Enhanced Photocatalytic Hydrogen Evolution by Mesoporous Graphitic Carbon Nitride/Black Phosphorus/Gold Nanohybrid

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At present, the global energy crisis is one of the key issue that attracts the attention of the whole world [1]. Herewith, exploring a clean and sustainable energy is urgently needed. Hydrogen (H_2) is considered to be the most promising energy carrier due to the its numerous advantages, such as high-caloric-value, pollution-free and sustainability properties. Photocatalytic hydrogen production from water decomposition has been regarded as one of the most ideal technology for green energy production [2]. On the other hand, the design of novel visible light active advanced materials is essential for the development of photocatalytic hydrogen production. Essentially, attention of researchers is focused on mainly the traditional catalysts such as TiO_2. However, these photocatalysts can absorb only UV part of light, which is restrict their photocatalytic application [3]. In this regard, we systematically investigated a novel ternary mesoporous graphitic carbon nitride/black phosphorus-gold nanoparticles (mpg-CN/BP-Au) for photocatalytic hydrogen reaction. mpg-CN, BP and Au nanoparticles were prepared individually and then Au NPs were decorated on binary heterojunction of mpg-CN/BP via simple liquid-phase sonication process. The photocatalytic HER of synthesized mpg-CN/BP-Au nanocomposite was compared with binary mpg-CN/Au, mpg-CN/BP and also pristine mpg-CN under the visible light irradiation ($\lambda > 420$ nm). Under 8 h of visible light illumination, HER rate of mpg-CN/BP-Au, mpg-CN/BP, mpg-CN/Au, mpg-CN nanostructures were reached up to 1024 µmol g^{-1}, 565 µmol g^{-1}, 529 µmol g^{-1} and 559 µmol g^{-1}, respectively, in the presence of TEOA electron donor.

The enhanced photocatalytic HER activity of mpg-CN/ BP-Au nanocomposites may be attributed the heterojunction formation type II between BP and mpg-CN materials which showed enhanced visible light absorption and reduced recombination of photogenerated charge carriers. In addition, Au nanoparticles increase the rate of adsorption of mpg-CN/BP because of the excellent electrical properties and spillover effect.

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