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Bandgap engineering and enhanced interface coupling of graphene-$BiFeO_3$ nanocomposites as efficient photocatalyst under visible light

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Experimental

The precursors of $BiFeO_3$ were synthesized by a sol-gel method. Briefly, $Bi(NO_3)_3 9H_2O$, $Fe(NO_3)_3 9H_2O$ and citric acid were dissolved in DMF to a molar ratio of 1:1:4. The concentrations of Bi^{3+} and Fe^{3+} in the final solution are all 0.25 mol/L. The sol was aged for 48 hrs at room temperature. Graphene oxide nanosheets prepared by a modified Hummer's method were then dispersed into the sol by ultrasonication. After the homogeneous dispersion of graphene oxide in the sol, the resultant mixture was thoroughly dried at 70^{o}C for 48 hrs, followed by the calcination of the dried gel at 200^{o}C for 2 hrs for the pyrolysis of organic solvents. Crystallization of the bismuth ferrite nanoparticles into perovskite $BiFeO_3$ phase was completed after the final heat treatment at 400^{o}C for 2 hrs.

In the $BiFeO_3$-graphene composite (denoted as BG-sg), $BiFeO_3$ particles of ~ 200 nm in diameter are anchored on the surface of the graphene nanosheets, as shown in the inset of Fig. 1s. Also in Fig. 1s, the XRD

patterns confirmed that the $BiFeO_3$ particles are perovskite phase of R3C structure. The presence of graphene nanosheets could be well observed in the SEM image, which is further evidenced by the Raman spectra of BG-sg (Fig. 2s) as indicated by the D and G bands from graphene. The content of graphene in the $BiFeO_3$-graphene composite is ~ 1.5 wt%, as determined from the TGA diagram shown in the inset of Fig. 2s.

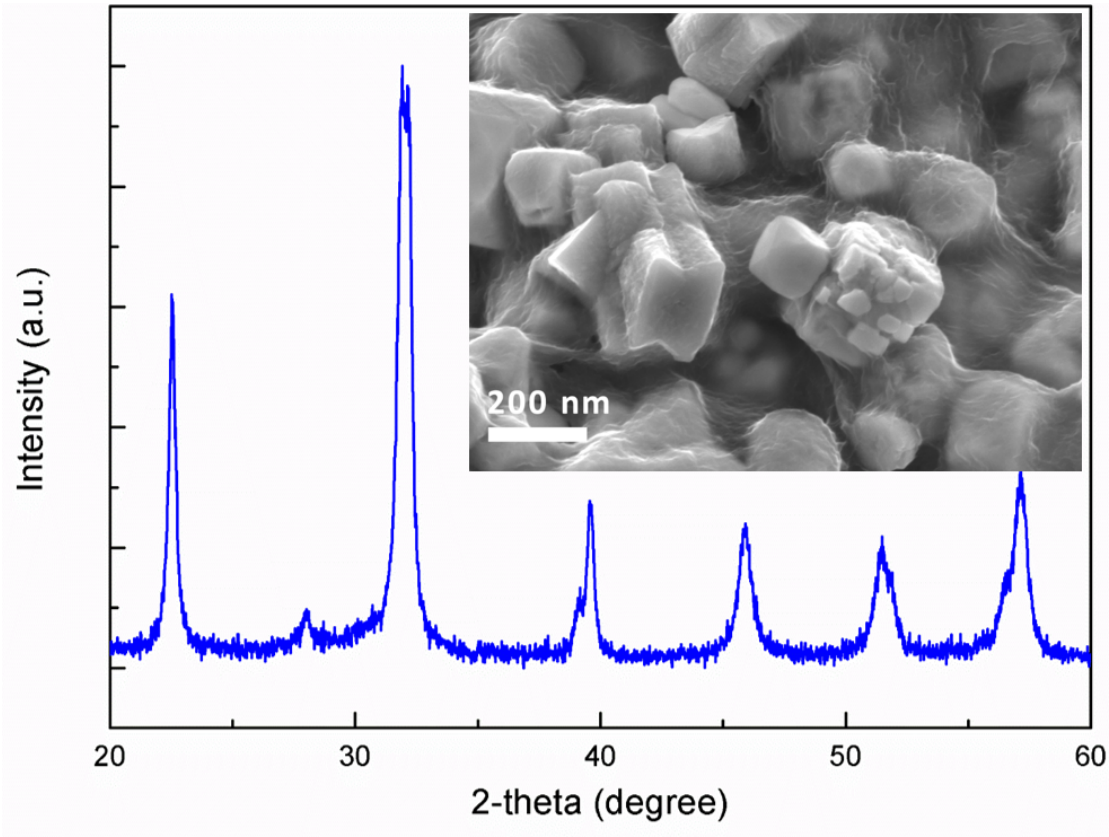

Figure. 1S XRD pattern of the $BiFeO_3$-graphene composite synthesized by the sol-gel method (BG-sg). Superimposed in the inset is the SEM image of BG-sg.

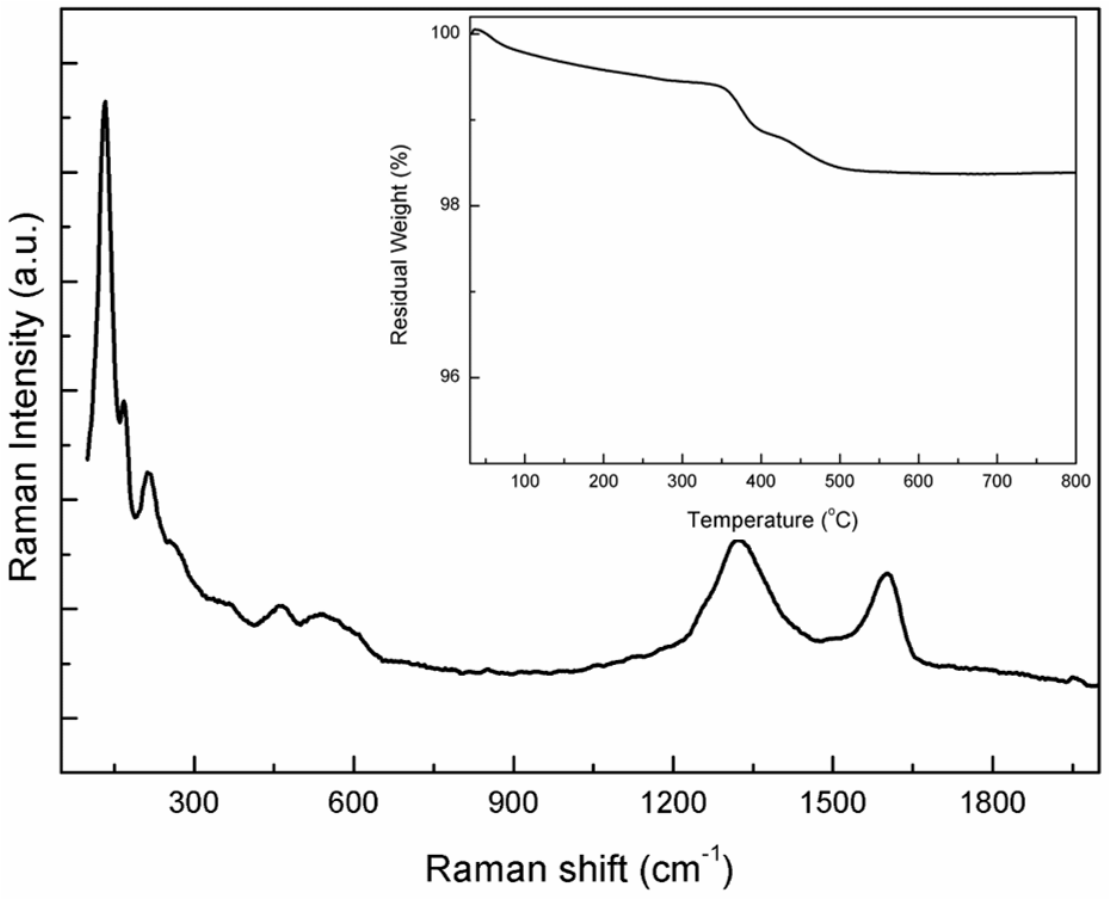

Figure 2S Raman spectra of BG-sg. The two distinctive bands at 1200 -1700 cm^{-1} are assigned to the D and G bands of graphene, while the bands at lower wavenumbers are the Raman peaks of perovskite $BiFeO_3$ phase. Superimposed in the inset is the Thermal Gravimetric Analysis (TGA) diagrams forBG-sg.

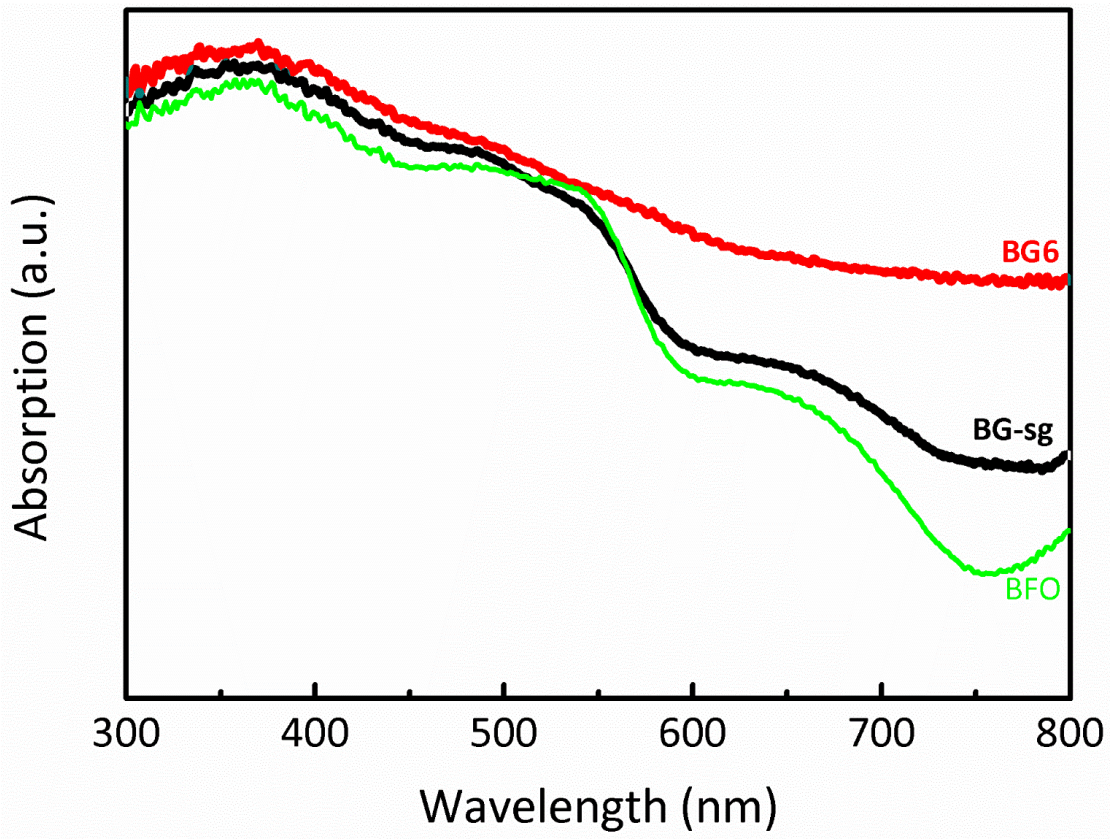

Figure 3S UV-vis absorption spectra of BG-sg, BG6 and BFO nanoparticles.

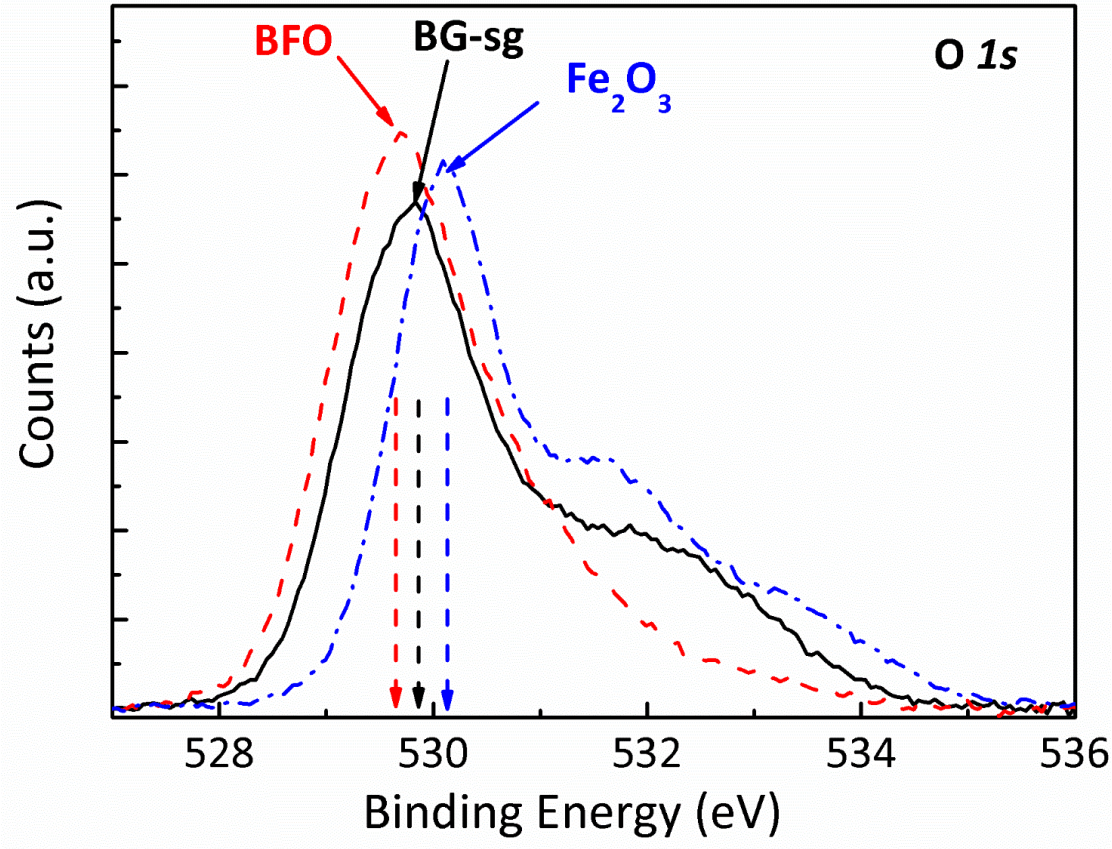

Figure 4S O 1s XPS spectra of BG-sg (solid line in black). Also superimposed are the O 1s XPS spectra of $BiFeO_3$ (dash line in red), Fe_2O_3 (dash-dot line in blue). The shift of O 1s XPS peak is better distinguished with arrows.

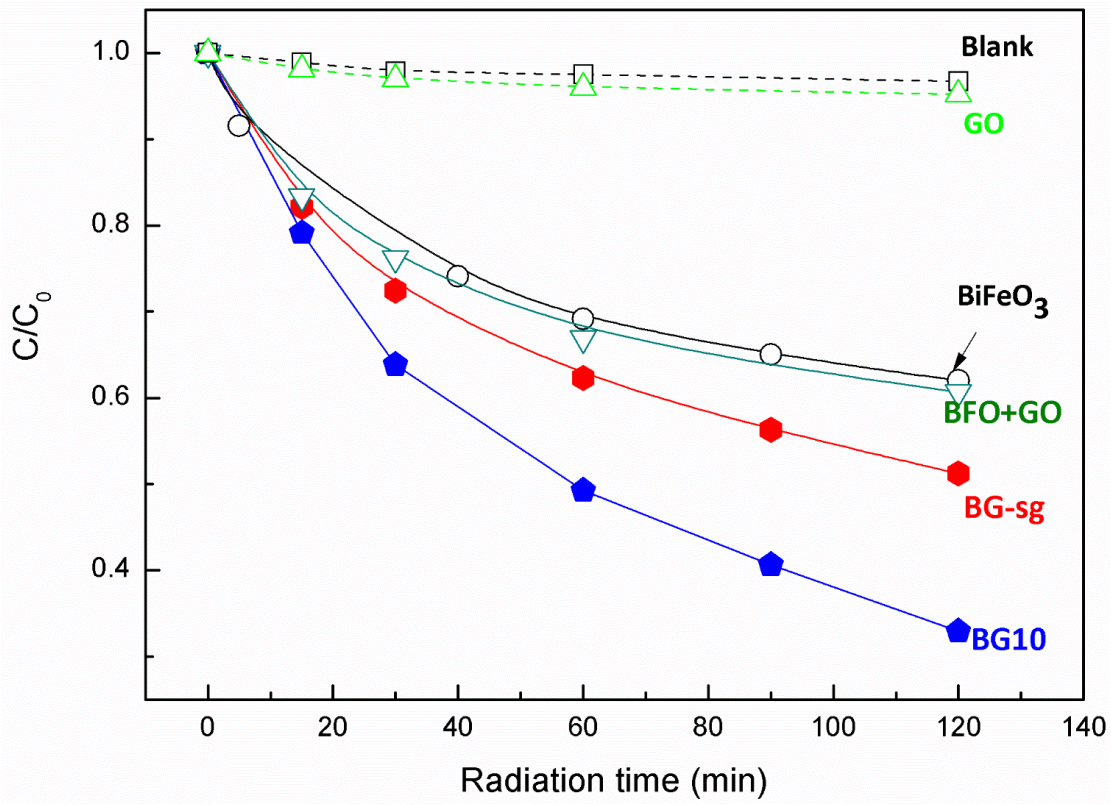

Figure 5s The photodegradation efficiencies of CR as a function of irradiation time under visible-light for BG-sg. For comparison, the photo degradation efficiencies for the simple mixture of $BiFeO_3$ and graphene (denoted as BFO+GO), $BiFeO_3$, pure graphene (GO) and BG10 are also superimposed.