

Solder-free electrical Joule welding of macroscopic graphene assemblies

Y. Liu^{a,1}, C. Liang^{b,1}, A. Wei^{c,1}, Y. Jiang^a, Q. Tian^a, Y. Wu^a, Z. Xu^{a,*}, Y. Li^{c,**}, F. Guo^a,
Q. Yang^a, W. Gao^a, H. Wang^{d,***}, C. Gao^{a,****}

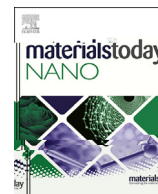
^a MOE Key Laboratory of Macromolecular Synthesis and Functionalization, Department of Polymer Science and Engineering, Key Laboratory of Adsorption and Separation Materials & Technologies of Zhejiang Province, Zhejiang University, 38 Zheda Road, Hangzhou 310027, PR China

^b School of Materials Science and Engineering, Zhejiang University, 38 Zheda Road, Hangzhou 310027, PR China

^c Department of Engineering Mechanics, School of Naval Architecture, Ocean and Civil Engineering, State Key Laboratory of Ocean Engineering, Shanghai Jiao Tong University, Collaborative Innovation Center for Advanced Ship and Deep-Sea Exploration, Shanghai 200240, PR China

^d Center for X-Mechanics, Zhejiang University, 38 Zheda Road, Hangzhou 310027, PR China

article info



Gold nanoclusters: synthetic strategies and recent advances in fluorescent sensing



M.I. Halawa^{a, b, c}, J. Lai^{a, b}, G. Xu^{a, b, d, *}

^a State Key Laboratory of Electroanalytical Chemistry, Changchun Institute of Applied Chemistry, Chinese Academy of Sciences, Changchun, Jilin 130022, PR China

^b University of Chinese Academy of Sciences, Beijing, 100049, PR China

^c Department of Pharmaceutical Analytical Chemistry, Faculty of Pharmacy, University of Mansoura, 35516, Mansoura, Egypt

^d University of Science and Technology of China, Anhui, 230026, China

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abstract

Fluorescent gold nanoclusters (AuNCs) have emerged as ideal sensor probes in different research fields 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.

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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 [1 e 4]. 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), defined as gold nanoclusters (AuNCs), have molecular-like properties owing to the strong quantum confinement 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 [7 e 9].

For AuNPs, several recent studies have extensively discussed their controlled synthesis with different sizes (5 e 50 nm), shapes (rods, nanocubes, nanoplates, nanowires, 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 Förster/fluorescence 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

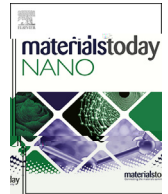
* Corresponding author.

E-mail address: guobaouxu@ciac.ac.cn (G. Xu).



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

B. Ouyang^{a,1}, Y. Zhang^{b,1}, X. Xia^c, R.S. Rawat^{a,**}, H.J. Fan^{b,*}

^a Natural Sciences and Science Education, National Institute of Education, Nanyang Technological University, 637616, Singapore

^b School of Physical and Mathematical Sciences, Nanyang Technological University, Singapore, 637371, Singapore

^c State Key Laboratory of Silicon Materials, Key Laboratory of Advanced Materials and Applications for Batteries of Zhejiang Province, School of Materials Science and Engineering, Zhejiang University, Hangzhou 310027, China

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abstract

Plasma, as an active, ionized, and electrically neutral gas, consists of electrons, ions, neutral atoms, and photons, and other excited species. Electrode materials are the keystone and backbone of modern devices [1,2]. Herein, the exploitation of new materials and modification 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 be a promising candidate in the preparation of advanced nanomaterials. The concept 'plasma', first proposed by Sir Isaac Newton, is recognized as the fourth state of matters [5]. Plasma is composed of ionized gases, liquids, and solids. In this state, plasma preserve electronically excited states, and provides a reactive environment for physical and chemical reactions. Hence, after almost one-century development, plasma-based techniques have evolved into an indispensable tool for various applications [7]. Typically, non-thermal plasma has attracted considerable attention in material engineering due to its non-heating effect and relatively high reactivity. This review focuses on the fabrication and modification of nanomaterials by plasma-based methods.

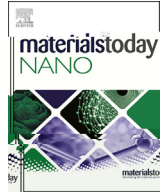
In this review, we briefly introduce the classification of plasma technologies and the principle of typical plasma-based methods. Then, we will review recent advances of plasma-based methods in material engineering based on different feedstocks (S, and P). Typically, plasma deposition, conversion, and etching are going to be illustrated with critical examples in literature. Representative instances applied in material engineering are inventoried and discussed. Notably, this review

* Corresponding author.

** Corresponding author.

E-mail addresses: rajdeep.rawat@nie.edu.sg (R.S. Rawat), fanhj@ntu.edu.sg (H.J. Fan).

¹ B.O. and Y. Z. contributed equally to this work.



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

X. Fu^a, X. Wu^{b, c}, Q. Yu^{a, *}

^a Center of Electron Microscopy and State Key Laboratory of Silicon Materials, School of Materials Science and Engineering, Zhejiang University, Hangzhou, 310027, China

^b State Key Laboratory of Nonlinear Mechanics, Institute of Mechanics, Chinese Academy of Sciences, Beijing, 100190, China

^c School of Engineering Science, University of Chinese Academy of Sciences, Beijing, 100049, China

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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 intensified especially because of the absence of intragranular cross-slip of dislocations. The critical dislocation slip is very TWIP steel dominant role of deformation twinning in accommodating plastic strain and plasticity has been long taken for granted especially in TWIP steels. However, plasticity (TWIP) extends dislocation plasticity deformation process in effect on Fe-30Mn-0.6C-1.5Al-0.8Si (wt.%) TWIP steel by in situ electron microscopy is found that dislocation plasticity instead of twinning dominates the work hardening, 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 flow 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

* Corresponding author.

E-mail address: yu_qian@zju.edu.cn (Q. Yu).



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

Z. Zeng, R. Xu, H. Zhao, H. Zhang, L. Liu, S. Xu, Y. Lei*

Fachgebiet Angewandte Nanophysik, Institut für Physik & IMN MacroNano (ZIK), Technische Universität Ilmenau, 98693 Ilmenau, Germany

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abstract

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. Nanostructuring of electrocatalysts provides an effective approach to

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

Y. Wang, X. Ma, B.S. Ghanem, F. Alghunaimi, I. Pinnau*, Y. Han**

Advanced Membranes and Porous Materials Center, Physical Sciences and Engineering Division, King Abdullah University of Science and Technology (KAUST), Al-Jaziri Building, Thuwal 23955-6900, Saudi Arabia

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abstract

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 O₂/N₂, H₂/N₂, H₂/CH₄, CO₂/CH₄, H₂S/CH₄, C₂H₄/C₂H₆, and C₃H₆/C₃H₈ 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 O₂/N₂, H₂/N₂, and H₂/CH₄ 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 (CO₂ and H₂S) removal from CH₄ in natural gas and olefin/paraffin separations. Experimental CO₂/CH₄ 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 CO₂/CH₄ upper bound was proposed to provide guidance for future membrane materials development. A number of PIMs have demonstrated outstanding performances in O₂/N₂, H₂/N₂, and H₂/CH₄ separations, and several functionalized PIMs have shown great promises in CO₂/CH₄ separation under realistic mixed-gas conditions. The potential of PIMs materials and their derivatives for H₂S/CH₄, C₂H₄/C₂H₆, and C₃H₆/C₃H₈ 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.

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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