

Enhanced charge mediator properties of photocatalysts with reduced graphene nanoribbons for photocatalytic acceleration of hydrogen production in aqueous media

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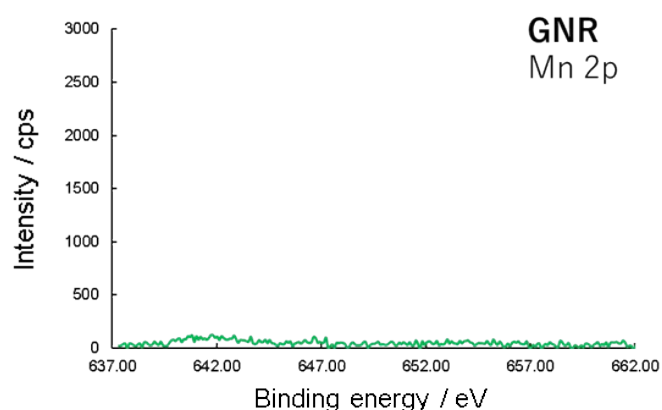


Figure S1. XPS spectra of GNR for Mn 2p.

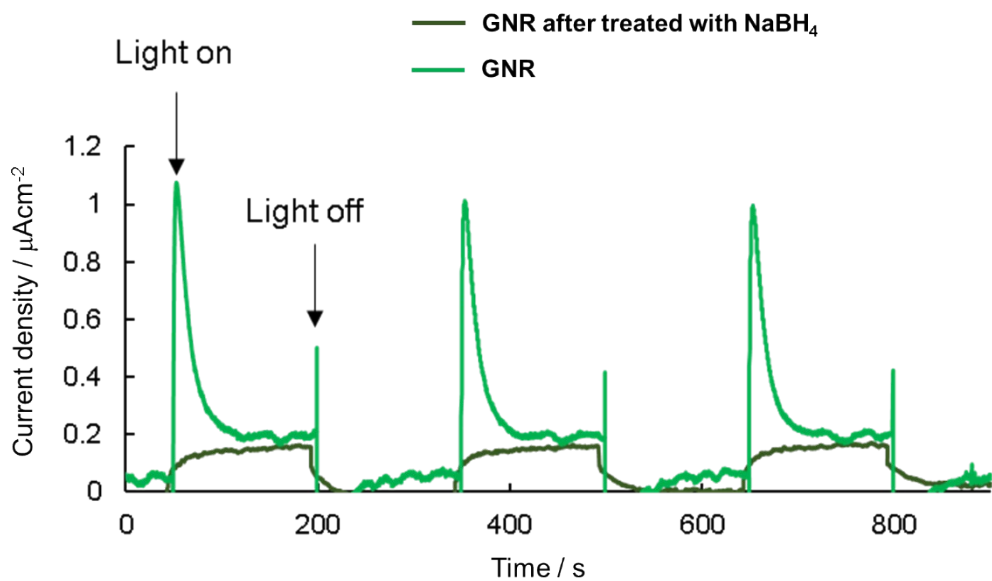


Figure S2. Photocurrent test of GNR and after NaBH₄ treatment (rGNR).

Table S1. Summary of XPS spectra of relative peak proportions in C 1s.

	$\pi-\pi^*$ [291.0 eV] (%)	C=O /COOH [288.9 eV] (%)	C=O [287.9 eV] (%)	C-O-C /C-O [286.4 eV] (%)	C-OH [285.6 eV] (%)	C-C /C=C [284.3 eV] (%)	C-H [282.6 eV] (%)	Total (%)
MWCNT	3.4				28.8	67.8		100.0
GNR	3.0	5.8	4.9	33.7	11.4	41.2		100.0
Pt/TiO₂								
Pt/TiO₂/MWCNT	4.8				31.0	64.2		100.0
Pt/TiO₂/pGNR	2.9		10.5	10.4	14.9	50.5	10.8	100.0
Pt/TiO₂/rGNR	7.3			27.1	20.3	45.3		100.0

Table S2. Summary of XPS spectra of relative peak proportions in O 1s.

	C-OH [533.1 eV] (%)	C-O [532.2 eV] (%)	-OH [531.9 eV] (%)	C=O [531.2 eV] (%)	Ti-O [530.6 eV] (%)	Total (%)
MWCNT						
GNR	21.6	59.9		18.5		100.0
Pt/TiO₂						
Pt/TiO₂/MWCNT	6.6		19.2		74.2	100.0
Pt/TiO₂/pGNR	4.5	4.0	14.4	5.6	71.5	100.0
Pt/TiO₂/rGNR	5.0	3.5	14.7		76.8	100.0

Table S3. Summary of XPS spectra of relative peak proportions in Ti 2p and Pt 4f

	Ti 2p _{1/2} [464.9 eV]	Ti 2p _{3/2} [459.1 eV]	Total (%)	Pt 4f _{5/2} [75.0 eV]	Pt 4f _{7/2} [71.2 eV]	Total (%)
MWCNT						
GNR						
Pt/TiO₂	36.0	64.0	100.0	89.2	10.8	100.0
Pt/TiO₂/MWCNT	34.6	65.4	100.0	90.5	9.5	100.0
Pt/TiO₂/pGNR	37.9	62.1	100.0	56.9	43.1	100.0
Pt/TiO₂/rGNR	36.6	63.4	100.0	88.3	11.7	100.0

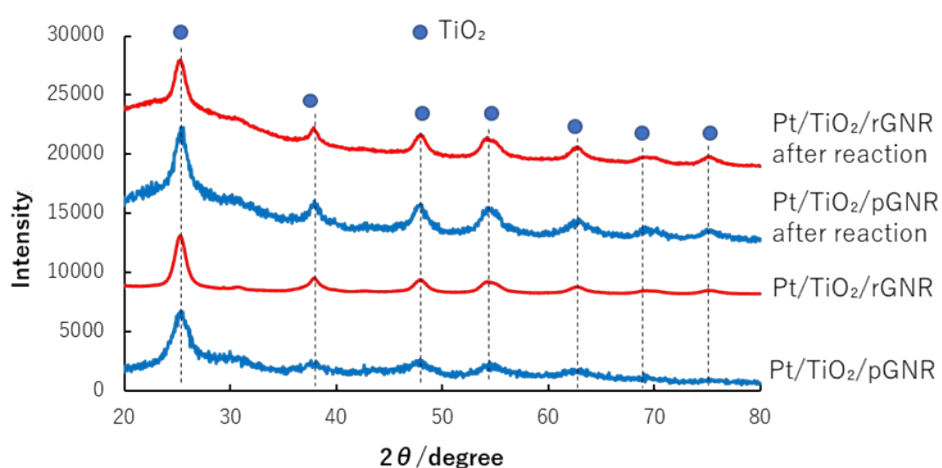


Figure S3. XRD pattern photocatalyst before and after reaction.

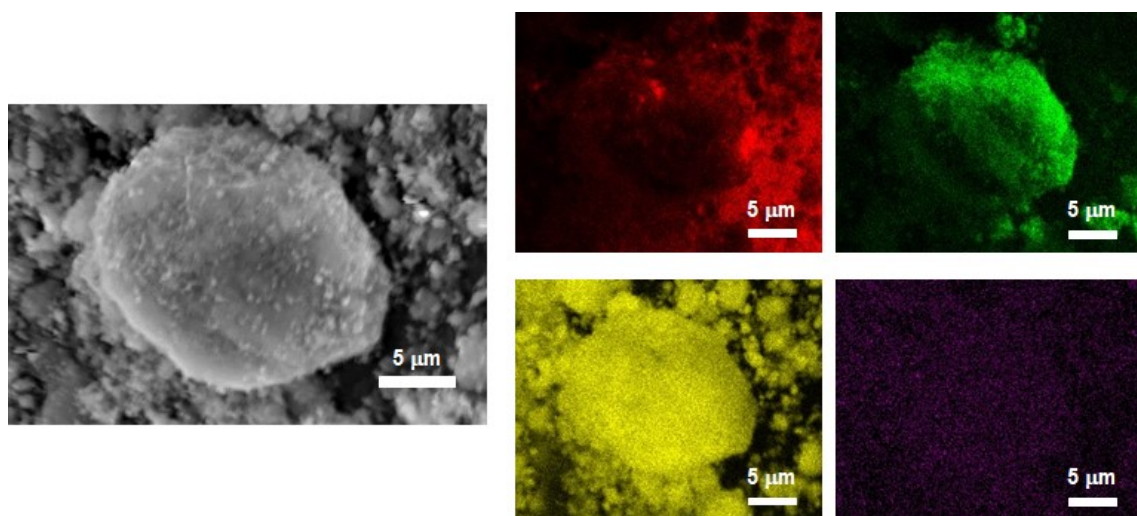


Figure S4. SEM-EDX image of Pt/TiO₂/rGNR.

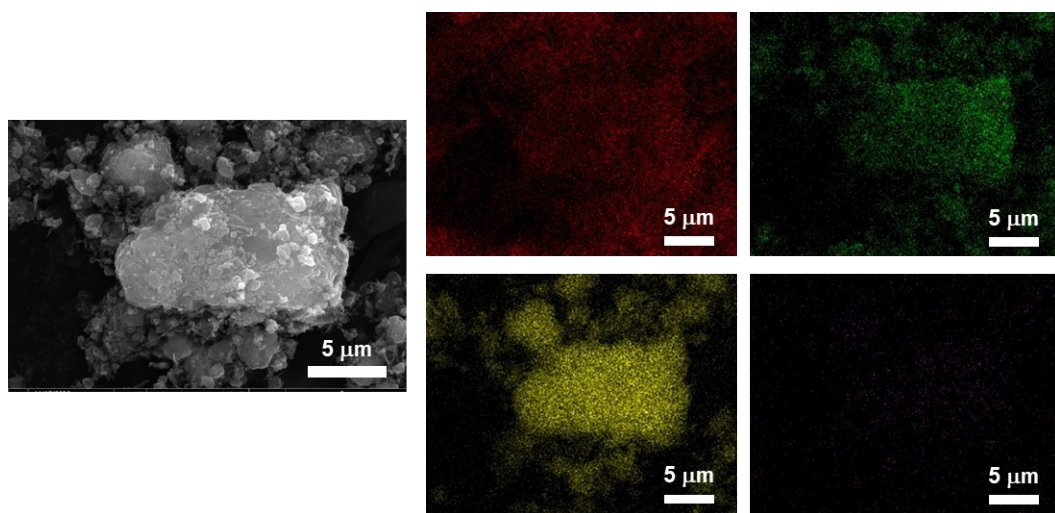


Figure S5. SEM-EDX image of Pt/TiO₂/rGNR after photocatalytic reaction.

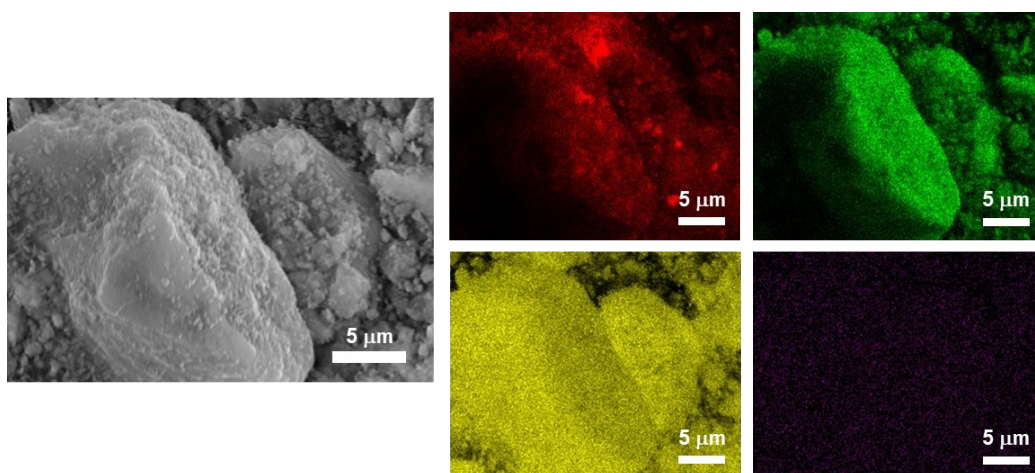


Figure S6. SEM-EDX image of Pt/TiO₂/pGNR.

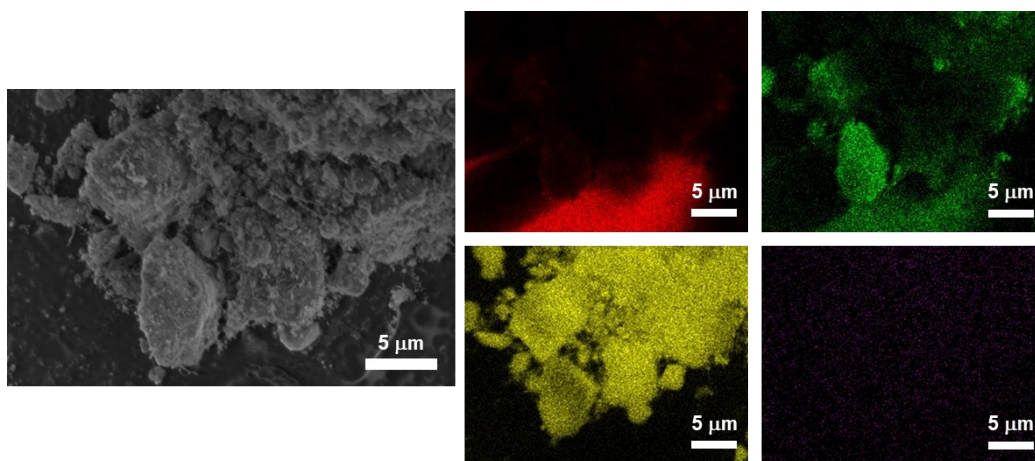


Figure S7. SEM-EDX image of Pt/TiO₂/pGNR after photocatalytic reaction.

Table S4. Summary of BET surface area data.

Sample	Surface area (m ² /g)
MWCNT	25.0
GNR	69.8
Pt/TiO ₂ /MWCNT	182.4
Pt/TiO ₂ /rGNR	190.2
Pt/TiO ₂	183.4

Table S5. Summary of related Pt/TiO₂/carbon materials composites photocatalytic activities.

Photocatalyst	Light source	Electron donor	Hydrogen production mmol h ⁻¹ g ⁻¹	AQY	ref ^a
Graphene sheet/TiO₂	500 W Xe lamp	Na ₂ S/ Na ₂ SO ₃	8.6		[43]
0.7wt%Pt/r-NGO/TiO₂	300 W Xe lamp	MeOH	0.1		[44]
2wt%Pt/rGO/TiO₂	300W Xe lamp	TEOA	8.53	8.2@420 nm	[45]
N-doped graphene/TiO₂	150W Xe lamp	TEOA	0.67	3.5@365nm	[46]
0.4Wt%Pt/rGO/TiO₂ aerogel	Hg lamp	MeOH	11.61		[47]
Graphene/TiO₂	UV lamp	MeOH	0.152		[48]
1wt%PT/reduced TiO₂/RGO	AM1.5	MeOH	16.0	1.85@365nm	[49]
1wt% Pt/RGO/TiO₂	AM1.5	MeOH	1.986		[50]
1wt% Pt/RGO/TiO₂	Hg lamp	Glycerol	28.5		[51]
Few layer grapahene/TiO₂	Hg lamp	MeOH	0.265		[52]
0.5wt%Pt/Cu-RGO/TiO₂	LED (365 nm)	EtOH	26.9	3.17@365 nm	[53]
1wt%CdS/GNR	300W Xe lamp	Lactic acid	1.891	19.3@420 nm	[30]
0.5wt%Pt/TiO₂/rGNR	300W Xe lamp	MeOH	2.54	9.5@350 nm	This work

a: Corresponding to the reference number is listed in the main text.