Enhanced photocatalytic Performance of TiO_2 nano-rods and nano-crystals using graphene as a cocatalyst

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Abstract

Different graphene/TiO_2 nanocomposites including graphene/TiO_2 nanorods and graphene/TiO_2 nanocrystals were prepared by using simple solution methods and further annealing process. The effective anchoring of TiO_2 nanorods or nanocrystals on the whole graphene sheets were demonstrated by transmission electron microscopy, UV-Vis and X-Ray Diffraction. It is demonstrated that not only compared with the commercial TiO_2 (P25), both pure TiO_2 nanorods and TiO_2 nanocrystals exhibit higher photocatalytic activities on the water splitting reaction under UV light irradiation, but also the introduction of small amount graphene in each kind of TiO_2 results in greatly improved photocatalytic activities for their graphene/TiO_2 nanocomposites. The large enhancement of photocatalytic properties can be attributed to the shortened electron transferring distance from size-reduced TiO_2 and the effective charges-separation assisted by graphene.

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Figures

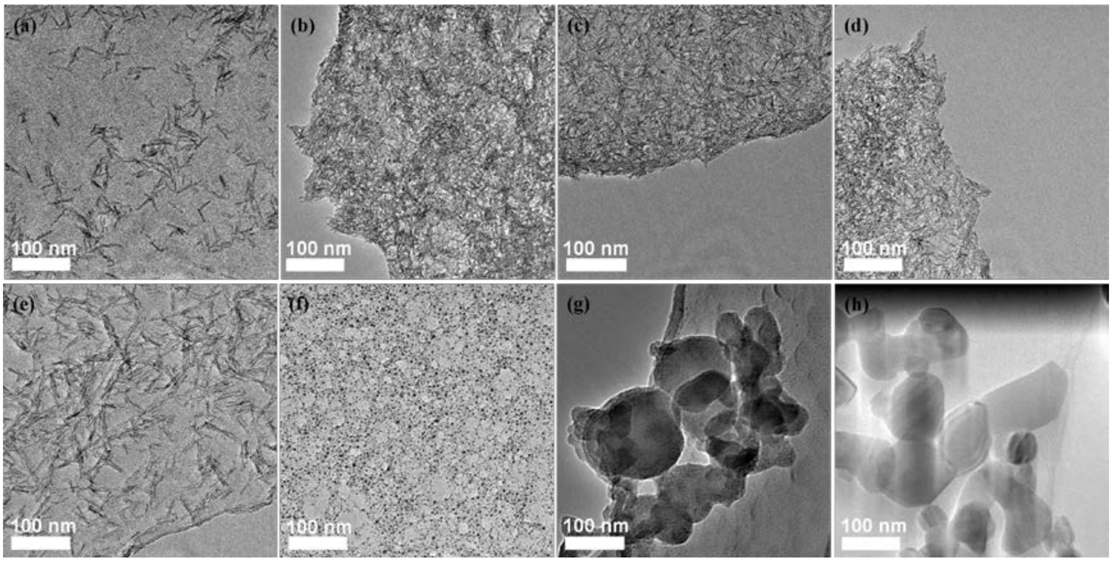

Figure 1 Typical TEM images of (a) pure TiO_2 nanorods and (b-e) graphene/TiO_2 nanorod nanocomposites with 1 wt%, 5 wt%, 10 wt% and 20 wt% of graphene, respectively. (f) graphene/TiO_2 nanocrystals nanocomposites with 10 wt% graphene. (g) Pure TiO_2 nanocrystals. (h) P25 (commercial TiO_2). The introduction of graphene during the preparation process of TiO_2 nanorods or nanocrystals has played an important role in preventing the aggregation of TiO_2 nanorods or nanocrystals, leading to much smaller diameters of TiO_2 nanorods or nanocrystals.

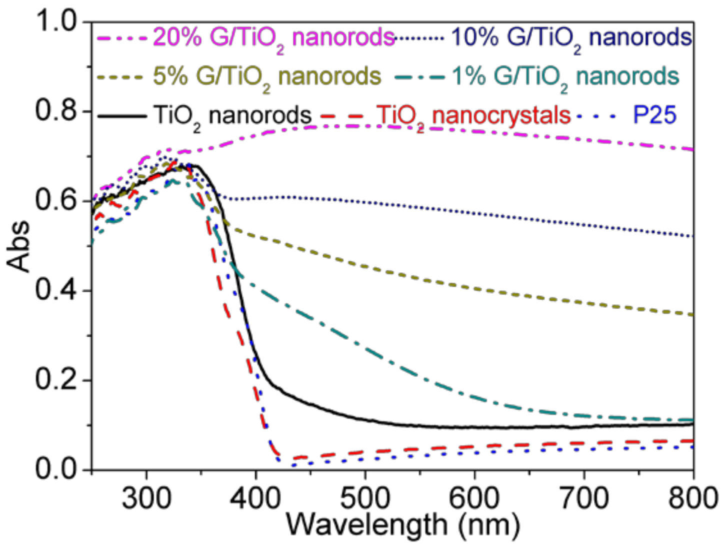

Figure 2 UV-visible-NIR absorption spectra of graphene/TiO_2 nanocrystals and nanorods. P25 was also tested for comparison. All the samples exhibit a characteristic peak for the TiO_2.

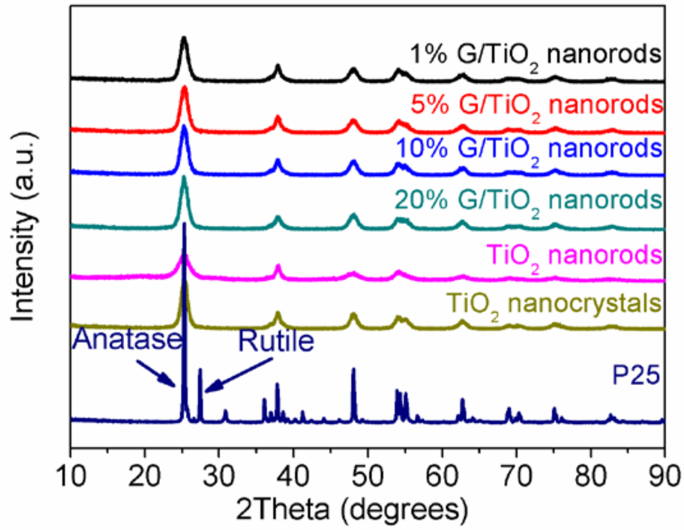

Figure 3 XRD analysis of graphene/TiO_2 nanocrystals and nanorods. The prepared TiO_2 nanorods and nanocrystals in the graphene/TiO_2 exhibit anatase TiO_2 phase, while P25 shows the diffraction peaks attributed to both anatase and rutile TiO_2 phases.

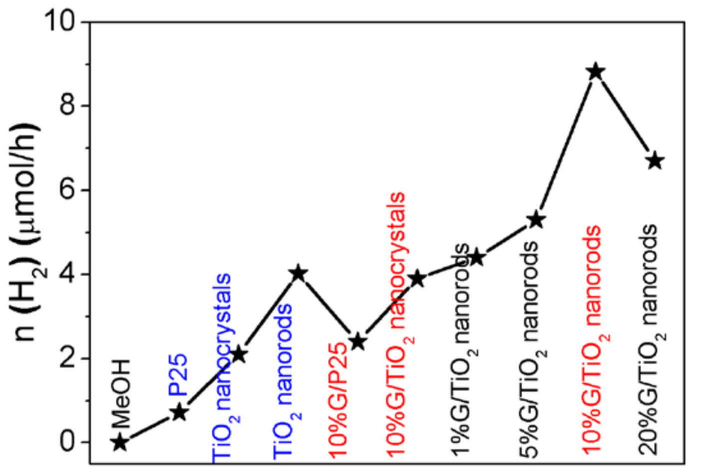

Figure 4 Photocatalytic performance which demonstrated the amount of hydrogen evolution under 1 h irradiation of UV–vis light for pure P25, TiO_2 nanorods, TiO_2 nanocrystals and different graphene/TiO_2 nanocomposites. Not only both pure TiO_2 nanorods and TiO_2 nanocrystals exhibit higher photocatalytic activities than pure P25, but also the introduction of small amount graphene in TiO_2 nanorods or TiO_2 nanocrystals results in greatly improved photocatalytic activities for their graphene/TiO_2 nanocomposites.