventional poly(vinylidene fluoride)-co-hexafluoropropylene (PVdF(HFP))/SWCNT/IL actuator. It is found that the PEDOT:PSS/SWCNT/IL actuator provides a better actuation strain performance than a conventional (PVdF(HFP))/SWCNT/IL actuator, as its electrode is an electrochemical

capacitor (EC) composed of an EDLC and PC. The PEDOT:PSS polymer helps produce a high specific capacitance, actuation strain, and maximum generated stress that surpass the performance of a conventional PVdF(HFP) actuator. The flexible and robust films created by the synergistic combination of PEDOT and SWCNT may therefore have significant potential as actuator materials for wearable energy-conversion devices. A double-layer charging kinetic model was successfully used to simulate the frequency dependence of the displacement responses of the PEDOT:PSS/IL and PEDOT:PSS/SWCNT/IL actuators.

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Times Cited: 1

Number of references: 64

Tags: Advanced materials - Double-layer capacitors

High-performance polymer actuators based on an iridium oxide and vapor-grown carbon nanofibers combining electrostatic double-layer and faradaic capacitor mechanisms (Japan) 2017

Terasawa, N (Terasawa, Naohiro); Asaka, K (Asaka, Kinji)

Source: SENSORS AND ACTUATORS B-CHEMICAL Volume: 240 Pages: 536-542 DOI: 10.1016/j.snb.2016.08.166 Published: MAR 2017

ABSTRACT: The electrochemical and electromechanical properties of polymer actuators that leverage the synergistic effect from combining a noble metal oxide (iridium oxide dihydrate (IrO₂ center dot 2H(2)O)), vapor-grown carbon nanofibers (VGCFs) and an ionic liquid (IL) in the electrode were compared with those of actuators prepared using VGCFs or single-walled carbon nanotubes (SWCNTs) without IrO₂, or with an IrO₂ center dot 2H(2)O/carbon black (CB)/IL composition. The electrode in this actuator system is equivalent to an electrochemical capacitor, and exhibits behavior similar to that of both an electrostatic double-layer capacitor (EDLC) and a faradaic capacitor (FC). The mechanism underlying the functioning of the IrO₂.2H(2)O/VGCF/IL actuators which exhibit from both EDLC and FC mechanisms was found to be different from that for devices produced using VGCFs or SWCNTs alone (which exhibit only the EDLC mechanism) and using IrO₂ center dot 2H(2)O/CB/IL, which exhibit from both EDLC and FC mechanisms, with the FC mechanism providing the largest contribution. An IrO₂ center dot 2H(2)O/VGCF/EMI[BF₄] actuator exhibited a maximum strain of 0.75%, a value approximately 1.8 times that obtained from a SWCNT-only actuator. This device also generated a maximum blocking force stress of 2.58 MPa (1.3 times that of a SWCNT-only actuator) and a maximum calculated stress of 0.66 MPa (2.2 times that of a IrO₂ center dot 2H(2)O/CB/EMI[BF₄] actuator).

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Times Cited: 0

Number of references: 33

Tags: Advanced materials - Double-layer capacitors

Insights into the effects of solvent properties in graphene based electric double-layer capacitors with organic electrolytes (China) 2016

Zhang, S (Zhang, Shuo); Bo, Z (Bo, Zheng); Yang, HC (Yang, Huachao); Yang, JY (Yang, Jinyuan); Duan, LP (Duan, Liangping); Yan, JH (Yan, Jianhua); Cen, KF (Cen, Kefa)

Source: JOURNAL OF POWER SOURCES Volume: 334 Pages: 162-169 DOI: 10.1016/j.jpowsour.2016.10.021 Published: DEC 1 2016

ABSTRACT: In this work, the microstructure of planar graphene-based EDLCs with different organic solvents are investigated with molecular dynamics simulations. Results show that an increase of solvent polarity could weaken the accumulation of counterions nearby the electrode surface, due to the screen of electrode charges and relatively lower ionic desolvation. It thus suggests that solvents with low polarity could be preferable to yield high EDL capacitance. Meanwhile, the significant effects of the size and structure of solvent molecules are reflected by non-electrostatic molecule-electrode interactions, further influencing the adsorption of solvent molecules on electrode surface. Compared with dimethyl carbonate, gamma-butyrolactone, and propylene carbonate, acetonitrile with relatively small-size and linear structure owns weak non-electrostatic interactions, which favors the easy re-orientation of solvent molecules. Moreover, the shift of solvent orientation in surface layer, from parallel orientation to perpendicular orientation relative to the electrode surface, deciphers the solvent twin-peak behavior near negative electrode. The as obtained insights into the roles of solvent properties on the interplays among particles and electrodes elucidate the solvent

influences on the microstructure and capacitive behavior of EDLCs using organic electrolytes. (C) 2016 Elsevier B.V. All rights reserved.

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Times Cited: 1

Number of references: 52

Tags: Advanced materials - Double-layer capacitors

Investigation into Pseudo-Capacitance Behavior of Glycoside-Containing Hydrogels (USA) 2017

Raravikar, N (Raravikar, Nachiket); Dobos, A (Dobos, Andrew); Narayanan, E (Narayanan, Eshwaran); Grandhi, TSP (Grandhi, Taraka Sai Pavan); Mishra, S (Mishra, Saurabh); Rege, K (Rege, Kaushal); Goryll, M (Goryll, Michael)

Source: ACS APPLIED MATERIALS & INTERFACES Volume: 9 Issue: 4 Pages: 3554-3561 DOI: 10.1021/acsami.6b11113

Published: FEB 1 2017

ABSTRACT: In the present study, we describe a detailed investigation on redox reactions responsible for pseudocapacitive behavior in glycoside-containing hydrogel formulations. Pseudocapacitive behavior was compared among various combinations of biocompatible hydrogel electrolytes, using carbon tape electrodes and transition metal electrodes based on fluorine-doped tin oxide. The hydrogels demonstrated a pseudocapacitive response only in the presence of transition metal electrodes but not in the presence of carbon electrodes. Hydrogels containing amine moieties showed greater energy storage than gels based purely on hydroxyl functional groups. Furthermore, energy storage increased with greater amine content in these hydrogels. We claim that the redox reactions in hydrogels are largely based on Lewis acid base interactions, facilitated by amine and hydroxyl side groups along the electrolyte chain backbones, as well as hydroxylation of electrode surfaces. Water plays an important role in these reactions, not only in terms of providing ionic radicals but also in assisting ion transport. This understanding of redox reactions will help determine the choice of transition metal electrodes, Lewis acid base pairs in electrolytes, and medium for ionic transport in future biocompatible pseudocapacitors.

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Times Cited: 0

Number of references: 33

Tags: Advanced materials - Double-layer capacitors

Molecular dynamics for the charging behavior of nano-structured electric double layer capacitors containing room temperature ionic liquids (USA) 2015

Kong, X (Kong, Xian); Lu, DN (Lu, Diannan); Liu, Z (Liu, Zheng); Wu, JZ (Wu, Jianzhong)

Source: NANO RESEARCH Volume: 8 Issue: 3 Pages: 931-940 DOI: 10.1007/s12274-014-0574-0 Published: MAR 2015

ABSTRACT: In this work, we study the charging behavior of RTIL-EDLs using a coarse-grained molecular model and constant-potential molecular dynamics (MD) simulations. In stark contrast to the predictions of conventional theories, the MD results show oscillatory variations of ionic distributions and electrochemical properties in response to the separation between electrodes. The rate of EDL charging exhibits non-monotonic behavior revealing strong electrostatic correlations in RTIL under confinement.

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Times Cited: 3

Number of references: 41

Tags: Advanced materials - Double-layer capacitors

Tube-Super Dielectric Materials: Electrostatic Capacitors with Energy Density Greater than 200 J.cm(-3) (Colombia) 2015

Cortes, FJQ (Quintero Cortes, Francisco Javier); Phillips, J (Phillips, Jonathan)

Source: MATERIALS Volume: 8 Issue: 9 Pages: 6208-6227 DOI: 10.3390/ma8095301 Published: SEP 2015

ABSTRACT: The construction and performance of a second generation of super dielectric material based electrostatic capacitors (EC), with energy density greater than 200 J.cm(-3), which rival the best reported energy density of electric double layer capacitors (EDLC), also known as supercapacitors, are reported. The first generation super dielectric materials (SDM) are multi-material mixtures with dielectric constants greater than 1.0×10^5 , composed of a porous, electrically insulating powder filled with a polarizable, ion-containing liquid. Second-generation SDMs (TSDM), introduced here, are anodic titania nanotube arrays filled with concentrated aqueous salt solutions. Capacitors using TiO₂ based TSDM were found to have dielectric constants at similar to 0 Hz greater than 10^7 in all cases, a maximum operating voltage of greater than 2 volts and remarkable energy density that surpasses the highest previously reported for EC capacitors by approximately one order of magnitude. A simple model based on the classic ponderable media model was shown to be largely consistent with data from nine EC type capacitors employing TSDM.

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Times Cited: 4

Number of references: 49

Tags: Advanced materials - Double-layer capacitors

Supercapacitors - Hybridcapacitors

Advanced Li-Ion Hybrid Supercapacitors Based on 3D Graphene-Foam Composites (Canada) 2016

Liu, WW (Liu, Wenwen); Li, JD (Li, Jingde); Feng, K (Feng, Kun); Sy, A (Sy, Abel); Liu, YS (Liu, Yangshuai); Lim, L (Lim, Lucas); Lui, G (Lui, Gregory); Tjandra, R (Tjandra, Ricky); Rasenthiram, L (Rasenthiram, Lathankan); Chiu, G (Chiu, Gordon); Yu, AP (Yu, Aiping)

Source: ACS APPLIED MATERIALS & INTERFACES Volume: 8 Issue: 39 Pages: 25941-25953 DOI: 10.1021/acsami.6b07365 Published: OCT 5 2016

ABSTRACT: Li-ion hybrid supercapacitors (LIHSs) have recently attracted increasing attention as a new and promising energy storage device. However, it is still a great challenge to construct novel LIHSs with high-performance due to the majority of battery-type anodes retaining the sluggish kinetics of Li-ion storage and most capacitor-type cathodes with low specific capacitance. To solve this problem, 3D graphene-wrapped MoO₃ nanobelt foam with the unique porous network structure has been designed and prepared as anode material, which delivers high capacity, improved rate performance, and enhanced cycle stability. First-principles calculation reveals that the combination of graphene dramatically reduces the diffusion energy barrier of Li⁺ adsorbed on the surface of MoO₃ nanobelt, thus improving its electrochemical performance. Furthermore, 3D graphene-wrapped polyaniline nanotube foam derived carbon is employed as a new type of capacitor-type cathode, demonstrating high specific capacitance, good rate performance, and long cycle stability. Benefiting from these two graphene foam-enhanced materials, the constructed LIHSs show a wide operating voltage range (3.8 V), a long stable cycle life (90% capacity retention after 3000 cycles), a high energy density (128.3 Wh.kg(-1)), and a high power density (13.5 kW.kg(-1)). These encouraging performances indicate that the obtained LIHSs may have promising prospect as next-generation energy storage devices.

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Times Cited: 0

Number of references: 61

Tags: Advanced materials - Hybridcapacitors

Battery type hybrid supercapacitor based on polypyrrole and lead-lead sulfate (Serbia) 2016

Alguail, AA (Alguail, Alsadek A.); Al-Eggiely, AH (Al-Eggiely, Ali H.); Gvozdenovic, MM (Gvozdenovic, Milica M.); Jugovic, BZ (Jugovic, Branimir Z.); Grgur, BN (Grgur, Branimir N.)

Source: JOURNAL OF POWER SOURCES Volume: 313 Pages: 240-246 DOI: 10.1016/j.jpowsour.2016.02.081 Published: MAY 1 2016

ABSTRACT: The electrochemically synthesized polypyrrole and lead-lead sulfate is examined as a potential electrodes for battery-type hybrid supercapacitors in acidic solution. The device exhibits battery-type behavior at low discharge rate, e.g. <0.5 A g(-1), and

continued

supercapacitors-type behavior at a higher discharge rate. Discharge in the specific current range of similar to 0.6-2.27 A g⁻¹ based on the active masses, can deliver capacity of 90-72 Ah kg⁻¹, energy of 58-40 Wh kg⁻¹ and power of 40-1350 W kg⁻¹, with the specific capacitance of the cell in the range of 300-250 F g⁻¹. The experimentally obtained values are compared with theoretical. (c) 2016 Elsevier B.V. All rights reserved.

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Times Cited: 0

Number of references: 27

Tags: Advanced materials - Hybridcapacitors

Controllable synthesis of layered Co-Ni hydroxide hierarchical structures for high-performance hybrid supercapacitors (China) 2016

Yuan, P (Yuan, Peng); Zhang, N (Zhang, Ning); Zhang, D (Zhang, Dan); Liu, T (Liu, Tao); Chen, LM (Chen, Limiao); Ma, RZ (Ma, Renzhi); Qiu, GZ (Qiu, Guanzhou); Liu, XH (Liu, Xiaohe)

Source: JOURNAL OF PHYSICS AND CHEMISTRY OF SOLIDS Volume: 88 Pages: 8-13 DOI: 10.1016/j.jpcs.2015.09.006

Published: JAN 2016

ABSTRACT: A facile solvothermal method is developed for synthesizing layered Co-Ni hydroxide hierarchical structures by using hexamethylenetetramine (HMT) as alkaline reagent. The electrochemical measurements reveal that the specific capacitances of layered bimetallic (Co-Ni) hydroxides are generally superior to those of layered monometallic (Co, Ni) hydroxides. The as-prepared Co_{0.5}Ni_{0.5} hydroxide hierarchical structures possesses the highest specific capacitance of 1767 F g⁻¹ at a galvanic current density of 1 A g⁻¹ and an outstanding specific capacitance retention of 87% after 1000 cycles. In comparison with the dispersed nanosheets of Co-Ni hydroxide, layered hydroxide hierarchical structures show much superior electrochemical performance. This study provides a promising method to construct hierarchical structures with controllable transition-metal compositions for enhancing the electrochemical performance in hybrid supercapacitors. (C) 2015 Elsevier Ltd. All rights reserved.

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Times Cited: 1

Number of references: 38

Tags: Advanced materials - Hybridcapacitors

Development of SnS₂/RGO nanosheet composite for cost-effective aqueous hybrid supercapacitors (India) 2017

Chauhan, H (Chauhan, Himani); Singh, MK (Singh, Manoj K.); Kumar, P (Kumar, Praveen); Hashmi, SA (Hashmi, Safir Ahmad); Deka, S (Deka, Sasanka)

Source: NANOTECHNOLOGY Volume: 28 Issue: 2 Article Number: 025401 DOI: 10.1088/1361-6528/28/2/025401

Published: JAN 13 2017

ABSTRACT: We synthesized SnS₂/RGO nanocomposite comprised of nanosheets of SnS₂ and graphene oxide via a one-pot hydrothermal approach. In situ as-synthesized SnS₂/RGO is devised for the first time to give high specific capacitance 500 Fg⁻¹, energy density 16.67 Wh kg⁻¹ and power density 488Wkg⁻¹. The cell retains 95% charge/discharge cycle stability up to 1000 cycles. In-short, the SnS₂/RGO nanosheet composite presented is a novel and advanced material for application in high stability moderate value hybrid supercapacitors. All the currently available surveys in literature state the potential applicability of SnS₂ as the anode material for reversible lithium/sodium ion batteries (LIBs/ NIBs) but there is a lack of equivalent studies on electrochemical capacitors. We filled up this knowledge gap by the use of the same material in a cost-effective, highly active hybrid supercapacitor application by utilizing its pseudocapacitance property combined with the layered capacitance property of graphene sheets.

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Times Cited: 0

Number of references: 50

Tags: *Advanced materials - Hybridcapacitors***Engineering metal organic framework derived 3D nanostructures for high performance hybrid supercapacitors (China) 2017**

Wang, RT (Wang, Rutao); Jin, DD (Jin, Dongdong); Zhang, YB (Zhang, Yabin); Wang, SJ (Wang, Shijie); Lang, JW (Lang, Junwei); Yan, XB (Yan, Xingbin); Zhang, L (Zhang, Li)

Source: JOURNAL OF MATERIALS CHEMISTRY A Volume: 5 Issue: 1 Pages: 292-302 DOI: 10.1039/c6ta09143a Published: 2017

ABSTRACT: Here we report an approach using the MOF (polyhedral ZIF-8) as a novel precursor to synthesize two electrode materials with different energy-storage mechanisms: the capacitor-like porous carbon polyhedra and the battery-like MoS₂-ZIF composite. The porous carbon polyhedra have a continuous 3D porous network with an extremely high surface area of 3680.6 m² g⁻¹ and a well-controlled pore size distribution, and the MoS₂-ZIF composite shows a three-dimensional (3D) nanostructure with an open framework. Furthermore, a novel hybrid supercapacitor is fabricated by employing these two 3D nanostructured MOF-derived electrode materials, which shows the best properties among the current hybrid supercapacitors with respect to energy, power and cycling life. The presented strategy for the controlled design and synthesis of 3D MOF-derived nanostructures provides prospects in developing high-performance active materials in advanced energy storage devices.

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Times Cited: 0

Number of references: 77

Tags: *Advanced materials - Hybridcapacitors***High-performance hybrid supercapacitor with 3D hierarchical porous flower-like layered double hydroxide grown on nickel foam as binder-free electrode (South Korea) 2016**

Zhang, L (Zhang, Luojiang); Hui, KN (Hui, Kwun Nam); Hui, KS (Hui, Kwan San); Lee, H (Lee, Haiwon)

Source: JOURNAL OF POWER SOURCES Volume: 318 Pages: 76-85 DOI: 10.1016/j.jpowsour.2016.04.010 Published: JUN 30 2016

ABSTRACT: The synthesis of layered double hydroxide (LDH) as electroactive material has been well reported; however, fabricating an LDH electrode with excellent electrochemical performance at high current density remains a challenge. In this paper, we report a 3D hierarchical porous flower-like NiAl-LDH grown on nickel foam (NF) through a liquid-phase deposition method as a high-performance binder-free electrode for energy storage. With large ion-accessible surface area as well as efficient electron and ion transport pathways, the prepared LDH-NF electrode achieves high specific capacity (1250 C g⁻¹ at 2 A g⁻¹ and 401 C g⁻¹ at 50 A g⁻¹) after 5000 cycles of activation at 20 A g⁻¹ and high cycling stability (76.7% retention after another 5000 cycles at 50 A g⁻¹), which is higher than those of most previously reported NiAl-LDH-based materials. Moreover, a hybrid supercapacitor with LDH-NF as the positive electrode and porous graphene nanosheet coated on NF (GNS-NF) as the negative electrode, delivers high energy density (30.2 Wh kg⁻¹) at a power density of 800 W kg⁻¹ and long cycle life, which outperforms the other devices reported in the literature. This study shows that the prepared LDH-NF electrode offers great potential in energy storage device applications. (C) 2016 Elsevier B.V. All rights reserved.

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Times Cited: 12

Number of references: 66

Tags: *Advanced materials - Hybridcapacitors**continued*

High Tunability and Performance of Cylindrical Hybrid Supercapacitors with Binary H₂Ti₁₂O₂₅-Li₄Ti₅O₁₂ Anodes (South Korea) 2016

Kim, JH (Kim, Jin Hyeon); Yoon, JR (Yoon, Jung-Rag); Lee, SH (Lee, Seung-Hwan)

Source: ELECTROCHIMICA ACTA Volume: 220 Pages: 231-236 DOI: 10.1016/j.electacta.2016.10.046 Published: DEC 1 2016

ABSTRACT: We fabricated asymmetric hybrid supercapacitors using binary materials composed of various ratios of H₂Ti₁₂O₂₅ and Li₄Ti₅O₁₂ as anodes and activated carbon as cathodes to investigate the tunability of their electrochemical performances. The binary materials have two advantageous properties: not only outstanding cyclability derived from Li₄Ti₅O₁₂, but also excellent rate ability derived from H₂Ti₁₂O₂₅. Because of these characteristics, hybrid supercapacitors with an 8:2 ratio of Li₄Ti₅O₁₂/H₂Ti₁₂O₂₅ as the anodes show promising electrochemical performance by complementary synergistic effects of H₂Ti₁₂O₂₅ and Li₄Ti₅O₁₂. Thus, we believe that hybrid supercapacitors containing Li₄Ti₅O₁₂/H₂Ti₁₂O₂₅ (8/2) could be used for high-grade energy storage devices that require longevity and ultrahigh electrochemical performance. (C) 2016 Published by Elsevier Ltd.

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Number of references: 17

Tags: Advanced materials - Hybridcapacitors

Layered Ni(OH)₂-Co(OH)₂ films prepared by electrodeposition as charge storage electrodes for hybrid supercapacitors (Portugal) 2017

Nguyen, T (Tuyen Nguyen); Boudard, M (Boudard, Michel); Carmezim, MJ (Joao Carmezim, M.); Montemor, MF (Fatima Montemor, M.)

Source: SCIENTIFIC REPORTS Volume: 7 Article Number: 39980 DOI: 10.1038/srep39980 Published: JAN 4 2017

ABSTRACT: Consecutive layers of Ni(OH)₂ and Co(OH)₂ were electrodeposited on stainless steel current collectors for preparing charge storage electrodes of high specific capacity with potential application in hybrid supercapacitors. Different electrodes were prepared consisting on films of Ni(OH)₂, Co(OH)₂, Ni_{1/2}Co_{1/2}(OH)₂ and layered films of Ni(OH)₂ on Co(OH)₂ and Co(OH)₂ on Ni(OH)₂ to highlight the advantages of the new architecture. The microscopy studies revealed the formation of nanosheets in the Co(OH)₂ films and of particles agglomerates in the Ni(OH)₂ films. Important morphological changes were observed in the double hydroxides films and layered films. Film growth by electrodeposition was governed by instantaneous nucleation mechanism. The new architecture composed of Ni(OH)₂ on Co(OH)₂ displayed a redox response characterized by the presence of two peaks in the cyclic voltammograms, arising from redox reactions of the metallic species present in the layered film. These electrodes revealed a specific capacity of 762 C g⁻¹ at the specific current of 1A g⁻¹. The hybrid cell using Ni(OH)₂ on Co(OH)₂ as positive electrode and carbon nanofoam paper as negative electrode display specific energies of 101.3 W h g⁻¹ and 37.8 W h g⁻¹ at specific powers of 0.2 W g⁻¹ and 2.45 W g⁻¹, respectively.

Accession Number: WOS:000391444200001

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Times Cited: 0

Number of references: 40

Tags: Advanced materials - Hybridcapacitors

A mini review of designed mesoporous materials for energy-storage applications: from electric double-layer capacitors to hybrid supercapacitors (South Korea) 2016

Lim, E (Lim, Eunho); Jo, C (Jo, Changshin); Lee, J (Lee, Jinwoo)

Source: NANOSCALE Volume: 8 Issue: 15 Pages: 7827-7833 DOI: 10.1039/c6nr00796a Published: 2016

ABSTRACT: In recent years, porous materials have attracted significant attention in various research fields because of their structural merits. In particular, well-designed mesoporous structures with two- or three-dimensionally interconnected pores have been recognized as electrode materials of particular interest for achieving high-performance electrochemical capacitors (ECs). In this mini review, recent progress in the design of mesoporous electrode materials for ECs, from electric double-layer capacitors

(EDLCs) and pseudo-capacitors (PCs) to hybrid supercapacitors (HSCs), and research challenges for the development of new mesoporous electrode materials has been discussed.

Accession Number: WOS:000374159600003

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Times Cited: 5

Number of references: 73

Tags: Advanced materials - Hybridcapacitors

Nb2O5 quantum dots embedded in MOF derived nitrogen-doped porous carbon for advanced hybrid supercapacitor applications (China) 2016

Liu, SN (Liu, Sainan); Zhou, J (Zhou, Jiang); Cai, ZY (Cai, Zhenyang); Fang, GZ (Fang, Guozhao); Cai, YS (Cai, Yangsheng); Pan, AQ (Pan, Anqiang); Liang, SQ (Liang, Shuquan)

Source: JOURNAL OF MATERIALS CHEMISTRY A Volume: 4 Issue: 45 Pages: 17838-17847 DOI: 10.1039/c6ta07856g

Published: 2016

ABSTRACT: Herein, we demonstrate an advanced hybrid material construction by the orthorhombic Nb2O5 quantum dots embedded in nitrogen-doped porous carbon derived from ZIF-8 dodecahedrons, referred to as NQD-NC. Then the applications of this material in LIBs and HSCs are studied in-depth. The LIB test reveals that the novel Nb2O5-based material shows excellent high-rate capability and long-term cyclic stability. Importantly, by assembling a HSC device using a NQD-NC anode and a commercial activated carbon cathode with an organic electrolyte, the HSC shows superior electrochemical performance including ultra-high energy and power density (76.9 W h kg⁻¹) and 11 250 W kg⁻¹, respectively) and superior cyclic stability (capacity retention of similar to 85% at 5 A g⁻¹) after 4500 cycles in a voltage range of 0.5-3.0 V). The excellent electrochemical performance of the HSCs indicates combining the advantages of lithium-ion batteries and supercapacitors, which is promising for the next generation of energy storage systems.

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Times Cited: 0

Number of references: 87

Tags: Advanced materials - Hybridcapacitors

Nitrogen-doped activated carbon for a high energy hybrid supercapacitor (China) 2016

Li, B (Li, Bing); Dai, F (Dai, Fang); Xiao, QF (Xiao, Qiangfeng); Yang, L (Yang, Li); Shen, JM (Shen, Jingmei); Zhang, CM (Zhang, Cunman); Cai, M (Cai, Mei)

Source: ENERGY & ENVIRONMENTAL SCIENCE Volume: 9 Issue: 1 Pages: 102-106 DOI: 10.1039/c5ee03149d Published: 2016

ABSTRACT: Nitrogen-doped activated carbons (NACs) were prepared through a one-step process. The obtained NACs show high surface areas of up to 2900 m² g⁻¹ with a moderate N content of up to 4 wt%. Electrochemical evaluation of the NACs shows a high specific capacity of 129 mA h g⁻¹ (185 F g⁻¹) in an organic electrolyte at a current density of 0.4 A g⁻¹, as well as excellent rate capability and cycling stability. The hybrid-type supercapacitor assembled using the NACs and a Si/C electrode exhibits a high material level energy density of 230 W h kg⁻¹ at 1747 W kg⁻¹. The hybrid device achieved 76.3% capacity retention after 8000 cycles tested at 1.6 A g⁻¹.

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Times Cited: 36

Number of references: 34

Tags: Advanced materials - Hybridcapacitors

[One-pot synthesis of hollow NiSe-CoSe nanoparticles with improved performance for hybrid supercapacitors \(China\) 2016](#)

Chen, HC (Chen, Haichao); Fan, MQ (Fan, Meiqiang); Li, C (Li, Chao); Tian, GL (Tian, Guanglei); Lv, CJ (Lv, Chunju); Chen, D (Chen, Da); Shu, KY (Shu, Kangying); Jiang, JJ (Jiang, Jianjun)

Source: JOURNAL OF POWER SOURCES Volume: 329 Pages: 314-322 DOI: 10.1016/j.jpowsour.2016.08.097 Published: OCT 15 2016

ABSTRACT: Hollow NiSe-CoSe samples have been synthesized for the first time via a one-pot solvothermal approach. The strategy is robust enough to synthesize NiSe-CoSe nanoparticles with different NiSe to CoSe ratios but with a similar hollow structure. Co ions in the NiSe-CoSe nanoparticles play decisive role for formation of the hollow structure; otherwise, the nanoparticles become solid for the NiSe sample. When used as the positive electroactive materials for energy storage, the NiSe-CoSe samples show excellent electrochemical activity in alkaline electrolyte. Using the synergistic effect between NiSe and CoSe, the electrochemical performance of NiSe-CoSe can be tuned by varying the NiSe to CoSe ratios. The NiSe-CoSe sample with a NiSe to CoSe ratio of 4:2 shows the best electrochemical performance in terms of superior specific capacity, improved rate capability and excellent cycling stability. In addition, the electrochemical performance of NiSe-CoSe sample with a NiSe to CoSe ratio of 4:2 is also evaluated via assembling hybrid supercapacitors with RGO, and the hybrid supercapacitor delivers both high power and energy densities (41.8 Wh kg⁻¹) at 750 W kg⁻¹ and 20.3 Wh kg⁻¹ at 30 kW kg⁻¹). (C) 2016 Elsevier B.V. All rights reserved.

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Times Cited: 1

Number of references: 40

Tags: Advanced materials - Hybridcapacitors

[Synthesis of Co-Ni oxide microflowers as a superior anode for hybrid supercapacitors with ultralong cycle life \(China\) 2017](#)

Liu, LY (Liu, Ling-Yang); Zhang, X (Zhang, Xu); Li, HX (Li, Hong-Xia); Liu, B (Liu, Bao); Lang, JW (Lang, Jun-Wei); Kong, LB (Kong, Ling-Bin); Yan, XB (Yan, Xing-Bin)

Source: CHINESE CHEMICAL LETTERS Volume: 28 Issue: 2 Pages: 206-212 DOI: 10.1016/j.ccllet.2016.07.027 Published: FEB 2017

ABSTRACT: Herein, nanoflakes composed microflower-like Co-Ni oxide (CoNiO) was successfully synthesized by a simple co-precipitation method. The atomic ratio of as-synthesized CoNiO is determined to be 1:3 through XRD and XPS analytical method. As a typical battery-type material, CoNiO and capacitor-type activated polyaniline-derived carbon (APDC) were used to assemble LIHCs as the anode and cathode materials, respectively. As a result, when an optimized mass ratio of CoNiO and APDC was 1:2, CoNiO//APDC LIHC could deliver a maximum energy density of 143 Wh kg⁻¹ at a working voltage of 1-4 V. It is worth mentioning that the LIHC also exhibits excellent cycle stability with the capacitance retention of similar to 78.2% after 15,000 cycles at a current density of 0.5 A g⁻¹. (C) 2016 Chinese Chemical Society and Institute of Materia Medica, Chinese Academy of Medical Sciences. Published by Elsevier B.V. All rights reserved.

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Number of references: 47

Tags: Advanced materials - Hybridcapacitors

[Ultrafast charge-discharge characteristics of a nanosized core-shell structured LiFePO₄ material](#)

continued

[for hybrid supercapacitor applications \(Japan\) 2016](#)

Naoi, K (Naoi, Katsuhiko); Kisu, K (Kisu, Kazuaki); Iwama, E (Iwama, Etsuro); Nakashima, S (Nakashima, Shota); Sakai, Y (Sakai, Yuki); Oriyasa, Y (Oriyasa, Yuki); Leone, P (Leone, Philippe); Dupre, N (Dupre, Nicolas); Brousse, T (Brousse, Thierry); Rozier, P (Rozier, Patrick); Naoi, W (Naoi, Wako); Simon, P (Simon, Patrice)

Source: ENERGY & ENVIRONMENTAL SCIENCE Volume: 9 Issue: 6 Pages: 2143-2151 DOI: 10.1039/c6ee00829a Published: 2016

ABSTRACT: Highly dispersed crystalline/amorphous LiFePO₄ (LFP) nanoparticles encapsulated within hollow-structured graphitic carbon were synthesized using an in situ ultracentrifugation process. Ultracentrifugation triggered an in situ sol-gel reaction that led to the formation of core-shell LFP simultaneously hybridized with fractured graphitic carbon. The structure has double cores that contain a crystalline LFP (core 1) covered by an amorphous LFP containing Fe³⁺ defects (core 2), which are encapsulated by graphitic carbon (shell). These core-shell LFP nanocomposites show improved Li⁺ diffusivity thanks to the presence of an amorphous LFP phase. This material enables ultrafast discharge rates (60 mA h g⁻¹ at 100C and 36 mA h g⁻¹ at 300C) as well as ultrafast charge rates (60 mA h g⁻¹ at 100C and 36 mA h g⁻¹ at 300C). The synthesized core-shell nanocomposites overcome the inherent one-dimensional diffusion limitation in LFP and yet deliver/store high electrochemical capacity in both ways symmetrically up to 480C. Such a high rate symmetric capacity for both charge and discharge has never been reported so far for LFP cathode materials. This offers new opportunities for designing high-energy and high-power hybrid supercapacitors.

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Number of references: 44

Tags: Advanced materials - Hybridcapacitors

Supercapacitors - Pseudocapacitors

[Al-doped alpha-MnO₂ for high mass-loading pseudocapacitor with excellent cycling stability \(China\) 2015](#)

Hu, ZM (Hu, Zhimi); Xiao, X (Xiao, Xu); Chen, C (Chen, Chi); Li, TQ (Li, Tianqi); Huang, L (Huang, Liang); Zhang, CF (Zhang, Chuanfang); Su, J (Su, Jun); Miao, L (Miao, Ling); Jiang, JJ (Jiang, Jianjun); Zhang, YR (Zhang, Yanrong); Zhou, J (Zhou, Jun)

Source: NANO ENERGY Volume: 11 Pages: 226-234 DOI: 10.1016/j.nanoen.2014.10.015 Published: JAN 2015

ABSTRACT: The Al-doped alpha-MnO₂ was prepared by hydrothermal method could promote the conductivity and improve the capacitance, which demonstrated by theoretical calculation and experiments. The Al doped alpha-MnO₂ electrode with a specific capacitance of about 213 F g⁻¹ and 146 F cm⁻³ under the high mass loading of similar to 4 mg cm⁻² had excellent cycling performance that of similar to 91% maintained after 15,000 cycles. In addition, different doping amount of Al as contrast were discussed, indicating that through modification and optimization of the chemical composition of the alpha-MnO₂ based electrode material by Al doping could greatly improve the electrochemical behavior and to achieve higher specific capacitance. Also, we believed that the notable cycling Life and high mass loading of Al doped alpha-MnO₂ electrode material was beneficial to the application of supercapacitors. As an energy storage device, a high energy density about 2.42 mW h cm⁻³ with power density of 5.72 W cm⁻³ could be achieved. (C) 2014 Elsevier Ltd. All rights reserved.

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Times Cited: 32

continued

Number of references: 43

Tags: *Advanced materials - Pseudocapacitors*

Co-doped Ni hydroxide and oxide nanosheet networks: laser-assisted synthesis, effective doping, and ultrahigh pseudocapacitor performance (China) 2016

Liang, DW (Liang, Dewei); Wu, SL (Wu, Shouliang); Liu, J (Liu, Jun); Tian, ZF (Tian, Zhenfei); Liang, CH (Liang, Changhao)

Source: JOURNAL OF MATERIALS CHEMISTRY A Volume: 4 Issue: 27 Pages: 10609-10617 DOI: 10.1039/c6ta03408j
Published: 2016

ABSTRACT: Herein, we report an environmentally friendly approach to obtain Co-doped Ni(OH)₂ nanosheet networks using a laser-induced cobalt colloid as a doping precursor followed by an aging treatment in a hybrid medium of nickel ions. The shape and specific surface area of the doped Ni(OH)₂ can be successfully adjusted by changing the concentration of sodium thiosulfate. Furthermore, a Co-doped Ni(OH)₂ nanosheet network was further converted into Co-doped NiO with its pristine morphology retained via facile thermal decomposition in air. Moreover, such novel mesoporous nanosheet network structures are also able to enlarge the electrode-electrolyte contact area and shorten the path length for ion transport. The synergetic effect of these two results is responsible for the observed ultrahigh pseudocapacitor performance.

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Times Cited: 2

Number of references: 54

Tags: *Advanced materials - Pseudocapacitors*

Construction of desirable NiCo₂S₄ nanotube arrays on nickel foam substrate for pseudocapacitors with enhanced performance (China) 2015

Cai, DP (Cai, Daoping); Wang, DD (Wang, Dandan); Wang, CX (Wang, Chenxia); Liu, B (Liu, Bin); Wang, LL (Wang, Lingling); Liu, Y (Liu, Yuan); Li, QH (Li, Qihong); Wang, TH (Wang, Taihong)

Source: ELECTROCHIMICA ACTA Volume: 151 Pages: 35-41 DOI: 10.1016/j.electacta.2014.11.040 Published: JAN 1 2015

ABSTRACT: In this work, we demonstrate a facile hydrothermal synthesis of NiCo₂S₄ nanotube arrays (NTAs) by simply treating the NiCo-precursor with Na₂S solution based on the Kirkendall effect. The NiCo₂S₄ NTAs grown on nickel foam substrate are directly evaluated as binder-free electrode for supercapacitors. Impressively, the NiCo₂S₄ NTA electrode delivers an ultrahigh capacitance of 15.58 F cm⁻² at a current density of 10 mA cm⁻², which is much higher than 3.63 F cm⁻² of the mesoporous NiCo₂O₄ nanowire array (NWA) electrode. In addition, the NiCo₂S₄ NTA electrode also exhibits good cycling stability with 79.3% capacitance retention at high current density of 60 mA cm⁻² after 2000 cycles. In view of the excellent electrochemical performance and the facile and cost-effective synthesis, such NiCo₂S₄ NTA electrode would hold great promise for high-performance supercapacitor applications in future. (C) 2014 Elsevier Ltd. All rights reserved.

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Times Cited: 47

Number of references: 37

Tags: *Advanced materials - Pseudocapacitors*

Flexible Sodium-Ion Pseudocapacitors Based on 3D Na₂Ti₃O₇ Nanosheet Arrays/Carbon Textiles Anodes (China) 2016

Dong, SY (Dong, Shengyang); Shen, LF (Shen, Laifa); Li, HS (Li, Hongsen); Pang, G (Pang, Gang); Dou, H (Dou, Hui); Zhang, XG (Zhang, Xiaogang)

Source: ADVANCED FUNCTIONAL MATERIALS Volume: 26 Issue: 21 Pages: 3703-3710 DOI: 10.1002/adfm.201600264
Published: JUN 7 2016

ABSTRACT: Here, a new class of flexible energy storage device called flexible sodium-ion pseudocapacitors is developed based on 3D-flexible Na₂Ti₃O₇ nanosheet arrays/carbon textiles (NTO/CT) as anode and flexible reduced graphene oxide film (GFs) as cathode without metal current collectors or conducting additives. The NTO/CT anode with advanced electrode architectures is

continued

fabricated by directly growing Na₂Ti₃O₇ nanosheet arrays on carbon textiles with robust adhesion through a simple hydrothermal process. The flexible GF//NTO/CT configuration achieves a high energy density of 55 Wh kg⁻¹ and high power density of 3000 W kg⁻¹. Taking the fully packaged flexible sodium-ion pseudocapacitors into consideration, the maximum practical volumetric energy density and power density reach up to 1.3 mWh cm⁻³ and 70 mW cm⁻³, respectively. In addition, the flexible GF//NTO/CT device demonstrates a stable electrochemical performances with almost 100% capacitance retention under harsh mechanical deformation.

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Times Cited: 4

Number of references: 53

Tags: Advanced materials - Pseudocapacitors

High Energy Density All Solid State Asymmetric Pseudocapacitors Based on Free Standing Reduced Graphene Oxide-Co₃O₄ Composite Aerogel Electrodes (South Korea) 2016

Ghosh, D (Ghosh, Debasis); Lim, J (Lim, Joonwon); Narayan, R (Narayan, Rekha); Kim, SO (Kim, Sang Ouk)

Source: ACS APPLIED MATERIALS & INTERFACES Volume: 8 Issue: 34 Pages: 22253-22260 DOI: 10.1021/acsami.6b07511

Published: AUG 31 2016

ABSTRACT: We report a simple and cost-effective route to a graphene-based composite aerogel encapsulating metal oxide nanoparticles for high energy density, free-standing, binder-free flexible pseudocapacitive electrodes. Hydrothermally synthesized Co₃O₄ nanoparticles are successfully housed inside the microporous graphene aerogel network during the room temperature interfacial gelation at the Zn surface. The resultant three-dimensional (3D) rGO-Co₃O₄ composite aerogel shows mesoporous quasiparallel layer stack morphology with a high loading of Co₃O₄, which offers numerous channels for ion transport and a 3D interconnected network for high electrical-conductivity. All solid state asymmetric pseudocapacitors employing the composite aerogel electrodes have demonstrated high areal energy density of 35.92 mu Wh/cm² and power density of 17.79 mW/cm² accompanied by excellent cycle life.

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Times Cited: 1

Number of references: 36

Tags: Advanced materials - Pseudocapacitors

High Performance All-Solid-State Flexible Micro-Pseudocapacitor Based on Hierarchically Nanostructured Tungsten Trioxide Composite (USA) 2015

Huang, XZ (Huang, Xuezheng); Liu, HW (Liu, Hewei); Zhang, X (Zhang, Xi); Jiang, HR (Jiang, Hongrui)

Source: ACS APPLIED MATERIALS & INTERFACES Volume: 7 Issue: 50 Pages: 27845-27852 DOI: 10.1021/acsami.5b09257

Published: DEC 23 2015

ABSTRACT: Here, we demonstrate all-solid-state, flexible micropseudocapacitors via direct laser patterning on crack-free, flexible WO₃/polyvinylidene fluoride (PVDF)/multiwalled carbon nanotubes (MWCNTs) composites containing high levels of porous hierarchically structured WO₃ nanomaterials (up to 50 wt %) and limited binder (PVDF, <25 wt %). The work leads to an areal capacitance of 62.4 mF.cm⁻² and a volumetric capacitance of 10.4 F.cm⁻³, exceeding that of graphene based flexible MSCs by a factor of 26 and 3, respectively. As a noncarbon based flexible MSC, hierarchically nanostructured WO₃ in the narrow finger electrode is essential to such enhancement in energy density due to its pseudocapacitive property. The effects of WO₃/PVDF/MWCNTs composite composition and the dimensions of interdigital structure on the performance of the flexible MSCs are investigated.

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Times Cited: 4

Number of references: 39

Tags: *Advanced materials - Pseudocapacitors*

[Multishelled Nickel-Cobalt Oxide Hollow Microspheres with Optimized Compositions and Shell Porosity for High-Performance Pseudocapacitors \(China\) 2016](#)

Li, XC (Li, Xiangcun); Wang, L (Wang, Le); Shi, JH (Shi, Jianhang); Du, NX (Du, Naixu); He, GH (He, Gaohong)

Source: ACS APPLIED MATERIALS & INTERFACES Volume: 8 Issue: 27 Pages: 17276-17283 DOI: 10.1021/acsami.6b04654 Published: JUL 13 2016

ABSTRACT: Here, we demonstrate a new and flexible strategy for the preparation of hollow Ni-Co-O microspheres with optimized Ni/Co ratios, controlled shell porosity, shell numbers, and shell thickness. Owing to its high effective electrode area and electron transfer number ($n(3/2) A$), mesoporous shells, and fast electron/ion transfer, the triple-shelled Ni-Co-1.5-O electrode exhibits an ultrahigh capacitance (1884 F/g at 3A/g) and rate capability (77.7%, 3-30A/g). Moreover, the assembled sandwiched Ni-Co-1.5-O//RGO@Fe₃O₄ asymmetric supercapacitor (ACS) retains 79.4% of its initial capacitance after 10 000 cycles and shows a high energy density of 41.5 W h kg⁻¹ at 505 W kg⁻¹. Importantly, the ACS device delivers a high energy density of 22.8 W h kg⁻¹ even at 7600 W kg⁻¹, which is superior to most of the reported asymmetric capacitors. This study has provided a facile and general approach to fabricate Ni/Co mixed transition-metal oxides for energy storage.

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Number of references: 42

Tags: *Advanced materials - Pseudocapacitors*

[On-Chip Micro-Pseudocapacitors for Ultrahigh Energy and Power Delivery \(China\) 2015](#)

Han, JH (Han, Jiu-hui); Lin, YC (Lin, Yu-Ching); Chen, LY (Chen, Luyang); Tsai, YC (Tsai, Yao-Chuan); Ito, Y (Ito, Yoshikazu); Guo, XW (Guo, Xianwei); Hirata, A (Hirata, Akihiko); Fujita, T (Fujita, Takeshi); Esashi, M (Esashi, Masayoshi); Gessner, T (Gessner, Thomas); Chen, MW (Chen, Mingwei)

Source: ADVANCED SCIENCE Volume: 2 Issue: 5 Article Number: 1500067 DOI: 10.1002/adv.201500067 Published: MAY 2015

ABSTRACT: Microscale supercapacitors based on hierarchical nanoporous hybrid electrodes consisting of 3D bicontinuous nanoporous gold and pseudocapacitive manganese oxide deliver an excellent stack capacitance of 99.1 F cm⁻³ and a high energy density of 12.7 mW h cm⁻³ with a retained high power density of 46.6 W cm⁻³.

Author(s) affiliation: [Han, Jiu-hui; Lin, Yu-Ching; Chen, Luyang; Tsai, Yao-Chuan; Ito, Yoshikazu; Guo, Xianwei; Hirata, Akihiko; Fujita, Takeshi; Esashi, Masayoshi; Gessner, Thomas; Chen, Mingwei] Tohoku Univ, WPI Adv Inst Mat Res, Sendai, Miyagi 9808577, Japan.

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Times Cited: 11

Number of references: 46

Tags: *Advanced materials - Pseudocapacitors*

[Self-assembling Ni\(OH\)\(2\)/alpha-Fe2O3 composites for pseudocapacitors with excellent electrochemical performance \(China\) 2017](#)

Li, ZJ (Li, Zijiong); Zhang, WY (Zhang, Weiyang); Su, YL (Su, Yuling); Li, ZK (Li, Zhikun); Groeper, J (Groeper, Jonathan)

Source: NANOTECHNOLOGY Volume: 28 Issue: 4 Article Number: 045603 DOI: 10.1088/1361-6528/28/4/045603

Published: JAN 27 2017

ABSTRACT: Novel two-dimensional (2D) nanostructured Ni(OH)(2) nanosheet/alpha-Fe₂O₃ nanoplate composites (NFCs) were successfully synthesized by a simple two-step solvothermal method where the proportion of alpha-Fe₂O₃ nanoplates was found to be controllable. These composites achieved excellent performance in aqueous electrolyte due to the synergistic effect between Ni(OH)(2) nanosheets and alpha-Fe₂O₃ nanoplates, such as high specific capacitance and long-term cycle stability. The obtained NFC8 possessed a maximum mass specific capacitance of 1745.33F g⁻¹ at a current density of 2 A g⁻¹, and with 84.28% retention after 3000 cycles galvanostatic charge/discharge at a high current density of 20A g⁻¹. The above results show that these novel 2D nanostructured Ni(OH)(2)/alpha-Fe₂O₃ composites are promising electrode materials for pseudocapacitors.

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Number of references: 44

Tags: Advanced materials - Pseudocapacitors

Stacked-Layer Heterostructure Films of 2D Thiophene Nanosheets and Graphene for High-Rate All-Solid-State Pseudocapacitors with Enhanced Volumetric Capacitance (China) 2017

Wu, ZS (Wu, Zhong-Shuai); Zheng, YJ (Zheng, Yijun); Zheng, SH (Zheng, Shuanghao); Wang, S (Wang, Sen); Sun, CL (Sun, Chenglin); Parvez, K (Parvez, Khaled); Ikeda, T (Ikeda, Taichi); Bao, XH (Bao, Xinhe); Mullen, K (Muellen, Klaus); Feng, XL (Feng, Xinliang)

Source: ADVANCED MATERIALS Volume: 29 Issue: 3 Article Number: UNSP 1602960 DOI: 10.1002/adma.201602960

Published: JAN 18 2017

ABSTRACT: Stacked-layer heterostructure films of 2D thiophene nanosheets and electrochemically exfoliated graphene are constructed for ultrahigh-rate all-solid-state flexible pseudocapacitors and micro-supercapacitors with superior volumetric capacitance due to the synergetic effect of the ultrathin pseudocapacitive thiophene nanosheets and the capacitive electrochemically exfoliated graphene.

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Times Cited: 0

Number of references: 43

Tags: Advanced materials - Pseudocapacitors

Three-dimensional nanotube electrode arrays for hierarchical tubular structured high-performance pseudocapacitors (China) 2016

Gao, Y (Gao, Yuan); Lin, YJ (Lin, Yuanjing); Chen, JQ (Chen, Jiaqi); Lin, QF (Lin, Qingfeng); Wu, Y (Wu, Yue); Su, WJ (Su, Wenjun); Wang, WL (Wang, Wenli); Fan, ZY (Fan, Zhiyong)

Source: NANOSCALE Volume: 8 Issue: 27 Pages: 13280-13287 DOI: 10.1039/c6nr03337g Published: 2016

ABSTRACT: Here, we report 3-D fluorine doped tin oxide (FTO) tubular arrays fabricated by a cost-effective ultrasonic spray pyrolysis (USP) method in anodic aluminum oxide (AAO) channels with high uniformity. The large surface area of such a structure leads to remarkable surface area enhancement up to 51.8 times compared to a planar structure. Combining with electrochemically deposited manganese dioxide (MnO₂) nanoflakes on the inner side wall of the FTO nanotubes, the unique hierarchical tubular structured pseudocapacitor electrode demonstrated the highest areal capacitance of 193.8 mF cm⁻² at the scan rate of 5 mV s⁻¹ and 184 mF cm⁻² at the discharge current density of 0.6 mA cm⁻², which is 18.5 times that of a planar electrode. And it also showed a volumetric capacitance of 112.6 F cm⁻³ at the scan rate of 5 mV s⁻¹ and 108.8 F cm⁻³ at the discharge current density of 0.6 mA cm⁻². In addition, the cyclic stability test also indicated that a nanostructured pseudocapacitive electrode has a much larger capacitance retention after 3000 cycles of the charge-discharge process compared with a planar electrode, primarily due to the mechanical stability of the nanostructure. Moreover, pseudocapacitor device fabrication based on such electrodes shows the volumetric capacitance of 17.5 F cm⁻³, and the highest specific energy of 1.56 x 10⁻³ Wh cm⁻³. With the merit of facile fabrication procedures and largely enhanced electrochemical performance, such a 3-D structure has high potency for energy storage systems for a wide range of practical applications.

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Times Cited: 2

Number of references: 42

Tags: Advanced materials - Pseudocapacitors

Ultrahigh-Performance Pseudocapacitor Electrodes Based on Transition Metal Phosphide Nanosheets Array via Phosphorization: A General and Effective Approach (China) 2015

Zhou, K (Zhou, Kai); Zhou, WJ (Zhou, Weijia); Yang, LJ (Yang, Linjing); Lu, J (Lu, Jia); Cheng, S (Cheng, Shuang); Mai, WJ (Mai, Wenjie); Tang, ZH (Tang, Zhenghua); Li, LG (Li, Ligui); Chen, SW (Chen, Shaowei)

Source: ADVANCED FUNCTIONAL MATERIALS Volume: 25 Issue: 48 Pages: 7530-7538 DOI: 10.1002/adfm.201503662 Published: DEC 22 2015

ABSTRACT: In this study, a general and effective phosphorization strategy is successfully demonstrated to enhance supercapacitor performance of various transition metals oxide or hydroxide, such as Ni(OH)(2), Co(OH)(2), MnO₂, and Fe₂O₃. For example, a 3D networked Ni₂P nanosheets array via a facile phosphorization reaction of Ni(OH)(2) nanosheets is grown on the surface of a Ni foam. The Ni foam-supported Ni₂P nanosheet (Ni₂P NS/NF) electrode shows a remarkable specific capacitance of 2141 F g⁻¹ at a scan rate of 50 mV s⁻¹ and remains as high as 1109 F g⁻¹ even at the current density of 83.3 A g⁻¹. The specific capacitance is much larger than those of Ni(OH)(2) NS/NF (747 F g⁻¹ at 50 mV s⁻¹). Furthermore, the electrode retains a high specific capacitance of 1437 F g⁻¹ even after 5000 cycles at a current density of 10 A g⁻¹, in sharp contrast with only 403 F g⁻¹ of Ni(OH)(2) NS/NF at the same current density. The similar enhanced performance is observed for Ni₂P powder, which eliminates the influence of nickel foam. The enhanced supercapacitor performances are attributed to the 3D porous nanosheets network, enhanced conductivity, and two active components of Ni²⁺ and P⁻ with rich valences of Ni₂P.

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Number of references: 57

Tags: Advanced materials - Pseudocapacitors

Catalysts - Electrocatalyst

3D Hierarchical Pt-Nitrogen-Doped-Graphene-Carbonized Commercially Available Sponge as a Superior Electrocatalyst for Low-Temperature Fuel Cells (China) 2016

Author(s): Zhao, L (Zhao, Lei); Sui, XL (Sui, Xu-Lei); Li, JL (Li, Jia-Long); Zhang, JJ (Zhang, Jing-Jia); Zhang, LM (Zhang, Li-Mei); Wang, ZB (Wang, Zhen-Bo)

Source: ACS APPLIED MATERIALS & INTERFACES Volume: 8 Issue: 25 Pages: 16026-16034 DOI: 10.1021/acsami.6b03520 Published: JUN 29 2016

ABSTRACT: Three-dimensional hierarchical nitrogen-doped graphene (3D-NG) frameworks were successfully fabricated through a feasible solution dip-coating method with commercially available sponges as the initial backbone. A spongy template can help hinder the graphene plates restacking in the period of the annealing process. The Pt/3D-NG catalyst was synthesized employing a polyol reduction process. The resultant Pt/3D-NG exhibits 2.3 times higher activity for methanol electro-oxidation along with the improvement in stability as compared with Pt/G owing to their favorable features including large specific surface area, high pore volume, high N doping level, and the homogeneous dispersion of Pt nanoparticles. Besides, Pt/3D-NG also presents high oxygen reduction reaction (ORR) performance in acid media when compared with Pt/3D-G and Pt/G. This work raises a valid solution for the fabrication of 3D functional freestanding graphene-based composites for a variety of applications in fuel cell catalysis, energy storage, and conversion.

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Times Cited: 2

Number of references: 58

Tags: Advanced materials - Electrocatalysts

Al³⁺-Induced growth of alpha-Co(OH)(2) nanoplates as high-capacity supercapacitors and water oxidation electrocatalysts (China) 2017

Author(s): Liu, RM (Liu, Rongmei); Jiang, ZX (Jiang, Zixiang); Ma, JP (Ma, Juping); Ni, L (Ni, Lu); Sun, XY (Sun, Xueying); Liu, Y (Liu, Yong); Chen, HX (Chen, Haixing); Liu, Q (Liu, Qi)

Source: RSC ADVANCES Volume: 7 Issue: 7 Pages: 3783-3789 DOI: 10.1039/c6ra26160d Published: 2017

ABSTRACT: In this paper, we report a metal ion-induced synthesis of alpha-Co(OH)(2) nanoplates as high-capacity supercapacitors and water oxidation electrocatalysts, which were synthesized by using metal ions of Al³⁺ as a structure-inducing agent through hydrothermal treatment. When used as electrode materials in supercapacitors, alpha-Co(OH)(2) nanoplates exhibit good capacitive properties of 709.1 F g⁻¹ at a current density of 1 A g⁻¹, maintaining 95.8% of the initial capacity at the current density of 5 A g⁻¹ after 1000 cycles. The alpha-Co(OH)(2) nanoplates can effectively oxidize water, showing excellent OER activity with a small overpotential of 348 mV at the current density of 10 mA cm⁻² and a large mass activity of 28.2 A g⁻¹, much higher than that of the beta-Co(OH)(2) particle electrocatalyst (0.2 A g⁻¹). These results provide a new and facile approach to fabricating high-performance electrodes for supercapacitors and water oxidation electrocatalysts.

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Times Cited: 0

Number of references: 35

Tags: Advanced materials - Electrocatalysts

Free-Standing 3D Hierarchical Carbon Foam-Supported PtCo Nanowires with "Pt Skin" as Advanced Electrocatalysts (China) 2016

Author(s): Liu, MM (Liu, Minmin); He, SJ (He, Shuijian); Chen, W (Chen, Wei)

Source: ELECTROCHIMICA ACTA Volume: 199 Pages: 218-226 DOI: 10.1016/j.electacta.2016.03.155 Published: MAY 1 2016

ABSTRACT: A two-step method was used for fabricating PtCo alloy nanowires supported on free-standing carbon foam network (PtCo-NWs/CF). First, Co nanowires (Co-NWs) were successfully in situ formed on CF (Co-NWs/CF) through a hydrothermal procedure with a subsequent post annealing treatment. Second, PtCo-NWs/CF composite was prepared via the displacement reaction between PtCl₄²⁻ and the as-synthesized Co-NWs in the presence of ascorbic acid. Moreover, by a simple electrochemical process, a "Pt-skin" can be formed on the PtCo nanowires. Due to the 3D hierarchical micron-grade porous carbon support and the PtCo alloy nanowires with a synergy effect between Pt and Co, the PtCo-NWs/CF shows excellent electrocatalytic activity toward ethanol oxidation reaction (EOR) and oxygen reduction reaction (ORR, undergoes a 4e⁻ pathway).

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Times Cited: 3

Number of references: 48

Tags: Advanced materials - Electrocatalysts

Hierarchical NiCo₂O₄ Hollow Microcuboids as Bifunctional Electrocatalysts for Overall Water-Splitting (China) 2016

Author(s): Gao, XH (Gao, Xuehui); Zhang, HX (Zhang, Hongxiu); Li, QG (Li, Quanguo); Yu, XG (Yu, Xuegong); Hong, ZL (Hong, Zhonglian); Zhang, XW (Zhang, Xingwang); Liang, CD (Liang, Chengdu); Lin, Z (Lin, Zhan)

Source: ANGEWANDTE CHEMIE-INTERNATIONAL EDITION Volume: 55 Issue: 21 Pages: 6290-6294 DOI: 10.1002/anie.201600525 Published: MAY 17 2016

ABSTRACT: Bifunctional electrocatalysts for the oxygen evolution reaction (OER) and hydrogen evolution reaction (HER) in alkaline electrolyte may improve the efficiency of overall water splitting. Nickel cobaltite (NiCo₂O₄) has been considered a promising electrode material for the OER. However, NiCo₂O₄ that can be used as an electrocatalyst in HER has not been studied yet. Herein,

we report self-assembled hierarchical NiCo₂O₄ hollow microcuboids for overall water splitting including both the HER and OER reactions. The NiCo₂O₄ electrode shows excellent activity toward overall water splitting, with 10 mA cm⁻² water-splitting current reached by applying just 1.65 V and 20 mA cm⁻² by applying just 1.74 V across the two electrodes. The synthesis of NiCo₂O₄ microflowers confirms the importance of structural features for highperformance overall water splitting.

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Times Cited: 17

Number of references: 36

Tags: Advanced materials - Electrocatalysts

In situ Grown Pyramid Structures of Nickel Diselenides Dependent on Oxidized Nickel Foam as Efficient Electrocatalyst for Oxygen Evolution Reaction (China) 2016

Author(s): Li, X (Li, Xiao); Han, GQ (Han, Guan-Qun); Liu, YR (Liu, Yan-Ru); Dong, B (Dong, Bin); Shang, X (Shang, Xiao); Hu, WH (Hu, Wen-Hui); Chai, YM (Chai, Yong-Ming); Liu, YQ (Liu, Yun-Qi); Liu, CG (Liu, Chen-Guang)

Source: ELECTROCHIMICA ACTA Volume: 205 Pages: 77-84 DOI: 10.1016/j.electacta.2016.04.108 Published: JUL 1 2016

ABSTRACT: In situ grown pyramid structures of nickel diselenides (NiSe₂) have been synthesized using oxidized nickel foam (NF(Ox)) as substrate by a facile solvothermal selenization. XRD results show that NiSe phase on NF and NiSe₂ phase on NF (Ox) have been obtained after the identical selenization process, respectively. The nanorods morphology of NiSe on NF and pyramid structure of NiSe₂ on NF (Ox) have been revealed by SEM images. The different structure and morphology of NiSe/NF compared with NiSe₂/NF (Ox) can be ascribed to the oxidation pretreatment of NF which affiliates the formation of ultrathin beta-Ni(OH)₂ nanosheets on NF. The electrochemical measurements for oxygen evolution reaction (OER) exhibit an enhanced electrocatalytic activity of NiSe₂/NF (Ox) with onset potential of 1.54 V (vs. RHE) and small Tafel slope of 96 mV dec⁻¹. Moreover, NiSe₂/NF (Ox) possesses lower charge-transfer resistance (R_{ct}) indicating a faster electron transfer rate than NiSe/NF. The excellent stability further confirms the improved electrocatalytic performance of NiSe₂/NF (Ox). We speculate that the high Ni²⁺ proportion and octahedral structure of NiSe₂ may be the keys for excellent electrocatalytic properties for OER. (C) 2016 Elsevier Ltd. All rights reserved.

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Number of references: 38

Tags: Advanced materials - Electrocatalysts

NiCoMnO₄ nanoparticles on N-doped graphene: Highly efficient bifunctional electrocatalyst for oxygen reduction/evolution reactions (Spain) 2017

Author(s): Pendashteh, A (Pendashteh, Afshin); Palma, J (Palma, Jesus); Anderson, M (Anderson, Marc); Marcilla, R (Marcilla, Rebeca)

Source: APPLIED CATALYSIS B-ENVIRONMENTAL Volume: 201 Pages: 241-252 DOI: 10.1016/j.apcatb.2016.08.044 Published: FEB 2017

ABSTRACT: In the present study, we synthesized NiCoMnO₄ nanoparticles anchored on nitrogen-doped graphene nanosheets as highly efficient bifunctional electrocatalysts for the Oxygen Reduction Reaction (ORR) and for the Oxygen Evolution Reaction (OER). Proper anchoring of NiCoMnO₄ nanoparticles on graphene layers was probed with various characterization techniques including X-ray diffraction, energy dispersive X-ray (EDX), Raman, and Fourier transform infrared (FTIR) spectroscopy as well as transmission electron microscopy (TEM). X-ray photoelectron spectroscopy (XPS) was also employed to shed light on the oxidation states of metallic atoms and types of doped nitrogen on graphene layers. According to the obtained results, the NiCoMnO₄/N-rGO hybrid showed excellent electrocatalytic activity towards ORR (E-onset = 0.92 V vs. RHE and high current density of 0.84 mA cm⁻²) and OER (E-onset = 1.5 V vs. RHE and high current density of 14 mA cm⁻²), much better than other evaluated catalysts. It has been shown that the NiCoMnO₄/N-rGO catalyzes ORR mostly through 4e process, just as the commercial Pt based catalyst. Moreover, it outperforms the commercial catalyst with very little decay in ORR activity over long continuous operation and shows excellent catalytic selectivity and methanol tolerance. (C) 2016 Elsevier B.V. All rights reserved.

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Number of references: 61

Tags: Advanced materials - Electrocatalysts

One-step electrodeposition of Ni-Co-S nanosheets film as a bifunctional electrocatalyst for efficient water splitting (China) 2016

Author(s): Liu, TT (Liu, Tingting); Sun, XP (Sun, Xuping); Asiri, AM (Asiri, Abdullah M.); He, YQ (He, Yuquan)

Source: INTERNATIONAL JOURNAL OF HYDROGEN ENERGY Volume: 41 Issue: 18 Pages: 7264-7269 DOI: 10.1016/j.ijhydene.2016.03.111 Published: MAY 18 2016

ABSTRACT: In this communication, we report that Ni-Co-S film electrochemically deposited on Cu foam (Ni-Co-S/CF) behaves as a bifunctional catalyst for both hydrogen evolution reaction (HER) and oxygen evolution reaction (OER) with good durability in strongly basic electrolyte. This 3D electrode behaves high activity of 10 mA cm⁻² at overpotential of 140 mV for HER and 100 mA cm⁻² at overpotential of 363 mV for OER in 1.0 M KOH. Furthermore, using Ni-Co-S/CF as both anode and cathode can afford 10 mA cm⁻² at cell voltage of 1.67 V toward overall water splitting in alkaline solution. Copyright (C) 2016, Hydrogen Energy Publications, LLC. Published by Elsevier Ltd. All rights reserved.

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Number of references: 26

Tags: Advanced materials - Electrocatalysts

Phosphorous-Nitrogen-Codoped Carbon Materials Derived from Metal-Organic Frameworks as Efficient Electrocatalysts for Oxygen Reduction Reactions (China) 2016

Author(s): Fu, Y (Fu, Yu'ang); Huang, Y (Huang, Yan); Xiang, ZH (Xiang, Zhonghua); Liu, GQ (Liu, Guangqing); Cao, DP (Cao, Dapeng)

Source: EUROPEAN JOURNAL OF INORGANIC CHEMISTRY Issue: 13-14 Special Issue: SI Pages: 2100-2105 DOI: 10.1002/ejic.201500822 Published: MAY 2016

ABSTRACT: Herein, a series of UiO-66-NH₂-derived phosphorus-nitrogen-codoped porous carbon materials (P-N-carbons) are prepared from phosphorus-doped UiO-66-NH₂ through postsynthetic modification (PSM) followed by one-step pyrolysis at various temperatures. The newly developed P-N-carbons exhibit high catalytic activity that is nearly equal to those of commercial Pt/C catalysts along with superior long-term stability and excellent methanol tolerance. This work shows not only that UiO-66-NH₂ can be considered as a self-sacrificial precursor and nitrogen source but also that metal-organic frameworks (MOFs) with active functional groups may be developed as efficient alternative precursors. Owing to the versatility of MOF structures, the MOF-derived porous carbon materials would broaden the family of nanoporous carbon materials significantly and provide new structures and multifunctional properties for use in electrocatalysts, sensors, supercapacitors, and batteries, for example.

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Number of references: 33

Tags: Advanced materials - Electrocatalysts

Porous and single-crystalline-like molybdenum nitride nanobelts as a non-noble electrocatalyst

[for alkaline fuel cells and electrode materials for supercapacitors \(China\) 2016](#)

Author(s): Liu, J (Liu, J.); Huang, K (Huang, K.); Tang, HL (Tang, H. L.); Lei, M (Lei, M.)

Source: INTERNATIONAL JOURNAL OF HYDROGEN ENERGY Volume: 41 Issue: 2 Pages: 996-1001 DOI: 10.1016/j.ijhydene.2015.11.086 Published: JAN 12 2016

ABSTRACT: Here, highly porous and “single-crystal-like” Mo₂N nanobelts with high density of nanopores have been synthesized on gram-scale. These novel Mo₂N nanobelts exhibited high electrocatalytic activity in alkaline electrolyte even better than that of other non-Pt materials and appear to be promising Pt-free cathodic electrocatalysts in alkaline fuel cells. This discovery reveals a new type of metal nitride ORR catalyst and appear to be promising Pt-free cathodic electrocatalysts in alkaline fuel cells. Copyright (C) 2015, Hydrogen Energy Publications, LLC. Published by Elsevier Ltd. All rights reserved.

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Number of references: 27

Tags: Advanced materials - Electocatalysts

[Semiconductor-Electrocatalyst Interfaces: Theory, Experiment, and Applications in Photoelectrochemical Water Splitting \(USA\) 2016](#)

Author(s): Nellist, MR (Nellist, Michael R.); Laskowski, FAL (Laskowski, Forrest A. L.); Lin, FD (Lin, Fuding); Mills, TJ (Mills, Thomas J.); Boettcher, SW (Boettcher, Shannon W.)

Source: ACCOUNTS OF CHEMICAL RESEARCH Volume: 49 Issue: 4 Pages: 733-740 DOI: 10.1021/acs.accounts.6b00001 Published: APR 2016

ABSTRACT: Experiments to directly measure the interface behavior and test the theory/simulations are challenging because conventional photoelectrochemical techniques do not measure the electrocatalyst potential during operation. We developed dual-working electrode (DWE) photoelectrochemistry to address this limitation. A second electrode is attached to the catalyst layer to sense or control current/voltage independent from that of the semiconductor back ohmic contact. Consistent with simulations, electrolyte-permeable, redox-active catalysts such as Ni(Fe)OOH form “adaptive” junctions where the effective barrier height for electron exchange depends on the potential of the catalyst. This is in contrast to semlcat interfaces with dense electrolyte impermeable catalysts, such as nanocrystalline IrO_x, that behave like solid-state buried (Schottky-like) junctions. These results elucidate a design principle for catalyzed photoelectrodes. The buried heterojunctions formed by dense catalysts are often limited by Fermi-level pinning and low photovoltages. Catalysts deposited by “soft” methods, such as electrodeposition, form adaptive junctions that tend to provide larger photovoltages and efficiencies. We also preview efforts to improve theory/simulations to account for the presence of surface states and discuss the prospect of carrier-selective catalyst contacts.

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Number of references: 53

Tags: Advanced materials - Electocatalysts

[Synthesis of hollow porous ZnCo₂O₄ microspheres as high-performance oxygen reduction reaction electrocatalyst \(China\) 2016](#)

Author(s): Wang, H (Wang, Hao); Song, XH (Song, Xinhang); Wang, HY (Wang, Haiyan); Bi, K (Bi, Ke); Liang, C (Liang, Ce); Lin, S (Lin, Sen); Zhang, R (Zhang, Ru); Du, YX (Du, Yinxiao); Liu, J (Liu, Jun); Fan, DY (Fan, Dongyu); Wang, YG (Wang, Yonggang); Lei, M (Lei, Ming)

Source: INTERNATIONAL JOURNAL OF HYDROGEN ENERGY Volume: 41 Issue: 30 Pages: 13024-13031 DOI: 10.1016/j.ijhydene.2016.05.046 Published: AUG 10 2016

ABSTRACT: Hollow porous ZnCo₂O₄ microspheres have been successfully prepared by a simple solution-based assembly followed by calcination under an air atmosphere using zinc acetylacetonate Zn(C₅H₇O₂)(₂) and cobalt acetylacetonate Co(C₅H₇O₂)(₃) as raw materials. Scanning electron microscopy (SEM) and Transmission electron microscope (TEM) are used to reveal the synthesis

mechanism of hollow porous structure, meanwhile, BET is used to analyze the specific surface area and pore size distribution. In the oxygen reduction reaction (ORR) test, hollow porous ZnCo₂O₄ microspheres exhibit enhanced ORR performance than bulk ZnCo₂O₄, mainly owing to the hollow porous structure which has more catalytic sites and higher efficiency of reactant exchange. Moreover, such catalyst also exhibits superior methanol tolerance ability and durability over commercial Pt/C catalyst. (C) 2016 Hydrogen Energy Publications LLC. Published by Elsevier Ltd. All rights reserved.

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Times Cited: 2

Number of references: 49

Tags: Advanced materials - Electrocatalysts

Ultrafine NiO Nanosheets Stabilized by TiO₂ from Monolayer NiTi-LDH Precursors: An Active Water Oxidation Electrocatalyst (China) 2016

Author(s): Zhao, YF (Zhao, Yufei); Jia, XD (Jia, Xiaodan); Chen, GB (Chen, Guangbo); Shang, L (Shang, Lu); Waterhouse, GIN (Waterhouse, Geoffrey I. N.); Wu, LZ (Wu, Li-Zhu); Tung, CH (Tung, Chen-Ho); O'Hare, D (O'Hare, Dermot); Zhang, TR (Zhang, Tierui)

Source: JOURNAL OF THE AMERICAN CHEMICAL SOCIETY Volume: 138 Issue: 20 Pages: 6517-6524 DOI: 10.1021/jacs.6b01606 Published: MAY 25 2016

ABSTRACT: Faceted NiO nanoparticles preferentially exposing high surface energy planes demand attention due to their excellent electrocatalytic properties. However, the activity of faceted NiO nanoparticles generally remains suboptimal due to their large lateral size and thickness, which severely limits the availability of coordinatively unsaturated active reactive edge and corner sites. Here, ultrafine NiO nanosheets with a platelet size of similar to 4.0 nm and thickness (similar to 1.1 nm) stabilized by TiO₂ were successfully prepared by calcination of a monolayer layered double hydroxide precursor. The ultrafine NiO nanosheets displayed outstanding performance in electrochemical water oxidation due to a high proportion of reactive NiO {110} facets, intrinsic Ni³⁺ and Ti³⁺ sites, and abundant interfaces, which act synergistically to promote H₂O adsorption and facilitate charge-transfer.

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Times Cited: 13

Number of references: 57

Tags: Advanced materials - Electrocatalysts

Catalysts - Photocatalyst

Facile synthesis of MoO₂ nanoparticles as high performance supercapacitor electrodes and photocatalysts (China) 2016

Zhou, E (Zhou, E.); Wang, CG (Wang, Chenggang); Zhao, QQ (Zhao, Qinqin); Li, ZP (Li, Zhipeng); Shao, MH (Shao, Minghui); Deng, XL (Deng, Xiaolong); Liu, XJ (Liu, Xiaojing); Xu, XJ (Xu, Xijin)

Source: CERAMICS INTERNATIONAL Volume: 42 Issue: 2 Pages: 2198-2203 DOI: 10.1016/j.ceramint.2015.10.008 Part: A Published: FEB 1 2016

ABSTRACT: Molybdenum dioxide (MoO₂) nanoparticles with the size of 200 nm in diameter were synthesized by a facile hydrothermal method. The nanoparticles were directly functionalized as supercapacitors (SCs) electrodes and photocatalysts. The electrochemical studies showed that the SCs demonstrated high capacitance of 621 F g⁻¹, which was 3 times larger than previous

reports. Furthermore, they exhibited good cyclic performance with 90% capacity retention after 1000 cycles at a current density of 1 A g(-1.) The photocatalytic activities were evaluated by the degradation of methylene blue (MB) and rhodamine B (RhB), respectively, and the nanoparticles demonstrated preferred selectivity on the degradation of RhB (70%) than that of MB (30%). (C) 2015 Elsevier Ltd and Techna Group S.r.l. All rights reserved.

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Number of references: 33

Tags: Advanced materials - Photocatalyst

Highly efficient visible-light-driven plasmonic photocatalysts based on graphene oxide mediated hybridization of graphite and Ag/AgBr (China) 2017

Geng, GW (Geng, Guangwei); Guan, B (Guan, Bo); Chen, PL (Chen, Penglei); Zhu, MS (Zhu, Mingshan); Yang, CC (Yang, Changchun); Liu, MH (Liu, Minghua)

Source: RSC ADVANCES Volume: 7 Issue: 16 Pages: 9948-9957 DOI: 10.1039/c6ra27462e Published: 2017

ABSTRACT: We demonstrate that without the use of GO, Gr could not be well hybridized with Ag/AgBr, while a good hybrid Gr/GO/Ag/AgBr could be produced when GO nanosheets are introduced into the system. Our results show that compared to Ag/AgBr, GO/Ag/AgBr and Gr/Ag/AgBr species, thus-fabricated Gr/GO/Ag/AgBr hybrids could display substantially enhanced catalytic activity towards the photobleaching of methyl orange under visible-light irradiation. It is disclosed that the good hybridization between Gr and Ag/AgBr, which is mediated by GO, and the facilitated separation of photogenerated electrons and holes, which is promoted both by GO and Gr, contribute much to the boosted catalytic performances. Considering the excellent hybridization capability of GO, the exceptional electronic characteristics, versatile multifunctionality and low-cost of Gr, our protocol might be applicable not only to the Ag/AgBr-based plasmonic photocatalysts but also to a wide variety of other functional materials, wherein Gr/GO-based advanced materials of desired and reinforced functions or properties might be inaugurated.

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Times Cited: 0

Number of references: 57

Tags: Advanced materials - Photocatalyst

Hybrid Semiconductor-Metal Nanorods as Photocatalysts (Israel) 2016

Ben-Shahar, Y (Ben-Shahar, Yuval); Banin, U (Banin, Uri)

Source: TOPICS IN CURRENT CHEMISTRY Volume: 374 Issue: 4 Article Number: 54 DOI: 10.1007/s41061-016-0052-0 Published: AUG 2016

ABSTRACT: In this review, we discuss synthesis approaches that offer a high degree of control over the hybrid nanoparticle structure and composition, the number of catalytic sites and the interfacial characteristics, including examples of a variety of photocatalyst architectures. We describe the structural and surface effects with regard to the functionality of hybrid nanosystems in photocatalysis, along with the effects of solution and chemical conditions on photocatalytic activity and efficiency. We conclude with a perspective on the rational design of advanced semiconductor-metal hybrid nanoparticles towards their functionality as highly efficient photocatalysts.

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Times Cited: 1

Number of references: 83

Tags: *Advanced materials - Photocatalyst, Advanced materials - Review article,*

Metal-free carbonaceous electrocatalysts and photocatalysts for water splitting (Singapore) 2016

Xu, Y (Xu, You); Kraft, M (Kraft, Markus); Xu, R (Xu, Rong)

Source: CHEMICAL SOCIETY REVIEWS Volume: 45 Issue: 11 Pages: 3039-3052 DOI: 10.1039/c5cs00729a Published: 2016

ABSTRACT: Due to their unique properties and characteristics, carbon and related carbon-based materials show great potential to replace some of the existing precious metal catalysts in water splitting technology. This tutorial review summarizes the recent significant progress in the fabrication and application of metal-free carbonaceous materials as photo- or electrocatalysts for water splitting. Synthetic strategies and applications of various carbonaceous materials, including graphitic carbon nitride (g-C₃N₄), graphene, carbon nanotubes (CNTs) as well as other forms of carbon-containing materials, for electrochemical or photochemical water splitting are presented, accompanied by a discussion of the key scientific issues and prospects for the future development of metal-free photo- and electrocatalysts.

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Times Cited: 11

Number of references: 52

Tags: *Advanced materials - Photocatalyst, Advanced materials - Review article*

Plasmon-Induced Water Splitting Using Metallic-Nanoparticle-Loaded Photocatalysts and Photoelectrodes (Japan) 2016

Ueno, K (Ueno, Kosei); Oshikiri, T (Oshikiri, Tomoya); Misawa, H (Misawa, Hiroaki)

Source: CHEMPHYSICHEM Volume: 17 Issue: 2 Pages: 199-215 DOI: 10.1002/cphc.201500761 Published: JAN 18 2016

ABSTRACT: Visible- and near-infrared-light-driven water splitting, which splits water molecules to generate hydrogen and oxygen gases, is a significant subject in artificial photosynthesis with the goal of achieving a low-carbon society. In recent years, considerable attention has been paid to studies on the development of a plasmon-induced water-splitting system responding to visible light. In this review, we categorized water-splitting systems as gold-nanoparticle-loaded semiconductor photocatalytic particles system and metallic-nanoparticles-loaded semiconductor photoelectrode systems, and introduce the latest studies according to these categories. Especially, we describe the studies that optimize a material or a structural design of metallic-nanoparticle-loaded semiconductor photoelectrodes and consider a whole water-splitting system, including a cathode design. Furthermore, we discuss important points when studying plasmon-induced water splitting, and we describe a methodology that enhances plasmon-induced water-splitting efficiency.

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Times Cited: 6

Number of references: 98

Tags: *Advanced materials - Photocatalyst, Advanced materials - Review article*

Progress in sonochemical fabrication of nanostructured photocatalysts (China) 2016

Yu, CL (Yu, Chang-Lin); Yu, JC (Yu, Jimmy C.); He, HB (He, Hong-Bo); Zhou, WQ (Zhou, Wan-Qin)

Source: RARE METALS Volume: 35 Issue: 3 Pages: 211-222 DOI: 10.1007/s12598-016-0694-7 Published: MAR 2016

ABSTRACT: This review summarized the recent development in fabrication of photocatalysts with special nanostructures and their applications. The typical sonochemical reactors and parameters in sonochemical synthesis are introduced and discussed. Sonochemically prepared structures including nano-/microspheres, one-dimensional (1D) nanorods, two-dimensional (2D) nanosheets (nanoflakes, nanosquares), noble metal nanoparticle (NP)-deposited and element-doped photocatalysts are

described and summarized. It is believed that sonication is a green methodology, and it holds great potential in the near future for nanostructured photocatalyst fabrication.

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Times Cited: 4

Number of references: 102

Tags: Advanced materials - Photocatalyst, Advanced materials - Review article,

Recent advances in bismuth-containing photocatalysts with heterojunctions (China) 2016

Chen, L (Chen, Lang); He, J (He, Jie); Liu, Y (Liu, Ying); Chen, P (Chen, Peng); Au, CT (Au, Chak-Tong); Yin, SF (Yin, Shuang-Feng)

Source: CHINESE JOURNAL OF CATALYSIS Volume: 37 Issue: 6 Pages: 780-791 DOI: 10.1016/S1872-2067(15)61061-0

Published: JUN 2016

ABSTRACT: Photocatalysis has received much attention owing to current energy and environmental crises. The use of an appropriate photocatalyst is important to a photocatalytic process. The development of photocatalysts that absorb light over a wide range of wavelengths and efficiently separate charge carriers remains a challenge and hot research topic. With strong visible-light-absorption ability, bismuth-containing photocatalysts are of great interest to scientists. However, measures have to be taken to enhance the light absorption efficiency and to lessen the problem of the recombination of charge carriers. Known approaches are the formation of heterojunctions through (1) loading of a noble metal, (2) semiconductor combination, (3) metal and nonmetal doping, (4) carbon-based material modification, and (5) Bi metal loading. The present review summarizes recent advances in this respect. Finally, the future development and potential applications of bismuth-containing photocatalysts with heterojunctions are briefly discussed. (C) 2016, Dalian Institute of Chemical Physics, Chinese Academy of Sciences. Published by Elsevier B.V. All rights reserved.

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Times Cited: 1

Number of references: 129

Tags: Advanced materials - Photocatalyst, Advanced materials - Review article,

Self-ordered Nanotubular TiO₂ Multilayers for High-Performance Photocatalysts and Supercapacitors (China) 2016

Zheng, LX (Zheng, Lingxia); Dong, YC (Dong, Yucheng); Bian, HD (Bian, Haidong); Lee, C (Lee, Chris); Lu, J (Lu, Jian); Li, YY (Li, Yang Yang)

Source: ELECTROCHIMICA ACTA Volume: 203 Pages: 257-264 DOI: 10.1016/j.electacta.2016.04.049 Published: JUN 10 2016

ABSTRACT: Arrays of multilayered TiO₂ nanotubes are successfully fabricated by anodizing commercial Ti foils with multi-pulsed voltage waveforms. The fabricated structures feature an interesting multilayered morphology with each layer consisting of self-ordered TiO₂ nanotubes (diameter of tens of nanometers and length of several hundred nanometers) aligned vertically to the Ti substrate, and the possible growth mechanism is proposed. The novel multilayered TiO₂ nanotubes exhibit significantly enhanced photocatalytic efficiency than the conventional TiO₂ nanotubes and the multilayered nanoporous TiO₂ structures previously reported by our group. Moreover, the multilayered TiO₂ nanotubes are for the first time investigated for supercapacitor applications, enabling superior capacitance and good cycling stability: the specific capacitance of the C-modified multilayered TiO₂ nanotubes is 60 times higher than the pristine multilayered TiO₂ nanotubes, and 1.6 times of the C-modified single-layered TiO₂ nanotubes. (C) 2016 Published by Elsevier Ltd.

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Times Cited: 3

Number of references: 75

Tags: *Advanced materials - Photocatalysts***Solvothermal synthesis of BiPO₄ nanorods/MWCNT (1D-1D) composite for photocatalyst and supercapacitor applications (India) 2016**

Vadivel, S (Vadivel, S.); Naveen, AN (Naveen, A. N.); Theerthagiri, J (Theerthagiri, J.); Madhavan, J (Madhavan, J.); Priya, TS (Priya, T. Santhoshini); Balasubramanian, N (Balasubramanian, N.)

Source: CERAMICS INTERNATIONAL Volume: 42 Issue: 12 Pages: 14196-14205 DOI: 10.1016/j.ceramint.2016.05.080

Published: SEP 2016

ABSTRACT: A novel BiPO₄/MWCNT (1D-1D) composite was synthesized by a simple one step solvothermal approach. The crystallinity, morphology, and photophysical properties of the samples were characterized by XRD, Raman, SEM, TEM, XPS, UV-vis spectroscopic techniques. The nanostructured BiPO₄/MWCNT composite showed large surface area and the incorporation of MWCNT caused a red-shift of BiPO₄ in (ultraviolet) UV region. A maximum specific capacitance of 504 F g⁻¹ at a scan rate of 5 mV s⁻¹ was obtained for BiPO₄/MWCNT composite. BiPO₄/MWCNT composite shows good capacity retention (94%) upon cycling over 1000 cycles. The BiPO₄/MWCNT composite exhibits better photocatalytic activity than pure BiPO₄ under UV light irradiation in view of degrading methyl orange (MO) as target pollutant. The degradation of MO could get 95% in BiPO₄/MWCNT photocatalysts under optimum reaction conditions. The improved photoactivity of BiPO₄/MWCNT could be attributed to effective separation of photoinduced hole-electron pairs between host BiPO₄ and MWCNT. This study offers a new fabrication strategy to prepare BiPO₄ based materials that can be used in energy storage devices and environmental applications. (C) 2016 Published by Elsevier Ltd and Techna Group S.r.l.

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Times Cited: 0

Number of references: 51

Tags: *Advanced materials - Photocatalysts***Sub-coherent growth of ZnO nanorod arrays on three-dimensional graphene framework as one-bulk high-performance photocatalyst (China) 2016**

Yu, M (Yu, Mei); Ma, YX (Ma, Yuxiao); Liu, JH (Liu, Jianhua); Li, XJ (Li, Xinjie); Li, SM (Li, Songmei); Liu, SY (Liu, Shenyao)

Source: APPLIED SURFACE SCIENCE Volume: 390 Pages: 266-272 DOI: 10.1016/j.apsusc.2016.08.061 Published: DEC 30 2016

ABSTRACT: Highly ordered ZnO nanorod arrays were grown vertically on the surface of three-dimensional graphene (3DG) framework bulk to prepare a one-bulk structure. In such structure, ZnO exhibits outstanding photocatalyst performance due to its hybridization with 3DG. The sub-coherency between ZnO and 3DG ensures the template-free growth of ZnO nanorod arrays and the exposing of its most active crystal surfaces {0001}. The hybridization prevents the agglomeration of ZnO nanoparticles, helping the formation of nanorod array morphology, enhancing the mass transfer of reactants and the separation of photogenerated holes. In the efficiency test, with tiny amount of ZnO catalyst (similar to 5.03 x 10⁻³ g), the concentration of methyl orange decreased to similar to 11% of the initial value within four hours. The structure possesses high average photocatalytic efficiency of 6.56 x 10⁻³ h⁻¹, much higher than that of bare ZnO nanorods. (C) 2016 Elsevier B.V. All rights reserved.

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Times Cited: 0

Number of references: 48

Tags: *Advanced materials - Photocatalysts* ■

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