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Review

Supplementary Materials: Titanium Dioxide/Graphene and Titanium Dioxide/Graphene Oxide Nanocomposites: Synthesis, Characterization and Photocatalytic Applications for Water Decontamination

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Table S1. Synthesis, characterization, and applications of TiO_2/G and TiO_2/GO nanocomposites in the literature.

Synthesis Method	Precursors	Characterization Techniques	Product Application	Remarks	Ref.
HT	$TiCl_4$ + GO	XRD, TEM, FTIR, UV−Vis, Raman, N_2 adsorption/desorption analysis and XPS	Photodegradation of RhB dye and Benzoic acid solutions under visible light irradiation	----	[56]
Alkaline HT	P90 + GO + NaOH	XRD, EDX, SEM, TEM, FTIR, PL, UV−Vis and XPS	Photodegradation of Malachite green oxalate dye	An alkaline medium helped in the formation of TiO_2 nanotubes and the reduction of GO to G	[58]
HT	TiF_4 + GO + HI	XRD, SEM, TEM, FTIR, Raman, EIS and XPS	Photodegradation of BPA under UV and visible light irradiation	HI was used as a morphology controlling agent and as a reducing agent to produce G from GO	[60]
HT	TiN + GO + HF	XRD, EDX, SEM, TEM, PL, DRS, N_2 adsorption/desorption analysis and XPS	Photodegradation of MB under visible light irradiation	HF was used to produce N-doped anatase TiO_2 plates with exposed {001} facets	[62]
HT	$TiCl_4$ + GO + H_2O_2 + urea + NH_4VO_3	XRD, TEM, DRS, Raman, EIS, and XPS	Photodegradation of AO7 under visible light irradiation	Urea is used as a source of N and NH_4VO_3 as a source of V to produce N,V–TiO_2–G samples	[57]
HT	TiO_2 + GO + APTMS	XRD, TEM, SEM, DRS, Raman, elemental analysis, FTIR, PL and AFM	Photodegradation of MB under visible light irradiation and Photocurrent measurements	APTMS was used to produce positive charges on TiO_2 surface so negatively charged GO was wrapped by electrostatic interaction	[63,64]
HT	TIP +TEA + GO + PP filter + $AgNO_3$	XRD, SEM, UV−Vis and TGA	Photodegradation of MB using TiO_2/G modified filters	$AgNO_3$ was used for Ag doping	[66]
HT	P25 + GO	XRD, TEM, N_2 adsorption/desorption analysis, TGA, and DRS	Photodegradation of MB and RBk5 under UV light irradiation	----	[61]
HT	TiO_2 nanowires + GO	XRD, TEM, SEM, FTIR, Raman, and EIS	Photodegradation of MB under the simulated solar light.	TiO_2 nanowires were more uniformly distributed with less agglomeration on G surface than	[73]

				TiO_2 nanoparticles	
ST	$TiCl_4$ + EG + G + NH_3	XRD, TEM, SEM, N_2 adsorption/desorption analysis, EIS and elemental analysis	Anodic material for lithium-ion batteries	NH_3 and EG were used to produce homogeneous and stable TiO_2/G nanocomposite	[82]
ST	TBT + GO + acid-treated MWCNTs	XRD, SEM, PL, and DRS	Photodegradation of MB and photoreduction of Cr(VI) under UV light irradiation	PL was used to analyze the hydroxyl radicals produced during the photocatalytic reaction	[83]
ST	TBT + G + NH_3	XRD, TEM, and Raman	Photodegradation of MB	N-doped TiO_2/G nanocomposites were produced and NH_3 was the N source	[84]
ST	$TiCl_4$/TIP + GO + P123	XRD, TEM, AFM, Raman, N_2 adsorption/desorption analysis and XPS	Photodegradation of RhB, Aldicarb, and Norfloxacin under simulated sunlight and visible light irradiation.	P123 was used to prevent the aggregation of TiO_2 nanoparticles and G sheets	[85]
ST	TBT + G	XRD, TEM, DRS, TG-DTA, PL, EIS and XPS	Photodegradation of HCHO under UV light irradiation	----	[86]
ST	TIP+GO	XRD, TEM, SEM, FTIR, DRS, PL and XPS	Photodegradation of MB under UV and visible light irradiation	----	[87]
ST	TBT + GO + HF	XRD, TEM, SEM, AFM, Raman, FTIR, TGA, PL, N_2 adsorption/desorption analysis, EPR, and XPS	Photodegradation of MB under UV light irradiation	HF was used to produce anatase TiO_2 plates with exposed {001} facets ESR was used to study the Reactive Oxygen Radicals ($^{\bullet}OH$ and $O_2^{\bullet-}$)	[89]
Mixing and sonication	TIP +GO	XRD, TEM, DRS, FTIR, N_2 adsorption/desorption analysis and XPS	Photodegradation of 2,4-D and RR195 under UV and visible irradiations	CTAB, H_2PtCl_6, palladium (II) acetate and $NaBH_4$ can be added to produce metal doped TiO_2/G nanocomposites	[17]
Mixing and sonication	Oleic acid capped TiO_2 nanorods + GO	XRD, TEM, UV−Vis, PL, and XPS	Photodegradation of AO7 under UV light irradiation	Oleic acid stabilized the formed TiO_2 nanorods	[92]
Mixing and	P25 + GO	XRD, TEM, SEM, UV−Vis, FTIR, N_2	Photodegradation of MB under	----	[93]

sonication		adsorption/desorption analysis and EDX	UV and visible light irradiation		
Mixing and sonication	TiO_2 + Carboxy G	XRD, TEM, SEM, EDX, UV–Vis, FTIR, PL and Raman	Photodegradation of RhB under simulated solar light	Carboxy functionalization improved the binding of TiO_2 and enhanced the photocatalytic activity	[94]
Mixing and sonication	P25 + GO	SEM, EDX, N_2 adsorption/desorption analysis, DRS, pH_{PZC}, DRIFT, and DTG,	Photodegradation of MO and DP under near-UV/Vis irradiation	The surface chemistry of the prepared nanocomposites was measured by pH_{PZC}	[90]
Sol-gel	Titania peroxo-complex + GO	XRD, TEM, AFM, N_2 adsorption/desorption analysis, FTIR, Raman, DRS and XPS	Photodegradation of butane gas under UV and visible light irradiation	----	[16]
Sol-gel	TIP + CTAB +G	XRD, SEM, FTIR, DRS and TG-DTA	Photodegradation of MB under simulated solar and visible light irradiation	----	[101]
LPD	$(NH_4)_2TiF_6$+ GO	SEM, TEM, AFM, N_2 adsorption/desorption analysis, DTG, Raman, DRS and XPS	Photodegradation of MO and DP under near-UV/Vis and visible light irradiation	Thermal treatment to reduce GO to G	[104,105]
LPD	$(NH_4)_2TiF_6$+ GO	XRD, SEM, AFM, N_2 adsorption/desorption analysis, TG-DTA, Raman and XPS	Photodegradation of MO and photoreduction of Cr(VI) under UV light irradiation	----	[106]
CVD	TiO_2 +acetylene	TEM, Raman, FTIR, DRS, and TGA	Photodegradation of phenol under visible light irradiation	Acetylene was used as a source of G	[113]
LBL	Polysulfone membrane + TiO_2 + GO	SEM, UV–Vis, and XPS	Photodegradation of MB under UV and simulated solar light irradiation	UV irradiation to reduce GO to G is performed	[114]
Micro-wave assisted	P25 + GO	XRD, TEM, FTIR, N_2 adsorption/desorption analysis and DRS	Photodegradation of MB	----	[115]
Spin coating	TBLAH + G + glycerol	XRD, TEM, SEM, DRS and contact angle meter	Photodegradation of MB under UV light irradiation for self-cleaning applications	Glycerol to increase the homogeneity of TBLAH /G dispersion	[19]

Abbreviations

2,4-D	2,4-dichlorophenoxyacetic acid;
AFM	atomic force microscopy;
AO7	acid orange 7;
APTMS	3-aminopropyl-trimethoxysilane;
BET	Brunauer–Emmett–Teller;
BPA	bisphenol A;
CTAB	cetyl trimethylammonium bromide;
CVD	chemical vapor deposition;
DP	diphenhydramine;
DRIFT	diffuse reflectance Fourier transform infrared spectroscopy;
DRS-UV	diffuse reflectance UV-Vis spectroscopy;
DTA	differential thermal analysis;
E. coli	*Escherichia coli*;
EDX	energy dispersive X-ray analysis;
EG	ethylene glycol;
EIS	electrochemical impedance spectroscopy;
ESR	electron spin resonance;
FTIR	Fourier transform infrared spectroscopy;
G	graphene;
GO	graphene oxide
H_2O_2	Hydrogen peroxide;
HT	hydrothermal;
LBL	layer by layer;
LPD	liquid phase deposition;
MB	methylene blue;
MO	methyl orange;
MWCNTs	multi-wall carbon nanotubes;
N,V–TiO_2–G	Nitrogen and Vanadium co-doped TiO_2/G nanocomposites;
NIR	near-infrared;
P123	triblock copolymer based on poly(ethylene glycol)-poly(propylene glycol)-poly(ethylene glycol);
pHPZC	the point zero of charge;
PL	photoluminescence spectroscopy;
PP filter	polypropylene filter;
QCM-D	quartz crystal microbalance with dissipation;
RBK-5	reactive black-5;

RhB	rhodamine B;
RR195	reactive red 195;
SEM	scanning electron microscopy;
ST	solvothermal;
TBLAH	Titanium (IV) bis ammonium lactate dihydroxide;
TBT	tetrabutyl-titanate;
TEA	triethanolamine;
TEM	transmission electron microscopy;
TGA	thermal gravimetric analysis;
TiN	Titanium nitride;
TIP	Titanium (IV) isopropoxide;
TPD	temperature programmed desorption;
XPS	X-ray photoelectron spectroscopy;
XRD	X-ray diffraction