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Oxidative Etching of Imprinted Nanopatterns by Combination of Vacuum Annealing and Plasma Treatment

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Combination of oxidative vacuum annealing and oxygen plasma treatment can serve as a simple and efficient method of line-width modification of imprinted nanopatterns. Since the vacuum annealing and oxygen plasma could lead mass loss of polymeric materials, either one of the process can yield a narrowed patterns. However, the vacuum annealing process usually demands quite high temperatures (≥ 300°C) and extended annealing time to get appreciable line-width reduction. Although the plasma treatment may be considered as an effective low temperature rapid process for the line-width reduction, it is also suffering for the lowered controllability on application to very fine patterns. We have found that the vacuum annealing temperature can be lowered by introducing the oxygen in the vacuum process and that the combination of oxygen plasma treatment with the vacuum annealing could yield the best result in the line-with reduction of the imprinted polymeric nanopatterns. Well-defined line width reduction by more than 50% was successfully demonstrated at relatively low temperatures. Furthermore, it was verified that this process was applicable to the nanopatterns of different shapes and materials.

Keywords: Nano imprint lithography, Vacuum annealing, Plasma treatment

N-004

Hydrogen Evolution from Biological Protein Photosystem I and Semiconductor BiVO4 Driven by Z-Schematic Electron Transfer

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Natural photosynthesis utilizes two proteins, photosystem I and photosystem II, to efficiently oxidize water and reduce NADP+ to NADPH. Artificial photosynthesis which mimics this process achieve water splitting through a two-step Z-schematic water splitting process using man-made synthetic materials for hydrogen fuel production. In this study, Z-scheme system was achieved from the hybrid materials which composed of hydrogen production part as photosystem I protein and water oxidizing part as semiconductor BiVO4. Utilizing photosystem I as the hydrogen evolving part overcomes the problems of existing hydrogen evolving p-type semiconductors such as water instability, expensive cost, few available choices and poor red light (>600 nm) absorbance. Some problems of photosystem II, oxygen evolving part of natural photosynthesis, such as demanding isolation process and D1 photo-damage can also be solved by utilizing BiVO4 as the oxygen evolving part. Preceding research has not suggested any protein-inorganic-hybrid Z-scheme composed of both materials from natural photosynthesis and artificial photosynthesis. In this study, to realize this Z-schematic electron transfer, diffusion step of electron carrier, which usually degrades natural photosynthesis efficiency, was eliminated. Instead, BiVO4 and Pt-photosystem I were all linked together by the mediator gold. Synthesized all-solid-state hybrid materials show enhanced hydrogen evolution ability directly from water when illuminated with visible light.

Keywords: Photosystem, Hydrogen production, Bismuth vanadate, Z-scheme, Water splitting, Bio hybrid materials, Solar energy