Solder-free electrical Joule welding of macroscopic graphene assemblies

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a r t i c l e i n f o

Materials Today Nano 3 (2018) 9 e 27

Contents lists available at ScienceDirect

Materials Today Nano

journal homepage: https://www.evise.com/p roPle/#/MTNANO/login

Gold nanoclusters: synthetic strategies and recent advances in uorescent sensing

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a r t i c l e i n f o

Article history:
Available online 14 November 2018

Keywords:
Fluorescent nanomaterials
Detecting probes
Synthetic approache
Metal nanoclusters
Biosensors

a b s t r a c t

Fluorescent gold nanoclusters (AuNCs) have emerged as ideal sensor probes in different research elds such as environmental, biological and clinical applications. AuNCs have acquired a paramount importance in sensing applications owing to their unique physicochemical and luminescence characteristics including excellent photostability and biocompatibility, high surface to volume ratio, besides size-dependent luminescence, large stokes shift, and high emission rates. In this review, we will pay special attention on the recent advances in the different synthetic strategies of AuNCs. Different parameters affecting photoluminescence properties of AuNCs and their quantum yield including AuNCs size, core composition, valence state of Au atoms, and ligand effect will be discussed in detail. This review will also provide a comprehensive and recent look on the various AuNCs-based sensing systems developed for the detection of heavy metal ions, inorganic anions, small biomolecules, protein tumor markers, enzymes, and nucleic acids. This review demonstrates the high sensitivity, selectivity, simplicity, and low cost of AuNCs as sensing probes for the various targeted analytes.

1. Introduction

Over the past decades, gold nanoparticles (AuNPs) have witnessed a paramount importance in various research areas, including chemical sensing, catalysis, biology, medicine, and environmental sciences [1e4]. AuNPs with size larger than 3 nm exhibit unique optical properties and have distinct feature of surface plasmon resonance (SPR), which results from the resonant collective oscillation of electrons in the conduction band with the incident light. While ultrasmall AuNPs (<3 nm), de ned as gold nanoclusters (AuNCs), have molecular-like properties owing to the strong quantum con nement effect that causes the continuous energy bands break up into discrete energy levels [5,6]. Therefore, AuNCs possess common features, such as HOMO-LUMO transition, photoluminescence (PL), electrochemiluminescence, lacking SPR peak, electromagnetism, redox behavior, and molecular chirality [7e9].

For AuNPs, several recent studies have extensively discussed their controlled synthesis with different sizes (5 e 50 nm), shapes (rods, nanocubes, nanoplates, nano owers, etc), and compositions (alloys such as Au/AgNPs, Au/Cu, Au/Pd,etc). These varied structural features can effectively affect the physical properties of AuNPs by exposing different facets ({110}, {210}, {111}, etc) and different active sites (corners and edges) [6]. Thereby, AuNPs have large surface to volume ratio and excellent catalytic activities toward many reactions, such as oxidation, hydrogenation, and coupling reactions, resulting in its implication in various applications, such as electrocatalysis, solar cells, and biofuel cells. Further, AuNPs have been widely employed in colorimetry, surface-enhanced infrared absorption spectroscopy, and surface-enhanced Raman scattering owing to the unique SPR feature of AuNPs. Unlike AuNCs, AuNPs are non-luminescent nanomaterials, and they can quench NCs luminescence through F6rster/ uorescence resonance energy transfer (FRET) owing to high molar absorptivity constant and overlapping of their photoexcitation with AuNCs emission.

For AuNCs, they have ultrasmall size (0.1 nm e 2 nm) consisting of few to several Au atoms; therefore, it is a big challenge to control the core size of AuNCs compared with AuNPs. Different emission

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https://doi.org/10.1016/j.mtnano.2018.11.001
2588-8420/

Materials Today Nano 3 (2018) 28 e 47

Contents lists available at ScienceDirect

Materials Today Nano

journal homepage: https://www.evise.com/ proÞle/#/MTNANO/login

A brief review on plasma for synthesis and processing of electrode materials

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a r t i c l e i n f o

Article history:
Available online 17 November 2018

Keywords:
Surface modi cation
Conversion reaction
Renewable energy
Plasma technique
Nano-materials

a b s t r a c t

Plasma, as an active, ionized, and electrically neutral gas, consists of electrons, ions, photons, and other excited specelectrode materials are the keystone and electronic devices [1,2]. Herein, the exploitation of new materials and modi cation of existing materials at the atomic level become two meaningful and feasible strategies to meet the requirement of our society. However, researchers have suffered several challenges in traditional approaches for the fabrication of electrode materials with desirable structures, including sluggish reaction rates, high reaction temperature, and long duration [3]. Hence, the innovation in preparation techniques is urgently required. Recently, plasma-based methods have emerged, which delivers a unique environment, distinguishing from conventional physical and chemical processes [4]. Such strategy is expected to s candidate in the preparation of advanced nanor

The concept 'plasma', rst proposed by recognized as the fourth state of matters [5] states (gas, liquid, and solid), plasma is compo electrons, ions of these neutral particles, and most plasma preserve electronically excited states, reactive environment for physical and chem Hence, after almost one-century development f based techniques have evolved into an indispe various applications [7]. Typically, non-the attracted considerable attention in material engi its non-heating effect and relatively high reactivity fabrication and modi cation of nanomaterials

In this review, we brie y introduce the clas technologies and the principle of typical plasma Then, we will review recent advances of plasma in material engineering based on different feedst S, and P). Typically, plasma deposition, conve tion are going to be illustrated with critical ex literature. Representative instances applied in inventoried and discussed. Notably, this review

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https://doi.org/10.1016/j.mtnano.2018.11.002

Materials Today Nano 3 (2018) 48 e 53

Contents lists available at ScienceDirect

Materials Today Nano

journal homepage: https://www.evise.com/ proÞle/#/MTNANO/login

Dislocation plasticity reigns in a traditional twinning-induced plasticity steel by *in situ* observation

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article info

Article history:
Available online 14 November 2018

Keywords:
Deformation twinning
Plasticity
Dislocation
TWIP steel
Microstructure

abstract

To twin or not to twin? The critical doubt emerges recently on the dominant role of def
twinning in contributing to strain hardening and plasticity, which has been long taken for
speci cally in twinning-induced plasticity (TWIP) steels. Here, the dynamic deformation proce
situ studied in a typical Fe-30Mn-3Si-3Al (wt.%) TWIP steel by using transmission electron mi
is found that dislocation activities, instead of twinning, reigns over the whole. As such,

the core of TWIP effect lies in extraordinary strain hardening by DT serving as a key mechanism, while the negligible dislocation forest hardening is often hinted. Hence, a good balanced result between tensile strength and especially superior ductility is obtained. In addition, the alloys of more or less TWIP effect always induce high fracture toughness and fatigue resistant properties [9e 12].

Yet, the TWIP effect runs into challenges recently in TWIP steels [13]. Tracing to the TWIP effect, DT contributes to plasticity primarily from the following three aspects [13e 17]: (1) the formation of deformation twinning accommodates plastic strain; (2) TBs serve as barriers to dislocation motion; and (3) TBs provide adequate sites for nucleating and accommodating dislocations. In contrast, it is long taken for granted that dislocation behaviors are ignorable, even often observable. This idea gets further intensi ed especially because of the absence of intragranular cross-slip of dislocations, except for planar slip, in varying TWIP steels with face-centered cubic (fcc) structures of low stacking fault energy (SFE). However, the cross-slip of extended dislocations plays a key effect on work hardening, as the dissolved planar intersected cross-slip planes may interact to form Lomer-Cottrell locks, which extraordinarily contributes to work hardening [18]. Actually, DT works through TBs [8,15]. The TBs, if imbedded in grains in advance (e.g. in nanotwinned metals), realize strain hardening by intensifying dislocation-mediated plasticity to produce dislocation generation and strong interplay with TBs. Yet, both the density and spacing of TBs in TWIP steels are usually at least one magnitude lower than that in nanotwinned metals [19,20]. Thereby, the dislocation plasticity may operate freely. Recently, a few results spring up to question whether or not DT indeed plays the dominant role in strain hardening in TWIP steels. For example, it is the forest hardening instead of DT that contributes to up to 90% of ow stress in a Fe-18Mn-0.6C-1.5Al-0.8Si (wt. %) TWIP steel [21]. In a Fe-22Mn-0.6C TWIP steel, DT happens only in part of grains because of orientation anisotropy [14,22]. The quantitative measurement

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https://doi.org/10.1016/j.mtnano.2018.11.004

Exploration of nanowire- and nanotube-based electrocatalysts for oxygen reduction and oxygen evolution reaction

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a r t i c l e i n f o

Article history:
Available online 14 November 2018

Keywords:
Nanowires
Nanotubes
Electrocatalysts
Oxygen reduction reaction
Oxygen evolution reaction
Anodic aluminum oxide templates

a b s t r a c t

Electrocatalysts for oxygen reduction and/or evolution are key components for proton-exchange membrane fuel cells (PEMFCs) and water electrolysis. However, the slow kinetics of oxygen reduction and/or evolution reactions largely hampers the efficiencies of PEMFCs and water electrolysis. Highly efficient electrocatalysts for oxygen reduction and evolution reactions must meet three requirements: (i) rapid transport of electrons, ions, and products of the reaction; (ii) sufficient catalysts/reactants contact area; and (iii) good intrinsic activity. Nanostructuration of electrocatalysts provides an effective approach to

Polymers of intrinsic microporosity for energy-intensive membrane-based gas separations

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a r t i c l e i n f o

Article history:
Available online 15 November 2018

Keywords:
Polymers of intrinsic microporosity (PIMs)
Polyimides of intrinsic microporosity (PIM-PIs)
Functional polymers
Membrane
Gas separation

a b s t r a c t

This review provides a new perspective on the role of the state-of-the-art polymers of intrinsic microporosity (PIMs) in key energy-intensive membrane-based gas separations including O_2/N_2, H_2/N_2, H_2/CH_4, CO_2/CH_4, H_2S/CH_4, C_2H_4/C_2H_6, and C_3H_6/C_3H_8 applications. A general overview on the gas separation properties of novel PIM materials developed in the past 15 years is presented with updated performance maps on the latest pure-gas 2015 O_2/N_2, H_2/N_2, and H_2/CH_4 permeability/selectivity upper bounds. Specifically, functionalized ladder PIMs and polyimides of intrinsic microporosity (PIM-PIs) are discussed targeting at high-performance, plasticization-resistant membranes for demanding acid gas (CO_2 and H_2S) removal from CH_4 in natural gas and olefin/paraffin separations. Experimental CO_2/CH_4 performance data of nearly 70 polymeric membrane materials available in the literature were gathered and plotted for the first time on the Robeson plot, from which a mixed-gas 2018 CO_2/CH_4 upper bound was proposed to provide guidance for future membrane materials development. A number of PIMs have demonstrated outstanding performances in O_2/N_2, H_2/N_2, and H_2/CH_4 separations, and several functionalized PIMs have shown great promises in CO_2/CH_4 separation under realistic mixed-gas conditions. The potential of PIMs materials and their derivatives for H_2S/CH_4, C_2H_4/C_2H_6, and C_3H_6/C_3H_8 separations are underexplored, and significant efforts are needed to develop stable and high-performance materials under mixed-gas conditions. Ultimately, fabricating PIMs materials into defect-free, inexpensive, thin-film composite or integrally-skinned asymmetric membranes is paramount to their successful large-scale commercialization.

1. Introduction

Industrial separation processes account for a significant fraction of the global energy consumption. Large energy consumption drives the demand to improve the process energy efficiency and explore altee70.56(i914e60di)-5C Tf 2242]TJncy and