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Welcome

Encouraged by the success of the 1st and 2nd IEEE International NanoElectronics Conference (INEC) held in Singapore in 2006 and Shanghai in 2008, the 3rd INEC is held in City University of Hong Kong from January 3 to 8, 2010. Extensive research on nanomaterials has unveiled many interesting and promising materials properties for novel applications in electronics, photonics, and biology. In order to benefit mankind for such discoveries, it is necessary to cross the chasm between nanomaterials and nanodevices and their applications. This effort requires a multi-disciplinary approach combining research in materials design, processing, modeling, characterization, and metrology. Commercialization of nanotechnology is also important to fuel future research. The aim of this conference is to identify the paths between fundamental research and potential electronic, photonic, and biological applications. INEC2010 provides a forum for international academics, researchers, practitioners, and students working in the areas of nanofabrication, nanoelectronics, nanophotonics, and nanobiology to discuss new developments, concepts, and practices, and to identify future research needs so that nano-research can be brought closer to its immense potential.

INEC2010 features 4 plenary and 22 invited talks by international scientists in nanofabrication, nanoelectronics, nanophotonics, and nanobiology. A special symposium on nanoscience and nanotechnology in China is held during the conference to foster further scientific exchange between scientists from Greater China and other parts of world. We are very fortunate to have 16 academicians of the Chinese Academy of Sciences, Chinese Academy of Engineering, and Academia Sinica to give presentations in this special symposium.

INEC2010 is the largest one of this growing event. We are very pleased to have received 911 contributed abstracts including 503 oral and 408 poster presentations from 35 countries and special administrative regions.

Hong Kong being a vibrant and modern city where east and west meet is very exciting. The city offers superb dining and attractions and boasts one of the most impressive skylines in the world. In addition to the technical events, I urge you to experience and enjoy our unique city.

Paul K Chu
General Chair
Effect of Annealing on the Properties of P-Type Nano Zn0.92Mn0.08O:N Films
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Fabrication and Photoelectrochemical Properties of Nanoporous WO3 Film
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Direct growth of Nb2O5 Nanobelts on Nb Foil
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Preparation and properties of p-type semi-transparent conductive nickel oxide films
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Investigations on Growth and Hydrogen Gas Sensing Property of ZnO Nanowires Prepared by Hydrothermal Growth
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Growth and Optical Properties of ZnO Nanorods Prepared through Hydrothermal Growth Followed by Chemical Vapor Deposition
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Fabrication and Photoelectrochemical Properties of Nanoporous WO$_3$ Film

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Abstract: Nanoporous tungsten oxide (WO$_3$) with pore size of about 80 nm has been fabricated by anodization in a 1 M Na$_2$SO$_4$ solution with 0.5 wt.% NaF (pH 4.0) at the anodization voltage of 40 V. The photoelectrochemical properties and photocatalytic activity of the nanoporous WO$_3$ film are investigated under visible light. The results show that the WO$_3$ nanoporous structure has better photoactivity than the plane structure due to light scattering. Thus, nanoporous WO$_3$ films have drawn increasing interest because of their wide applications in photoelectrochemical splitting of water, degradation of toxic substances in water and air, and conversion of photon energy into electrical charges in solar cells [1-4]. TiO$_2$ is currently the best known and most widely used highly efficient photocatalytic material. However, only a small UV fraction of solar light (3-5%) can be utilized [5-6] due to the wide bandgap of anatase (3.0 eV) and rutile (3.2 eV) TiO$_2$. Therefore, an imperative and challenging issue is to develop new and efficient visible-light-sensitive photocatalysts. Tungsten oxide (WO$_3$) possessing a lower bandgap of 2.4-2.8 eV is an important semiconductor photocatalyst. The small optical bandgap enables the photon adsorption to shift to visible light to result in better utilization of solar radiation. Since the photocatalytic reaction is a surface reaction process and adsorption of the probe molecule on the surface of a photocatalyst is a critical step in the photocatalytic process, materials with a large surface area can enhance the photocatalytic activity and light-electron conversion efficiency. Nanoporous WO$_3$ films have high light sensitivities due to a large surface area which is beneficial to adsorption of probing molecular species. In addition, the nanoporous structure can absorb incident photons more effectively in comparison with a flat surface due to light scattering. Thus, nanoporous WO$_3$ films have drawn increasing interest in the photocatalysis due to the high surface to volume ratio and enhanced adsorption of incident photons. In this work, nanoporous WO$_3$ films are fabricated on W foil by anodization in fluoride-containing electrolyte. The structure and composition of nanoporous WO$_3$ film are characterized by XRD, SEM, and XPS. The photocatalytic activity and photoelectrochemical properties are also investigated.

METHODS AND RESULTS

Nanoporous WO$_3$ films were fabricated by anodizing pure a W foil (99.6% purity, 0.5 mm thick) as described previously [7]. In brief, W foils were mechanically polished by SiC sandpapers and then anodized at an alkali electrolyte at a low voltage to remove the oxide layer. The electrochemical cell consisted of a conventional two-electrode configuration with the tungsten sheet serving as the working electrode and a graphite foil as the counter electrode (1 cm separation). Anodization was carried out at different voltage of 20 V, 40 V, and 60 V for 2 hours in an aqueous electrolyte of 1M Na$_2$SO$_4$ and 0.5 wt.% NaF (pH 4.0, 298 K). After anodization, the samples were rinsed with diluted HF and deionized water and then dried in air. The obtained nanoporous WO$_3$, initially amorphous, were crystallized by annealing at 723 K in an oxygen atmosphere for 3 h at a heating rate of 10 K/min. For comparison, non-porous planar WO$_3$ films were also prepared in 1M Na$_2$SO$_4$ without fluoride under the same anodization conditions.

Fig. 1 shows the top SEM images of the samples anodized in 1M Na$_2$SO$_4$ (a) and 1M Na$_2$SO$_4$-0.5wt.% NaF electrolyte (b) at anodic voltage of 40 V for 2 h. It is obvious that the surface morphologies of the two samples are different. Regular self-assembled nanoporous structures are formed in the 1M Na$_2$SO$_4$-0.5wt.% NaF electrolyte but a planar film is obtained without fluoride under the same anodization conditions. The pore diameter of nanoporous film is approximately 80 nm and wall thickness of pore is about 10-15 nm. At lower and higher voltages, nanoparticle films instead of regular nonporous structures are observed. These results suggest that the voltage during anodization and fluorine concentration in the electrolyte are very important to the formation of regular nanoporous nanostructures on the W foil, as reported in the literature [8-9]. Fig. 2 depicts the XRD patterns of the anodized and post-annealed nanoporous structures. It appears that the anodized nanoporous structure is amorphous. After annealing in oxygen at 723 K for 3 h, the XRD patterns can be indexed to a monoclinic phase of WO$_3$ (JPCD card, No. 43-1305), which suggests that monoclinic WO$_3$ nanoporous films are formed on the W foil. XPS results indicate that the thickness of nanoporous film is about 260 nm.

The photoelectrochemical properties of the annealed porous and flat structure WO$_3$ are investigated in a 0.5 M Na$_2$SO$_4$ solution under Xe lamp irradiation with a power of 100 mW/cm$^2$. Photocurrents are monitored by an electrochemical analyzer (CH Instruments 630B, Shanghai, China) in a standard three-electrode configuration with a platinum foil as the counter...
electrode, a saturated Ag/AgCl as the reference electrode, and the self-assembled nanoporous WO₃ as the photoanode. The potential is swept linearly at a scanning rate of 10 mV • S⁻¹. Fig. 3 shows the curves of photocurrent vs. bias potential of the self-organized nanoporous WO₃ and plane WO₃ film. The dark current without irradiation is almost zero. The photocurrent densities of the self-assembled nanoporous WO₃ dramatically increase with bias potential when the bias potential exceeds 0.2 V, but the photocurrent of the WO₃ film is smaller. The photocurrent of the self-assembled nanoporous WO₃ reaches 0.48 mA/cm² at 1.5 V bias potential and is about three times that of the WO₃ film.

The photocatalytic activity of nanoporous WO₃ is also investigated by the degradation of the MO solution under Xe-lamp irradiation with a filter to remove ultraviolet radiation. Fig. 4 shows the relationship between the concentration of MO in aqueous solution and radiation time. The results suggest that nanoporous WO₃ has better photocatalytic performance under visible light.

In summary, nanoporous WO₃ film have been fabricated via a simple anodization method in fluoride based electrolyte. The as-prepared nanoporous WO₃ film is a good photocatalyst that can decompose contamination in water under visible light and has better photoelectrochemical and photocatalytic performance than a planar WO₃ film.

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Fig. 1. Top SEM images of the samples anodized in 1M Na₂SO₄ (a) and 1M Na₂SO₄-0.5wt.% NaF electrolyte (b) at anodic voltage of 40 V for 2 hours.

Fig. 2. XRD patterns of post-annealed (a) and as-anodized (b) nanoporous WO₃ film.

REFERENCES