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Hybrid Nanostructures

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Abstract

The quick growth of electrochemical energy storage which are applied in various fields like electronics for portable consumer, vehicles of hybrid electrics and also for power and energy management in an industrial scale. Electrochemical capacitors (ECs) is the decisive of electrochemical energy storage systems which can supply an eminent of prolonged life cycle and an excessive power performance, yet in the energy storage field for replacing batteries notably when high power delivery or uptake is required. In order to achieve high performance ECs, the most recent progress in the development of nanostructure electrode materials for EC technology, primarily focused on materials based on carbon that combine with hybrid nanostructures with pseudo capacitive metal oxides or conducting polymers. The rational design and synthesis of hybrid nanostructure electrode materials of ECs were the remaining challenges and future research directions for next generation. It is one of the most promising and rapidly emerging research areas in nanotechnology field. Design, fabrication, and applications of hybrid nanostructures are reviewed, respectively. There has been significant interest in the development of multicomponent nanocrystals formed by the assembly of two or more different materials with control over size, shape, composition, and spatial orientation. With the unique properties of various metals, the semiconductor nanorods has been found of selective growth on the tips of metals, behind that combination of optical and electrical properties which can act by wires.

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Introduction

Hybrid materials, based on conducting polymers (CP) and inorganic materials, attracted a lot of interest from past two decades[1,2]. Metal nanoparticles, carbon nanotubes and inorganic semiconducting materials as composites have been synthesized along with the conducting polymers in order to exploit their synergistic properties[3-6]. The high chance of construction for high quality of CP/SC interfaces, which can provide by hybrid assemblies of CPs and inorganic SCs while photo catalysis, solar cells, sensors and super capacitors in the account of enable as a wide range of promising applications[7,8]. Simple mixing by mechanical and chemical polymerization of in-situ, to electrochemical methods have been utilize by a spacious align of synthetic proposition[9]. To acquire competent handle accomplished the composition and morphology intricate synthetic protocols are genuinely desired[9]. Silicon carbide (SiC) possess an excellent physical and chemical properties[10], such as good mechanical and chemical stability, biocompatibility, photo luminescent behavior, high thermal conductivity and last but not the least it is available in an affordable price[11-15]. In this way, substrate for high power and temperature electronics[16], spintronic[17], optoelectronic appliance[17], and processing for quantum information[18] which has been utilize as a broad spectrum for applications of SiC. For protrusive functional region, SiC nanoparticles have been employed in photocatalytic remediation of the environment, in case as a model compound of acetaldehyde degradation[19].

With the help of photocatalytic process this material get reduce of water or CO_2 by the grant of conduction band edge position of SiC. SiC and other component are tender in an alluring alley to gear the notable properties concurrently by the SiC-based hybrid materials. In this vein, SiC has been already combined with different CPs, such as polypyrrole (PPy)[20,21,22], polyaniline (PANI)[5,23] and poly (3-thiophene-acetic-acid)[24]. PANI is particularly attractive, because of its versatile redox behavior, excellent chemical and electrochemical stability, large

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capacitance, and electro chromic properties[25-27]. The commonality in these reports is that every synthesis was carried out by in situ oxidative chemical polymerization, differing only in the oxidizing agent employed (e.g., $FeCl_3$). In such procedures the oxidant reacts with the monomer to form a radical cation, which initiates the polymerization by reacting with another monomer or radical cation[28]. For new doable synthesis of components the following requirements are definite handle on its configuration, morphology which come across hybrid materials with intact properties adapt nearly definite appropriateness is to be determined. Photo catalysis happened due to solar energy conversion and environmental remediation in the interface of SC or electrolyte[29,30]. This method is used to enhance the price of biomass and it also has an advantage of in-situ CP formation by the two SCs intimate contact on the inorganic SC nanostructure surface[31]. The pioneering studies were performed on colloidal, or Nano particulate, titanium dioxide (TiO_2) slurries[32,33] using pyrrole as the monomer.

Materials and Methods

An NSL technique was employed[34] to create the surface confined hybrid Au-Ag triangular nanostructures supported on a glass substrate. NSL process begins from the self-assembly of size monodisperse nanospheres into a two-dimensional (2D) colloidal crystal. Evaporation of nanosphere solvent from the solution, the substrate crystallizes in a hexagonal close manner by the capillary forces which bring the nanospheres together. The components of nanosphere mask assembly are deposited of silver and gold metals on the nanosphere substrate. The metal deposition further removed by sonication using ethanol as a solvent that results a triangular nanostructure. The Nanostructures have out of plane heights of silver nanostructures ~ 50 nm and the upper gold nanostructures ~ 5 nm in thickness, and ~100 nm in plane widths of each nanostructure and ~ 400 nm period of the nanostructure array.

Uses

The success of nanostructure formation is mainly depends on the constancy of transcription that is when observed at the dimension of sub-10 nm is expected to be a lower level. Why because at this length the packing surface charge distribution of amphiphilic molecules is homogeneous. This results of the random nucleation of inorganic component across the organic surface and continue to grow until they come closer to each other. This limitation can be overcome with the use of bulky amphiphiles that are sterically constrained with rigid molecular structure so as to produce such a packing arrangements that structurally give a continuous binding across the template surface.

Unitary nano-objects.

As a strive for formulation of multifunctional dispersed nano object, the combination of two or more particle having same nano scale object is gaining attention. Generally this is attained by forming a satellite like structure that is coagulation of spherical particles with different size and composition where the larger component acts as a central platform and holds the smaller particle to produce unitary nano object.

Transformative self-assembly

The equilibrium based strategy of self-assembly has the limitation of adaptability that can be overcome by incorporation of multiple length scales and high order complexity that results a hybrid structure. Unlikely the alternative pathways for construction of nano objects that undergoes continuous change throughout the length scale resulting a complex order shape. This is classified as transformative self-assembly that is discriminates because of their non-linearity and appearing behavior from the mechanisms of higher order self-assembly which operated under equilibrium state. Three systematic approaches involving self-organizing media, reaction–diffusion systems or coupled-mesophase transformations.

Nucleation

Two different formation mechanisms of hybrid structure have been proposed: “oriented crystal growth” and “self-assembly”. In the latter, it was proposed that the adjacent hybrid structure tend to self-organize at a planar interface to show a common crystallographic orientation. In the “oriented crystal growth” it originates from the nano molecules selectively adsorbs and therefore suppress the growth of hybrid structure along this particular direction. However, we noted that both hypotheses share a common understanding that the formation of the hybrid structure starts from heterogeneous nucleation process. In our case, the formation of hybrid nano structure be explained by heterogeneous nucleation and subsequent oriented crystal growth. The nanowires acting as backbones provide sites for the preferential deposition of nano molecules, and the growth process of the shell structure is proposed.

Summary

The design, fabrication and application of the proposed hybrid Au-Ag triangular nanostructure were reviewed. The refractive index sensitivity is calculated according to Finite Difference Time Domain method of the hybrid silver-gold triangular nano structure. The sensitivity of the experiment was detected by using protein A. The resulted nano structure used to detect Staphylococcal Enterotoxin B solution. The design and experimental results of nanostructures can be used in the nano biosensor research field. It also has much inherent utilization in chemical material research. The synthesis of the hybrid Au-Ag nanostructures of different materials with various shapes was reported. The electrical properties of individual CdSe nanorods with and without Au tips are shown.

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