Fabrication of nanoporous silicon pillar array/CdS thin film heterojunction photoanode, for photoelectrochemical water splitting

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Abstract

Hydrogen is one of the best eco-friendly and high energy capacity alternatives to harmful fossil fuels. Today, we need a method that, contrary to usual methods, is also pure and clean in the step of hydrogen production! Photoelectrochemical water splitting is a one-step and renewable method of producing hydrogen without producing greenhouse gases; In fact, this method means the decomposition of water by sunlight. For photoelectrochemical water splitting, we use photoelectrochemical cell and photoelectrodes.

Silicon nanoporous pillar array is a relatively new composite system of silicon. To prepare it, as a substrate and morphology controller, we use the hydrothermal etching single crystal Si wafer in a solution of iron(III) nitrate nonahydrate and HF, by an autoclave. Finally, the array of these pillars is formed almost uniformly over the entire surface of the substrate and we will see the color change of the substrate surface from silver-gray to dark black.

In theory, an n-type CdS, with an about 2.4eV bandgap, and a suitable conduction edge position, can be an efficient photoanode. To deposit CdS thin films on this substrate, we will use the Chemical Bath Deposition method, and a magnetic stirrer and an aqueous solution of Cadmium Acetate as the cadmium source, the Thiourea as the sulfur source, and Ammonium Acetate buffer as a complexing agent. So, we will expose the substrate to the solution so that either Cd ions and S ions are absorbed one by one on the substrate surface and converted to CdS on there, or colloidal CdS particles are formed in the solution and then adsorbed to the substrate. However, a shiny yellow CdS layer will form on the substrate. So, After the film deposition, we will remove the sample from the solution, rinsed with ammonia aqueous solution, and cleaned with ultrasonic deionized water.

Image

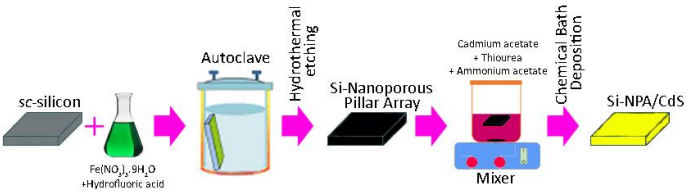


Figure 1. Schematic summary of the method of fabrication of Si-NPA/CdS photoanode

Recent Publications

1. Reddy, M., and N. V. Prasad. "Properties of CdS Chemically Deposited thin films on the Effect of Ammonia Concentration." IOSR-JAP 4.4 (2013): 01-07.
2. Jiang, Chaoran, et al. "Photoelectrochemical devices for solar water splitting–materials and challenges." Chemical Society Reviews 46.15 (2017): 4645-4660.
3. Bai, Shouli, et al. "Photoanode of LDH catalyst decorated semiconductor heterojunction of BiVO4/CdS to enhance PEC water splitting efficiency." International Journal of Hydrogen Energy 44.45 (2019): 24642-24652.
4. Liu, Jing, et al. "Preparation of CdS nanorods on silicon nanopillars surface by hydrothermal Method." Materials Research Bulletin 120 (2019): 110591.
5. Cheng, Yan, et al. "Photovoltaic broadband photodetectors based on CH3NH3PbI3 thin films grown on silicon nanoporous pillar array." Solar Energy Materials and Solar Cells 204 (2020): 110230.



Biography

Mohsen Bayat is a master's student in Analytical Chemistry at the Khajeh Nasir Toosi University of Technology (KNTU: The Oldest Technical University in Iran). His main research interest and also master's thesis is in the fields of Photoelectrochemistry, Photocatalyst, Semiconductors, and Nanotechnology. Therefore, his research focus is on integrating theory and experiment with the design and fabrication of photoelectrodes for use in Photocatalytic and (Photo)electrochemical Water Splitting.

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Notes/Comments: