Large-scale synthesis of boron nitride based hybrid nanosheets for water cleaning

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Abstract

Boron nitride nanosheets (BNNSs), so-called “white graphene”, have recently received increasing attention, both theoretically and experimentally.[1-3] Although many synthetic procedures have been proposed for the synthesis of BNNSs, finding a simple, catalyst-free, and large-scale production route is still a challenge. Here, there are two methods with facile, low cost, and high yield process are developed, in which dynamic templating approach and mechanical solid-state exfoliation allows scalable production of porous and crumple BNNSs with a high surface area.[1,4] Especially, a series of remarkable properties, including extreme large surface areas, high thermal conductivity high resistance to oxidation and good chemical inert-ness, make BNNSs a promising hybrid materials with potential applications in oil removal and photocatalytic.

Effective oil/water separation from water are of significant, worldwide importance for water source protection. Multifunctional sorbent materials with excellent sorption capacity, stability and recyclability properties need to be developed. We report flexible and multifunctional polymer/porous BNNSs hybrid nanosheets membranes with very high water permeability that exhibit high effectivity and stability in the purification of simulated wastewater tainted with either oils (as an oil/water emulsion).[5] Remarkably, the flexible nature of these porous membranes enabled simplicity of operation for water remediation processing and ease of post-processing collection. The porous composite membrane also displays a remarkably high permeability of $8*10^4$ L·μm/m^2·h·bar, roughly three orders of magnitude higher than pure polymer. The saturated porous composite membrane can be readily cleaned for reuse by simple washing while maintaining high performance characteristics, as shown in Figure 1. The results demonstrate the potential efficacy and practicality of this porous hybrid membranes for oil/water separation from water.

We also report a novel porous BN/TiO_2 hybrid nanosheets with new actively chemical bonding specie B−O−Ti, which benefits from the richly exposed boron dangling bonds at the open edges of pores of porous BN nanosheets as a photocatalyst support material. Such actively chemical bonding specie makes the hybrid nanosheets not only responsive in a wide wavelength range including UV and visible light spectrum but also enhances photocatalytic effect (up to 99%) for both degradation of organic molecules and reduction of inorganic heavy metals ions, as shown in Figure 2. In addition, the porous BN/TiO_2 hybrid nanosheets exhibit a good cycling stability up to 6 cycles maintaining high photocatalytic activity. These results provide new insights for design of advanced hybrid photocatalysts with actively chemical bonding specie, which can be applied in environmental protection, water split-ting, and photo-electrochemical conversion.

References

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Figures

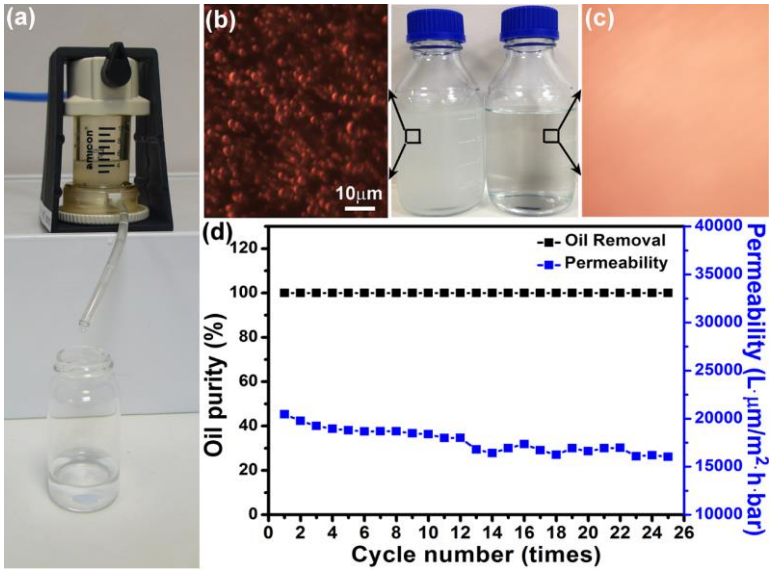

Figure 1. (a) The separation apparatus and processing of an oil/water emulsion; only the water permeates the PVDF/BNNSs composite membrane. (b) Optical microscopic images of the feed oil/water emulsion (creamy white) and (c) filtrate (clear). (d) Plots of PVDF/BNNSs composite membrane permeability and level of oil contamination (oil removal) of the filtrate.

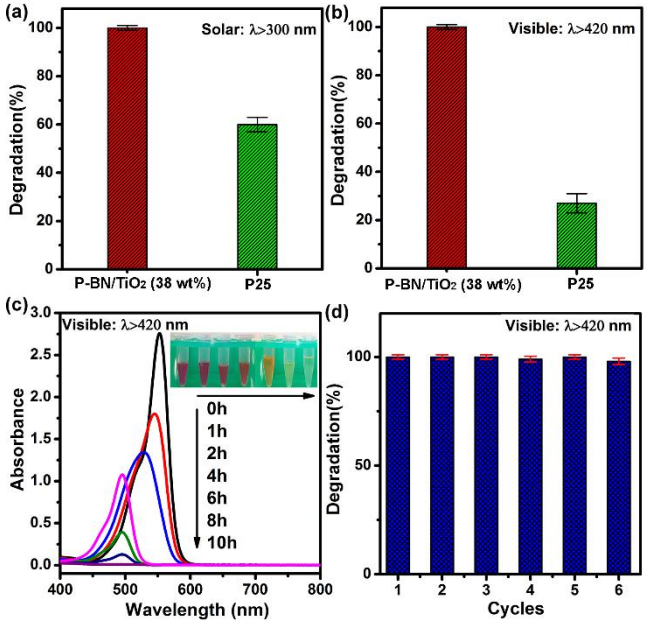

Figure 2. (a) Photodegradation of rhodamine B (RhB) in dark and under simulated sunlight irradiation by P25, synthesized TiO_2 nanoparticles, non-porous and porous BN/TiO_2 hybrid nanosheets with different loading amount of TiO_2 nanoparticles. (b) UV–Vis absorbance spectrum of the RhB solution in the porous BN/TiO_2 hybrid nanosheets (38 wt%) under simulated sunlight irradiation. The inset shows the photographs of the RhB solutions after different irradiation time. (c) The degradation performance of RhB of porous BN/TiO_2 hybrid nanosheets (38 wt%) and P25 under simulated solar light with 6 successive cycles.