Electronic Supplementary Material (ESI) for Nanoscale

Supporting Information

Generalized syntheses of nanocrystal/graphene hybrids in high-boiling-point organic solvents

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Table S1 Detail experimental parameters of all the NC/CCG hybrids.

NCs	HU/HI	Precursors/Solvents in 3-neck flask	Inj. Shot	Inj. Temp.	Rxn. Temp.	Inert /Open	Rxn. Time
Cu	HI	Oleylamine	0.1 mmol of $Cu(acac)_2$ + OLA-GO + 1 ml oleylamine, heated to 100^oC to form complex	260^oC	260^oC	Inert	30 mins
Ag	HU	0.5 mmol $AgNO_3$ +15 ml Toluene + OLA-GO	-	-	110^oC (10^oC/min)	Inert	6 hrs
Pd	HU	1.64 mmol $Pd(acac)_2$ + 10 ml TOP + OLA-GO	-	-	300^oC (5^oC/min)	Inert	30 mins
Pt	HU	0.05 mmol $Pt(acac)_2$ + OLA-GO + 10 ml Benzyl Ether	-	-	230^oC (10^oC/min)	Inert	1 hr
Fe_3O_4	HU	0.03 mmol $Fe(acac)_3$ + 5 ml Benzyl Ether + OLA-GO	-	-	300^oC (20^oC/min)	Inert	1 hr
Fe_2O_3	HI	0.09 g Oleic acid + 10 ml diphenyl ether	0.15 mmol of $Fe(CO)_5$ + OLA-GO	100^oC	265^oC (5^oC/min)	Inert	1 hr
CdS	HI	0.1 mmol CdO + 0.08 g Oleic Acid + 4.9 ml n-Octadecene	0.05 mmol Sulfur powder+ 1 ml n-Octadecene + OLA-GO	300^oC	250^oC	Inert	30 mins
CdSe	HI	0.1 mmol CdO + 0.5 g Oleic Acid + 10 ml of n-Octadecene	1ml of (0.37mmol Selenium powder + 5ml n-Octadecene + 0.4ml TOP)	225^oC	225^oC	Inert	30 mins
CdTe	HI	0.1 mmol of CdO + 0.09 g Oleic Acid + 4.8 ml ODE	0.05 mmol of Tellurium powder + 1.2 ml TOP + OLA-GO, heat up to 200^oC to form complex, drop to room temperature before injection	220^oC	190^oC	Inert	30 mins
$CuInS_2$	HI	0.1 mmol $Cu(acac)_2$ + 0.1 mmol $In(acac)_3$ + 7 ml ortho-Dichlorobenzene	0.02 mmol of Sulfur powder + OLA-GO + 3 ml ortho-Dichlorobenzene	100^oC	185^oC (20^oC/min)	Inert	1 hr
$CuInSe_2$	HU	0.1 mmol CuCl + 0.1 mmol $InCl_3$ + 0.2 mmol Se + OLA-GO	-	-	240^oC (3^oC/min)	Inert	4 hrs
In_2O_3	HU	0.1 mmol $In(acac)_3$ + OLA-GO + 10ml Benzyl Ether	-	-	300^oC	Open	1 hr
SnO_2	HU	0.1mmol $SnCl_2(acac)_2$ + OLA-GO + 10ml Benzyl Ether	-	-	280^oC	Open	1 hr
Ru	HU	0.06 mol $Ru(acac)_3$ + 0.12 mmol of 1,2 Hexadecanediol + OLA-GO + 10 ml Benzyl Ether	-	-	300^oC (8^oC/min)	Inert	30 mins
ZnS	HU	1.79 g Oleic acid + 3 ml n-Octadecene + 3 mmol Sulfur Powder + 0.5 ml Diethylzinc	-	-	300^oC (5^oC/min)	Inert	2 hrs
ZnSe	HI	7.5 ml Hexadecylamine	0.4 ml Ditheylzinc + 0.5 ml of 1 M TOP-Se complex + 4 ml TOP + OLA-GO	310^oC	270^oC	Inert	1 hr

*Note: **HU**: Heating up; **HI**: Hot injection; **Inj.**: Injection; **Temp.**: Temperature; **Rxn.**: Reaction; **acac**: Acetylacetonate; **TOP**: Trioctylphosphine.

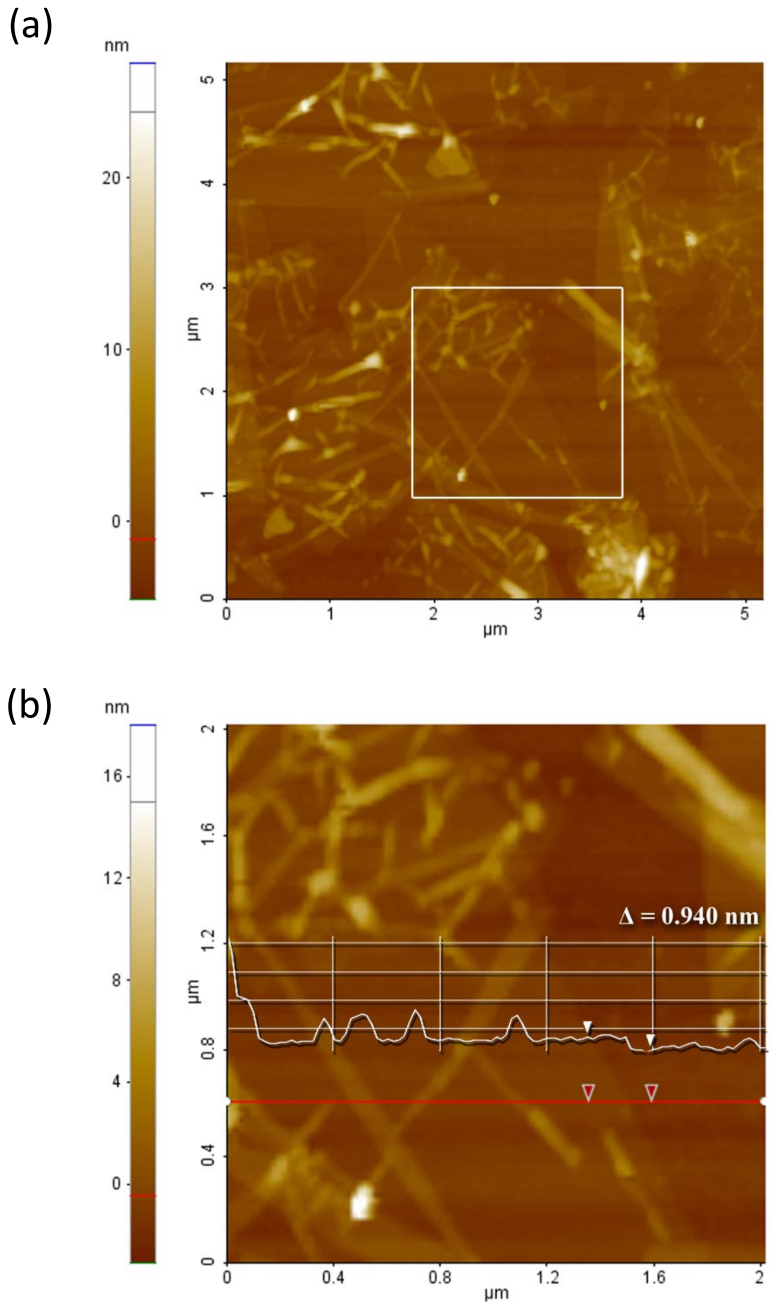

Fig. S1 AFM images of (a) GO. (b) Height profile of the square cropped-area of (a). Height difference measured between the GO sheet and substrate (the cursor pair in b) is 0.940 nm, consistent with the thickness of single layer GO sheet.

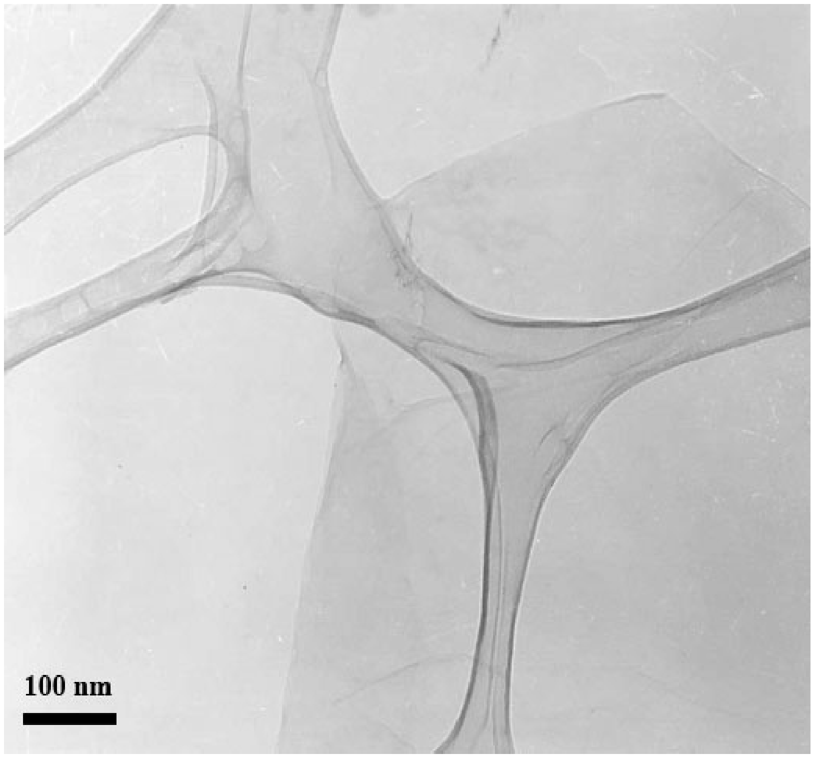

Fig. S2 TEM image of as-prepared GO on holey carbon support film. The crumpled silk wave is the landmark of thin graphene sheet.

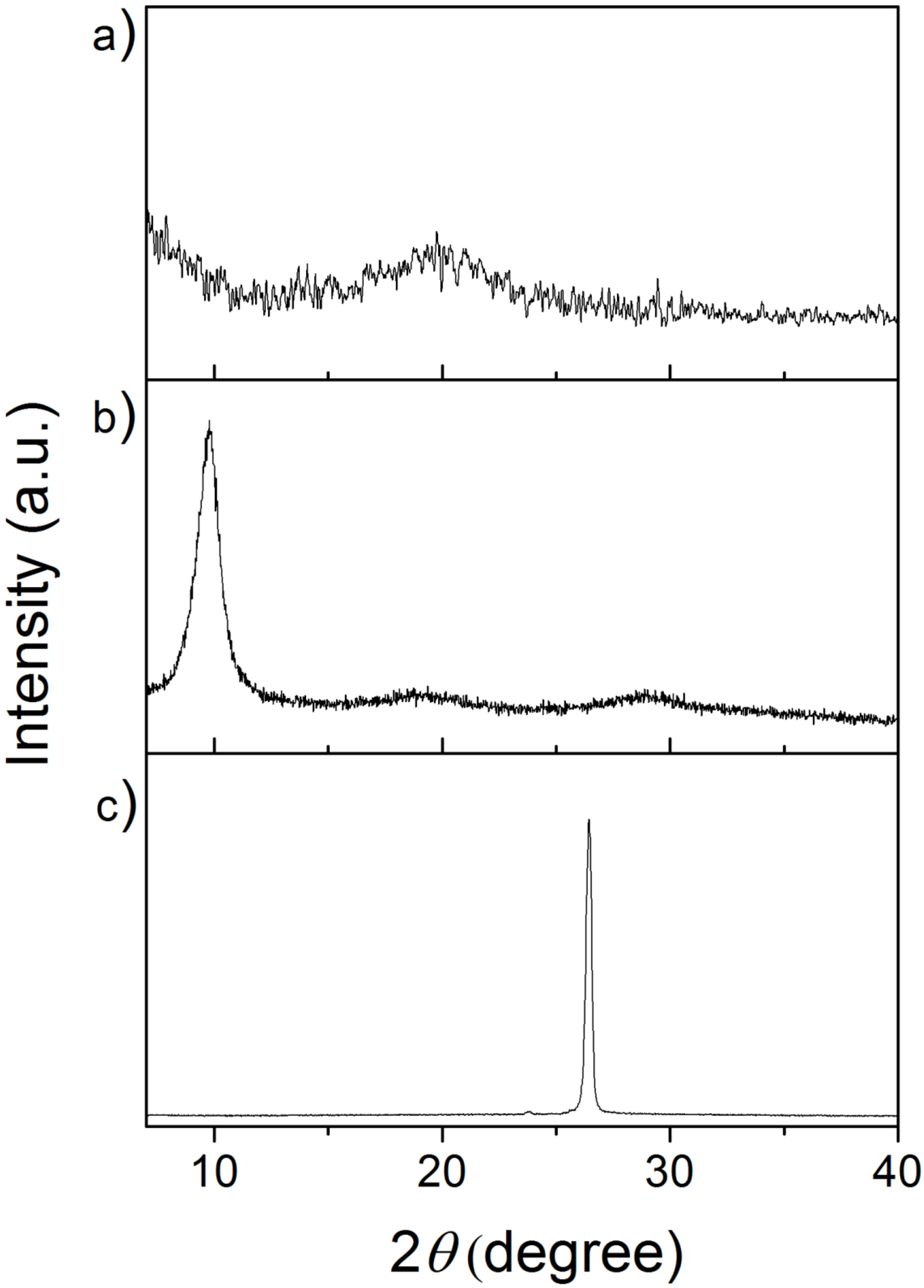

Fig. S3 XRD patterns of (a) OLA-GO, (b) graphite oxide and (c) graphite.

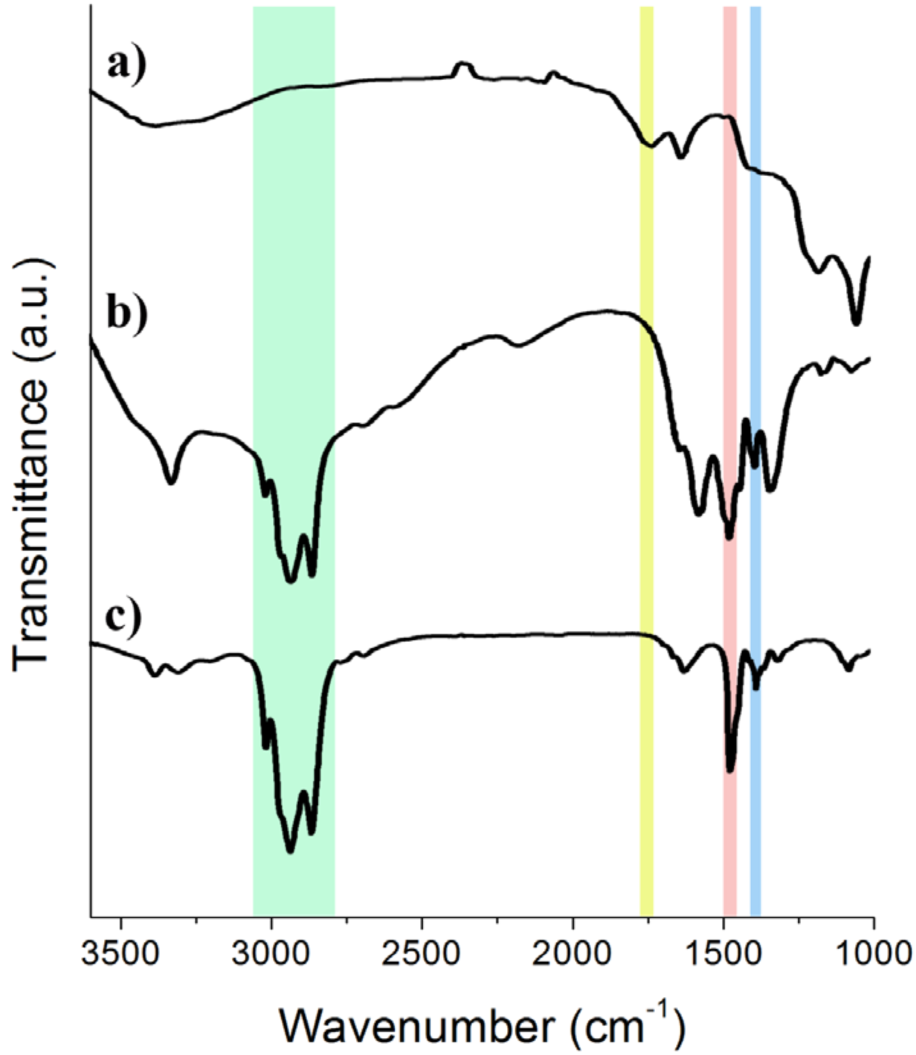

Fig. S4 FTIR spectra of (a) GO, (b) OLA-GO, and (c) OLA. The bands located at 2850cm^{-1} and 2925cm-^{1} in (b) and (c) corresponded to anti-symmetric and symmetric C-H stretching vibrations of OLA alkyl group respectively. The bands at 1460cm^{-1} and 1380cm^{-1} are C-H bending vibrations of alkyl groups. The band 1730cm^{-1}, which is assigned to -COOH vibrations of GO is disappeared after functionalization, as shown in (a) and (b).

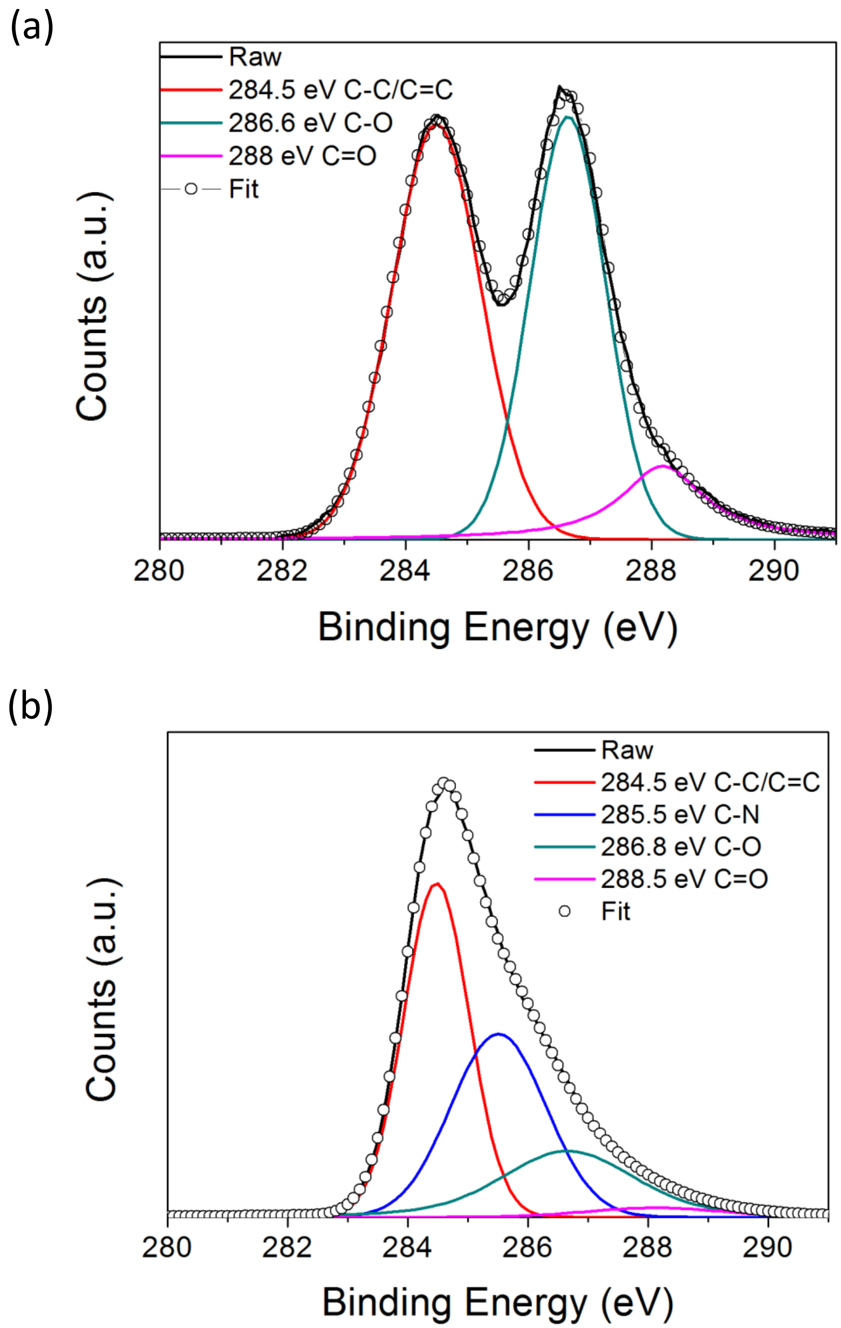

Fig. S5 XPS spectra of (a) as-prepared GO, and (b) OLA-GO.

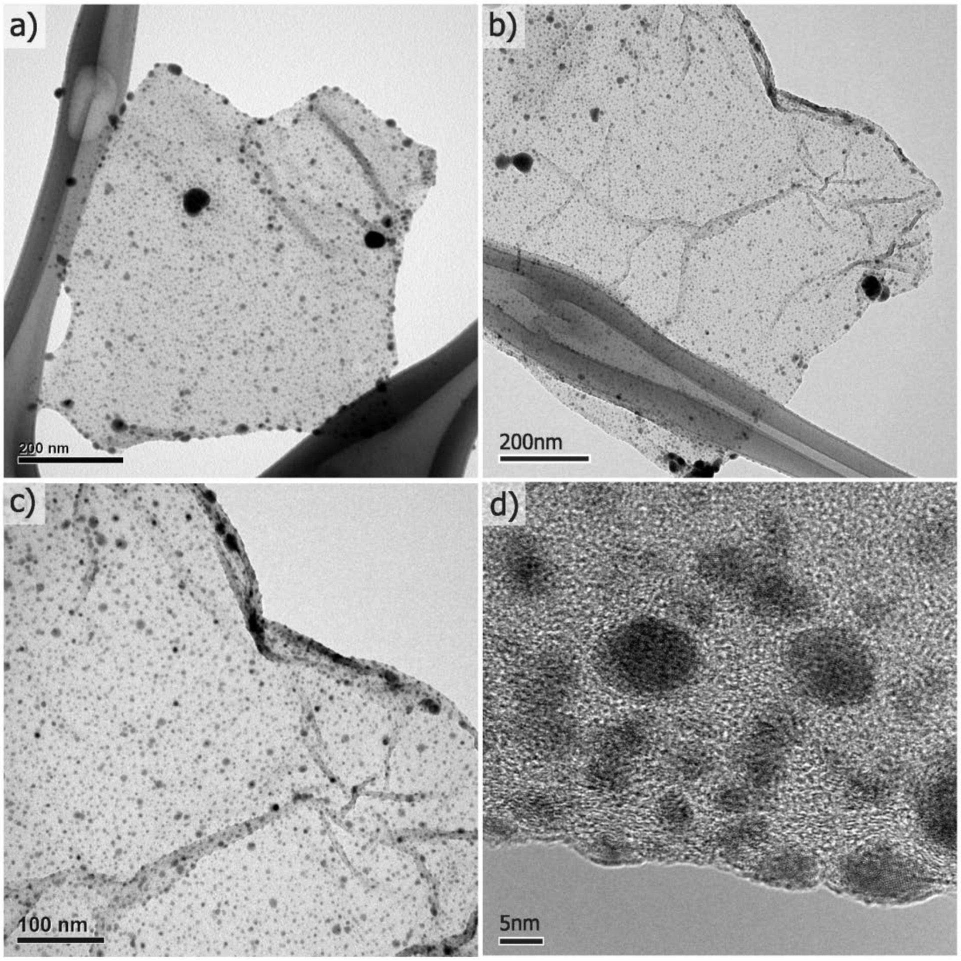

Fig. S6-1 (a-d) TEM images of Ag/CCG hybrid.

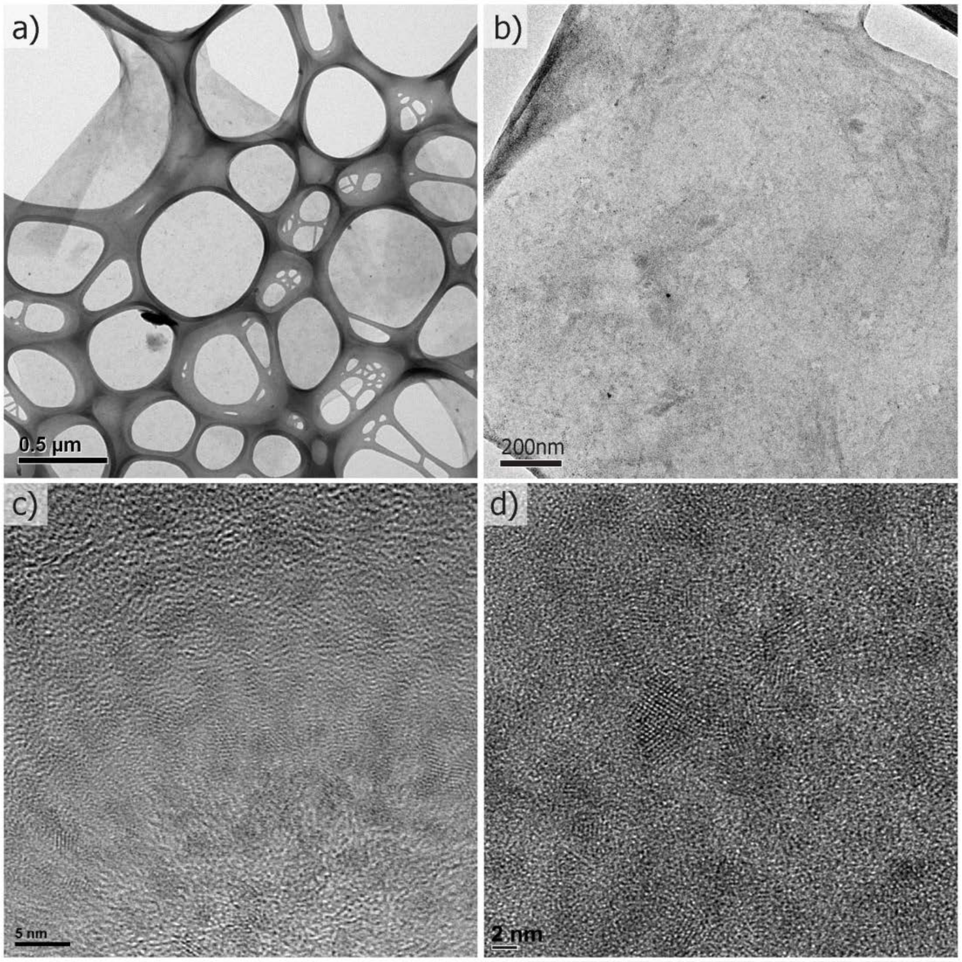

Fig. S6-2 (a-d) TEM images of CdS/CCG hybrid.

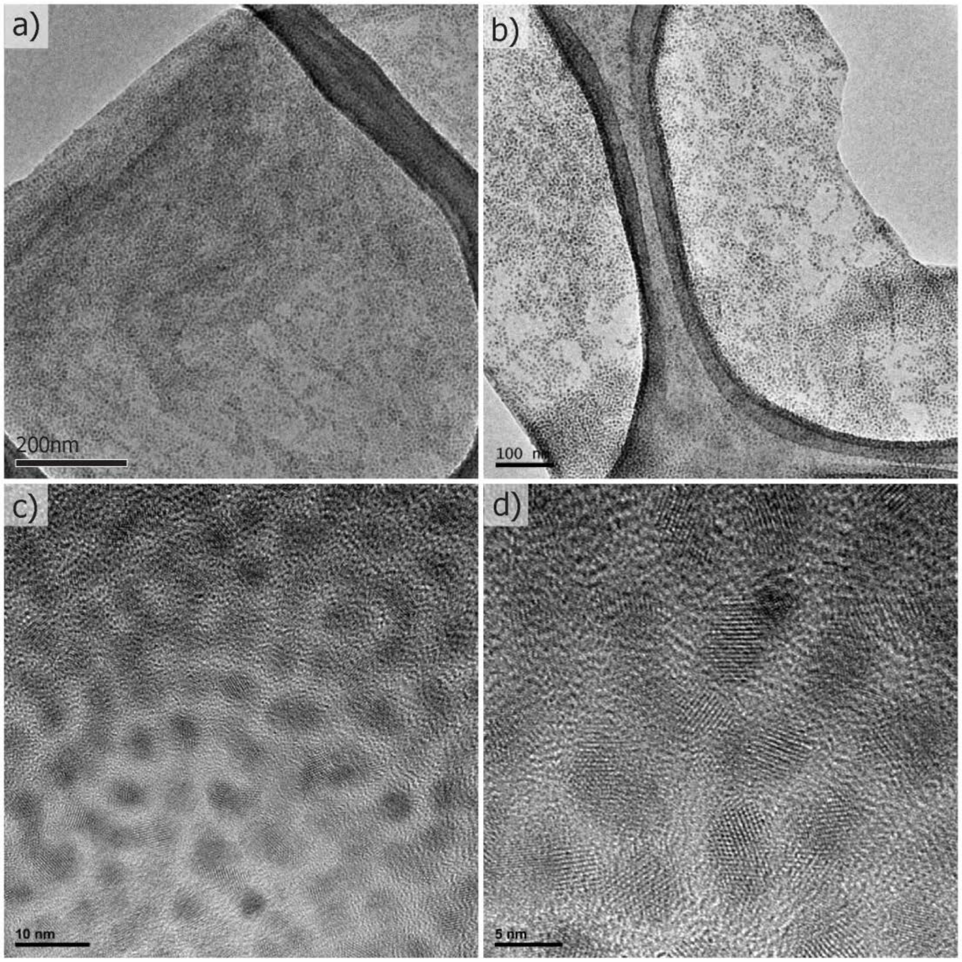

Fig. S6-3 (a-d) TEM images of CdSe/CCG hybrid.

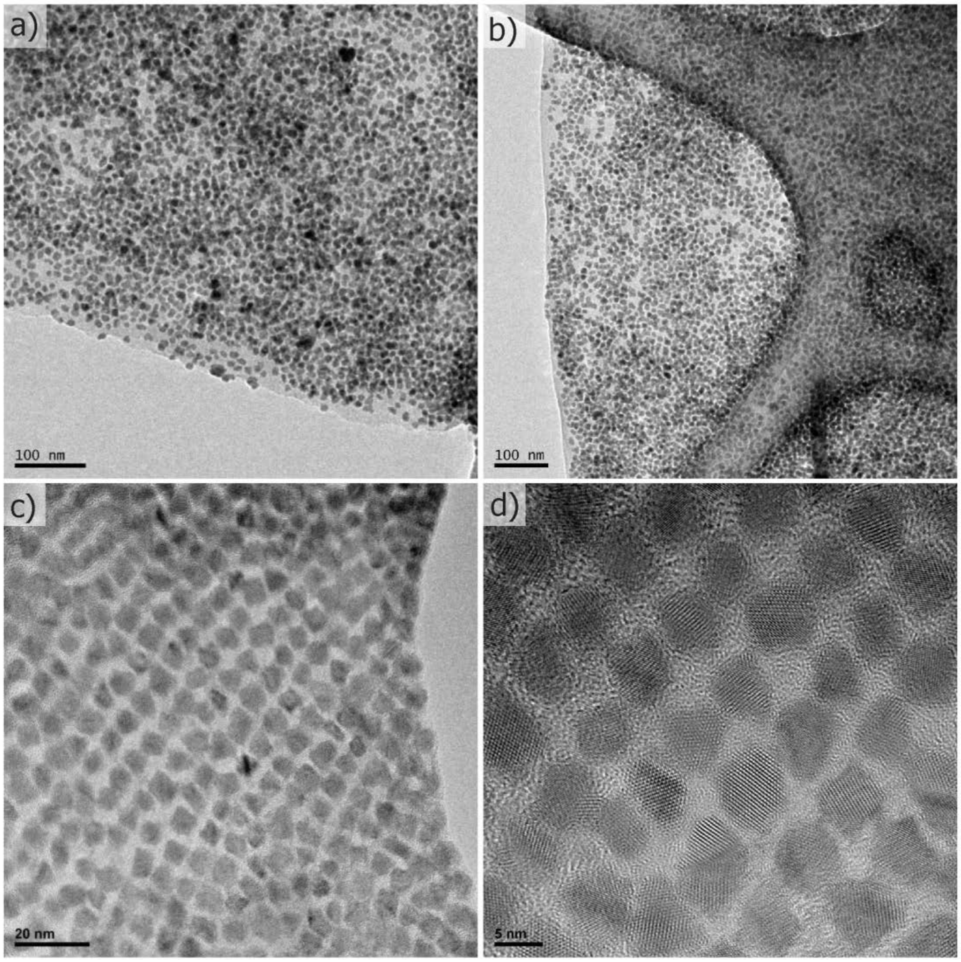

Fig. S6-4 (a-d) TEM images of CdTe/CCG hybrid.

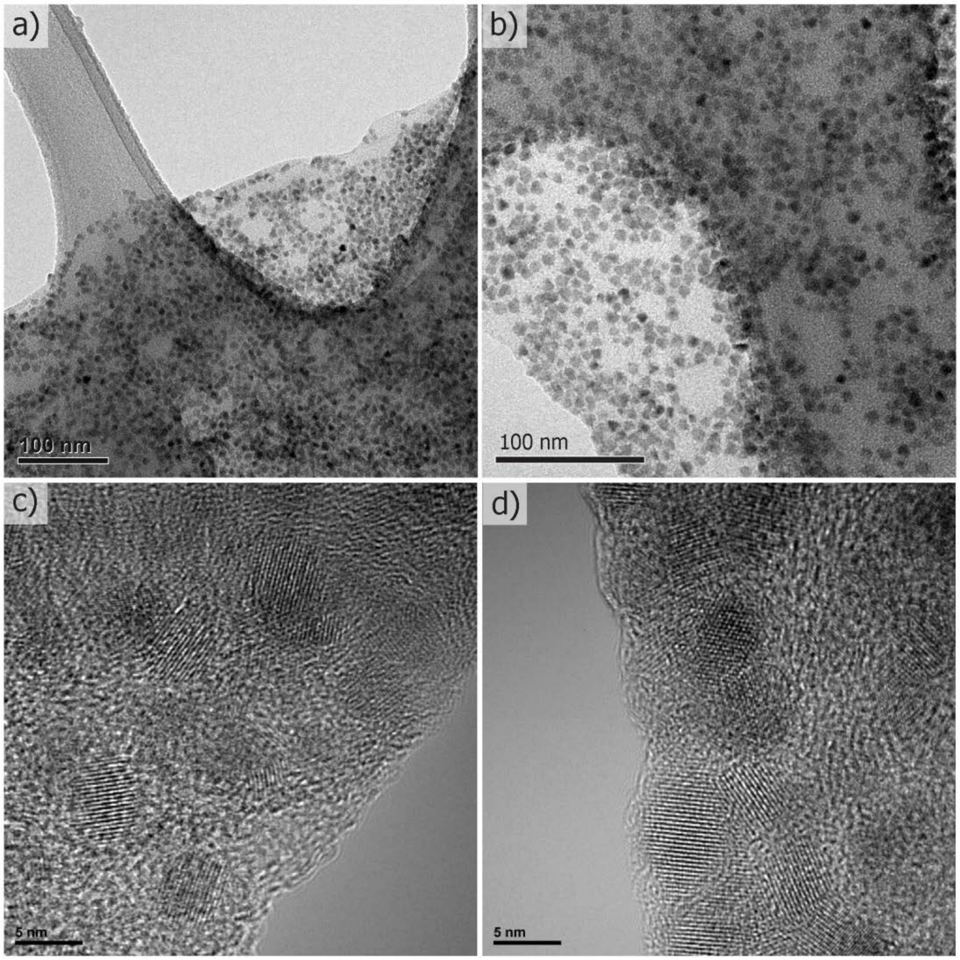

Fig. S6-5 (a-d) TEM images of $CuInS_2$/CCG hybrid.

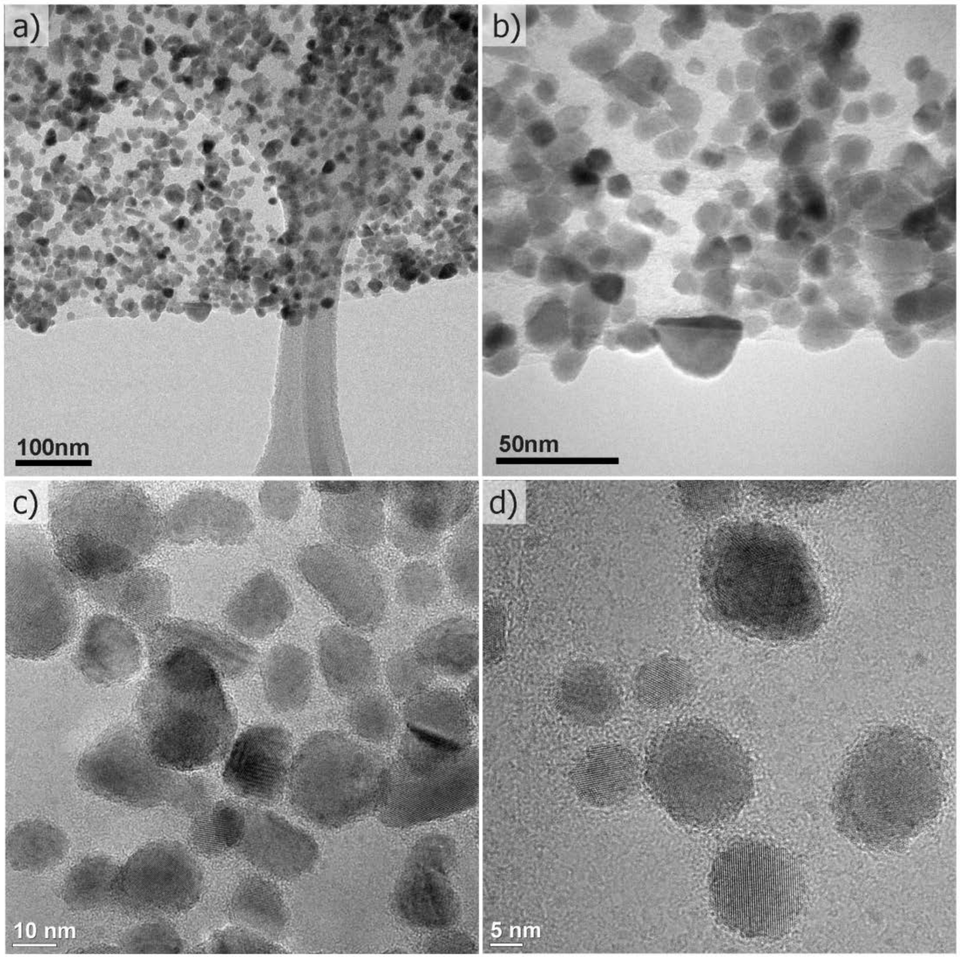

Fig. S6-6 (a-d) TEM images of $CuInSe_2$/CCG hybrid.

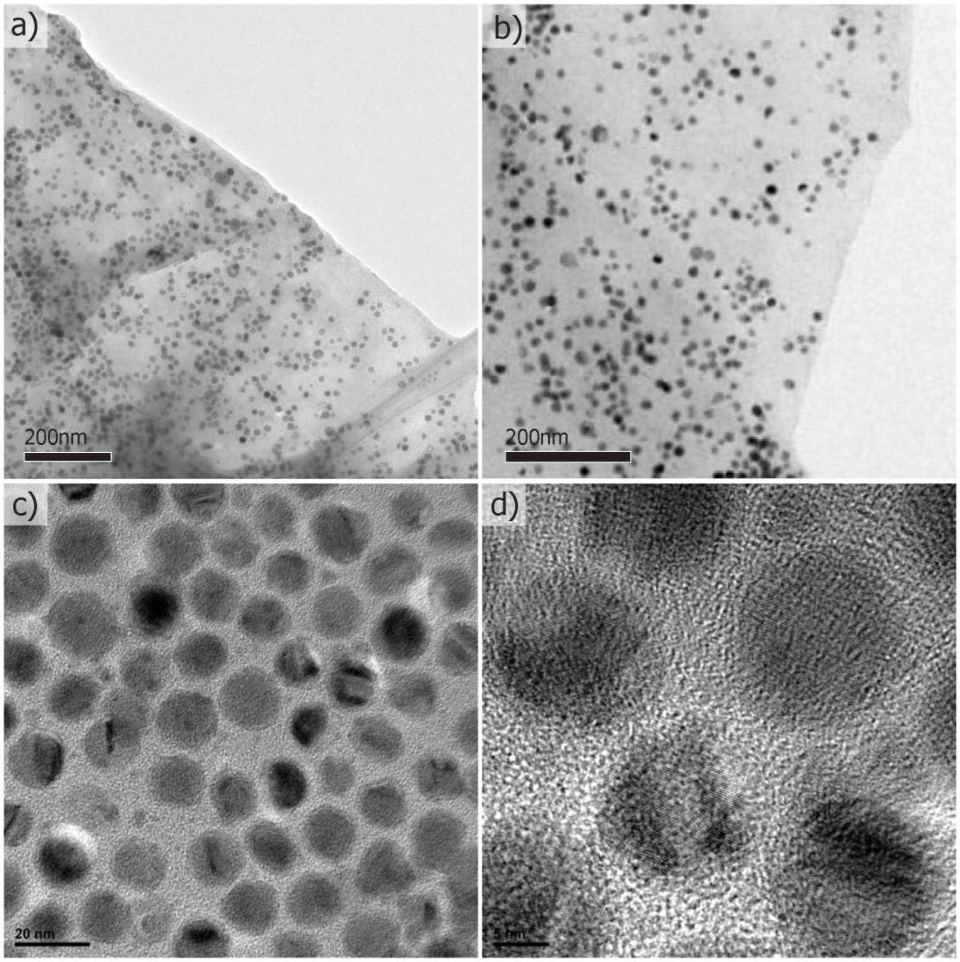

Fig. S6-7 (a-d) TEM images of Cu/CCG hybrid.

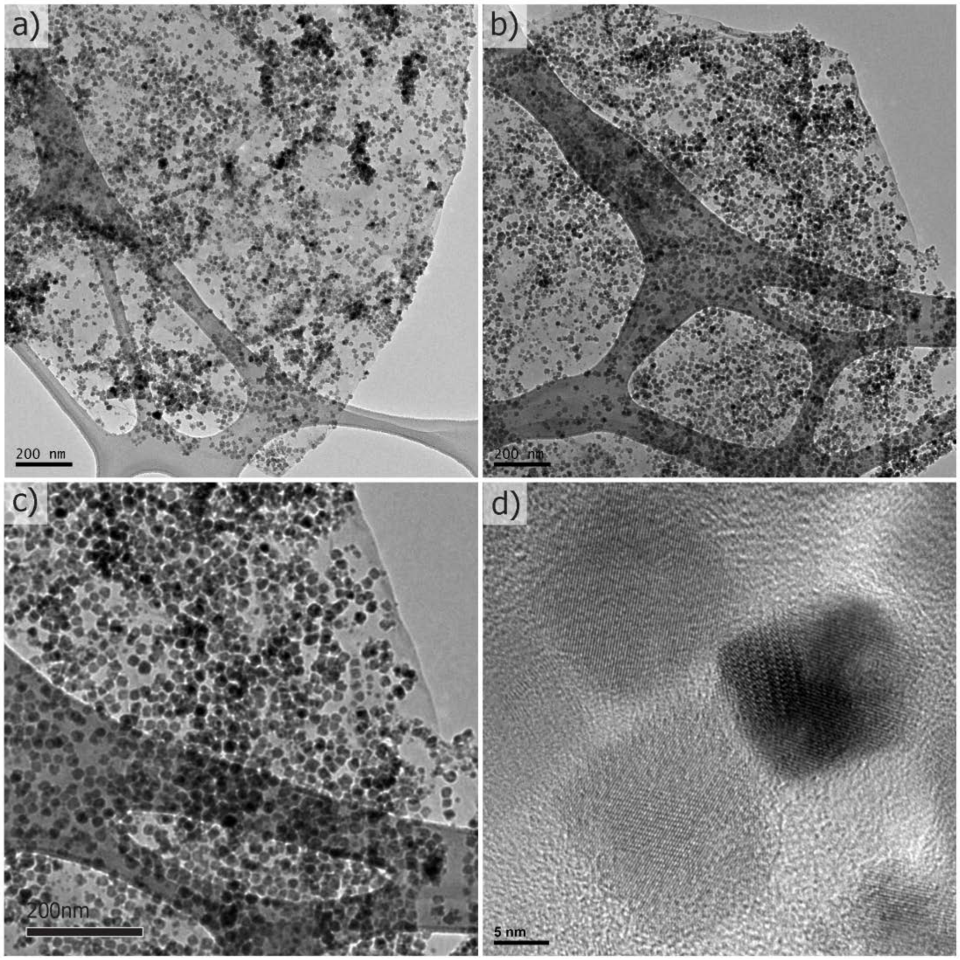

Fig. S6-8 (a-d) TEM images of Fe_2O_3/CCG hybrid.

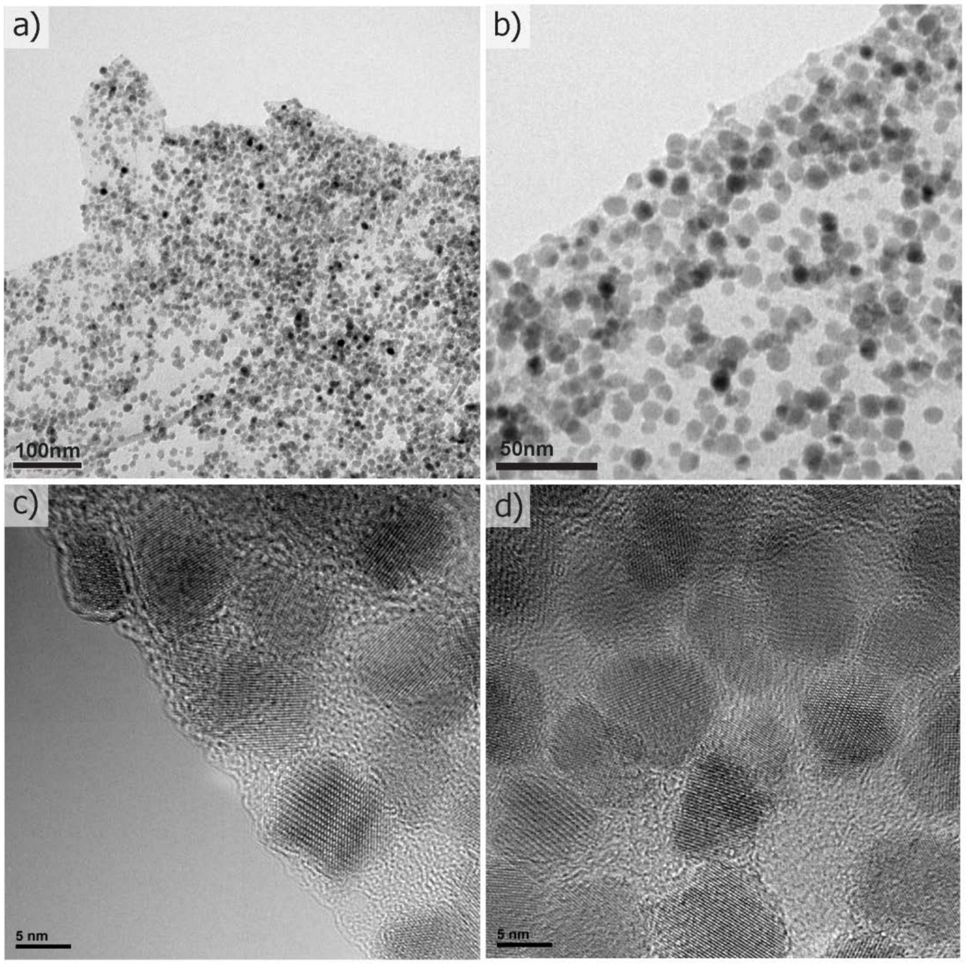

Fig. S6-9 (a-d) TEM images of Fe_3O_4/CCG hybrid.

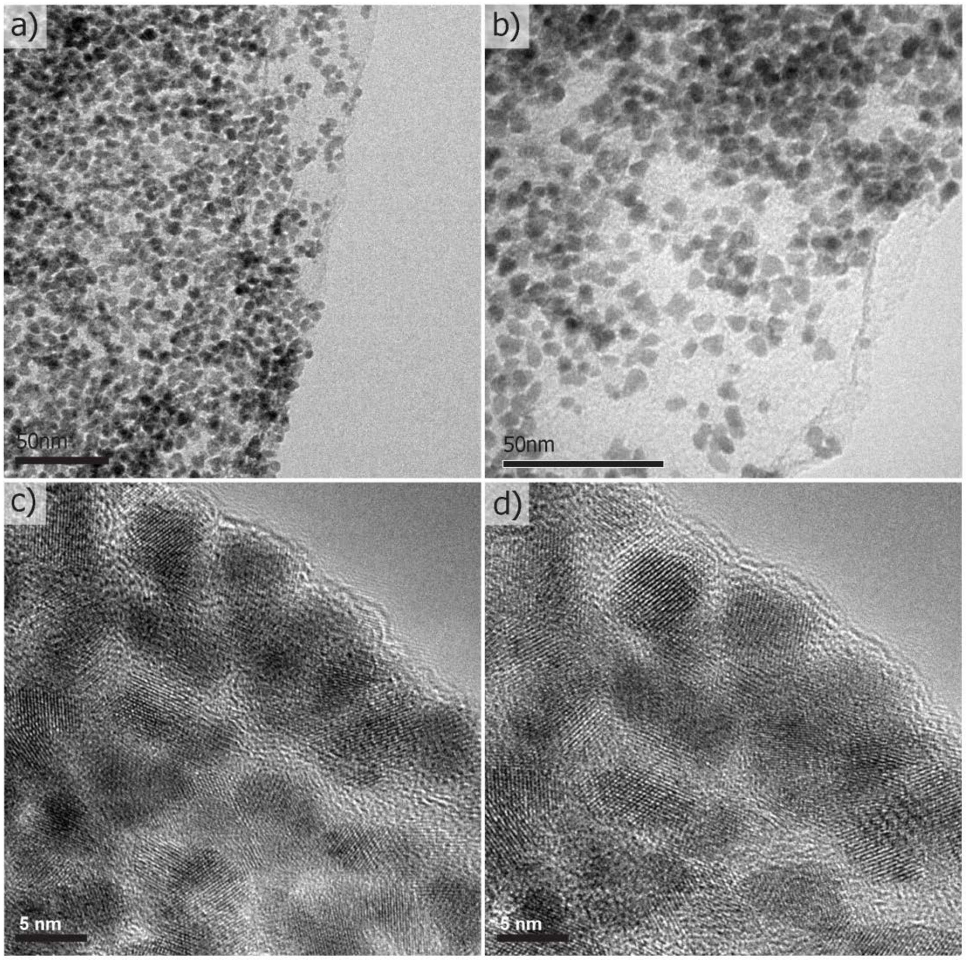

Fig. S6-10 (a-d) TEM images of In_2O_3/CCG hybrid.

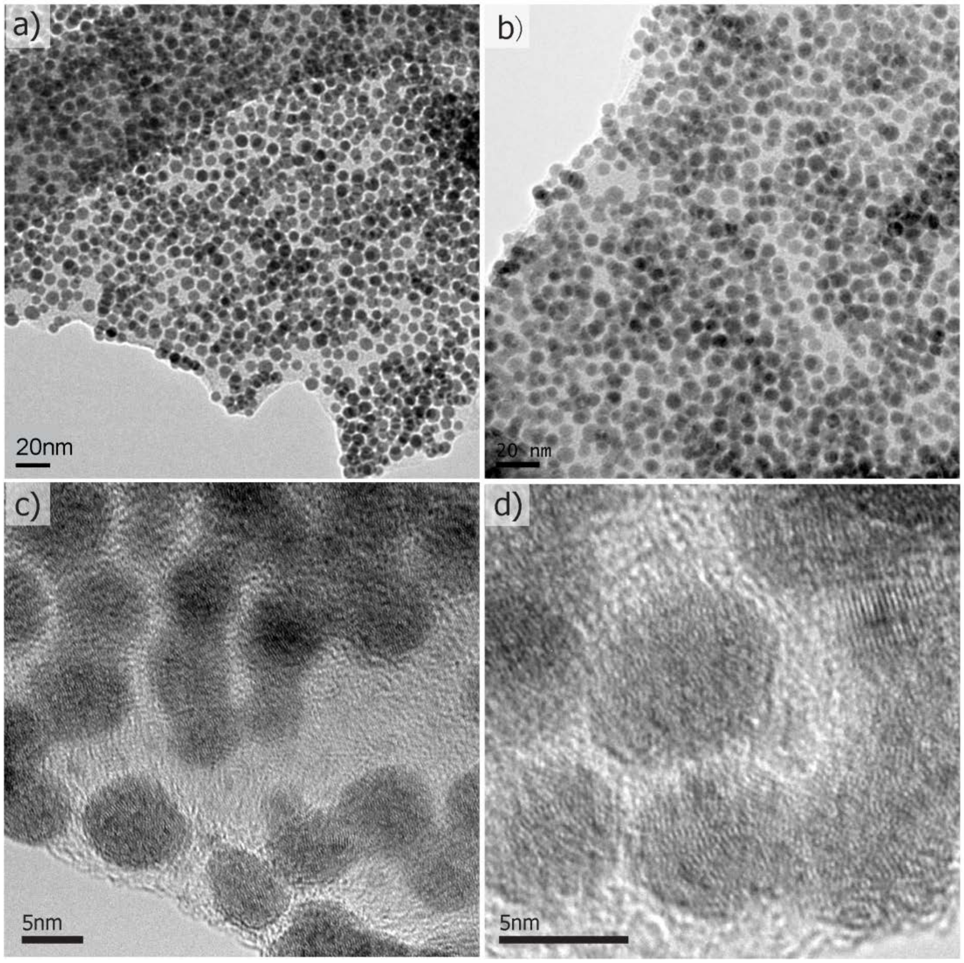

Fig. S6-11 (a-d) TEM images of Pd/CCG hybrid.

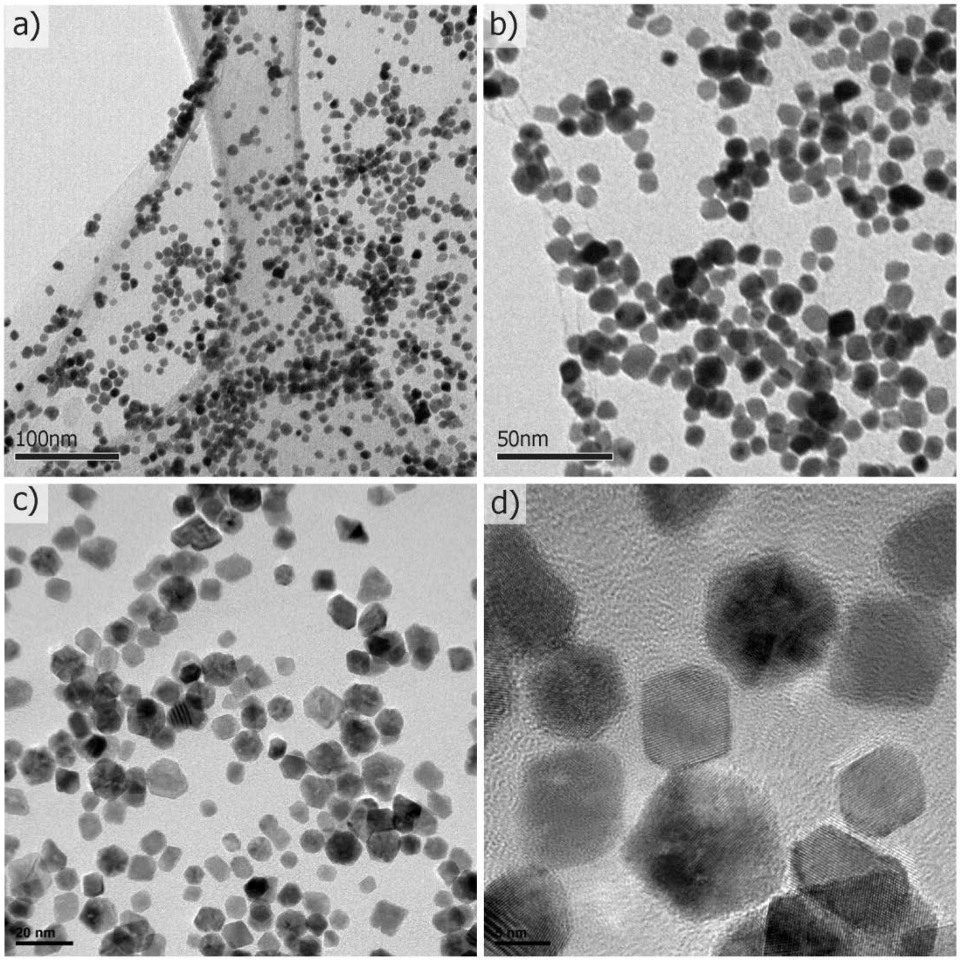

Fig. S6-12 (a-d) TEM images of Pt/CCG hybrid.

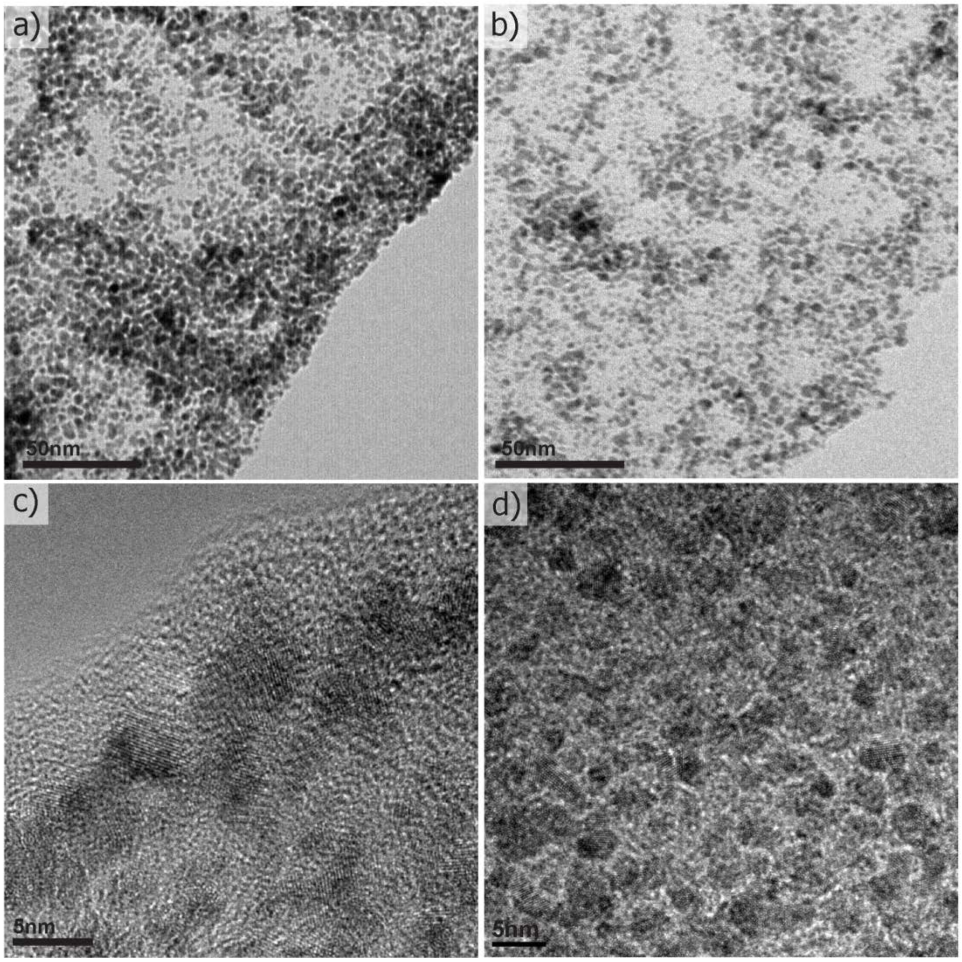

Fig. S6-13 (a-d) TEM images of Ru/CCG hybrid.

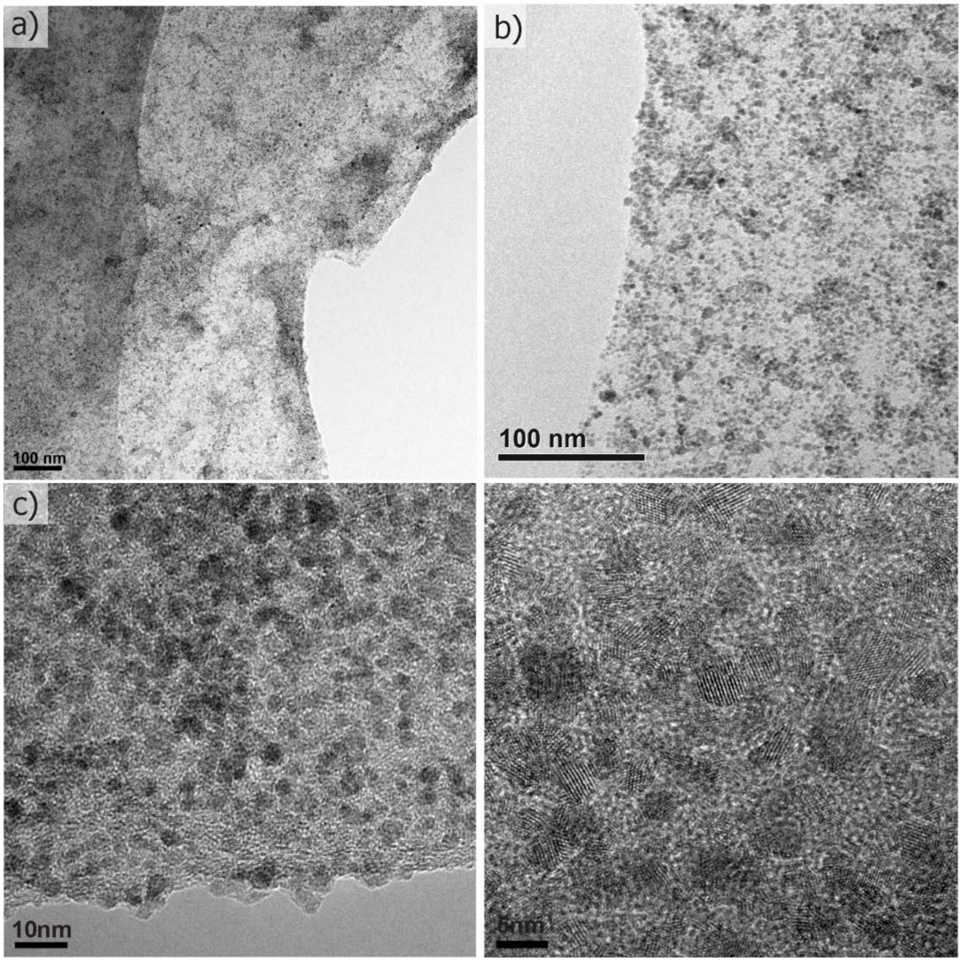

Fig. S6-14 (a-d) TEM images of SnO_2/CCG hybrid.

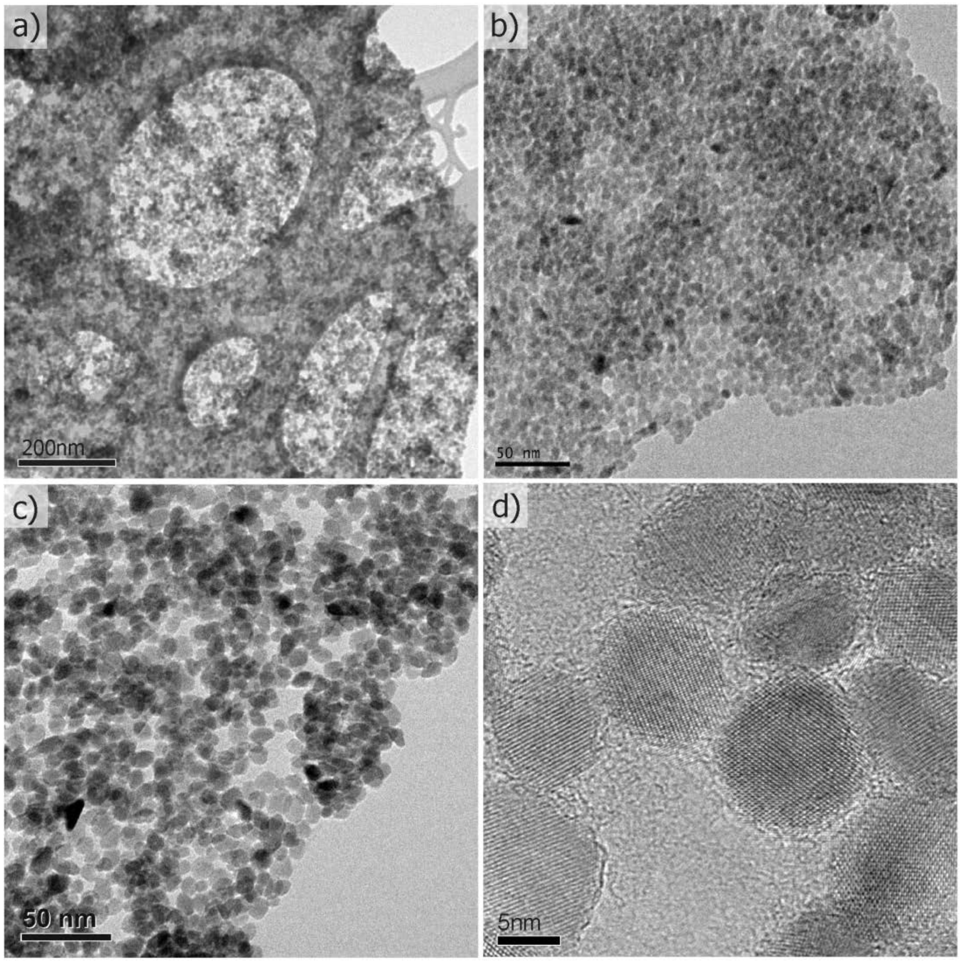

Fig. S6-15 (a-d) TEM images of ZnS/CCG hybrid.

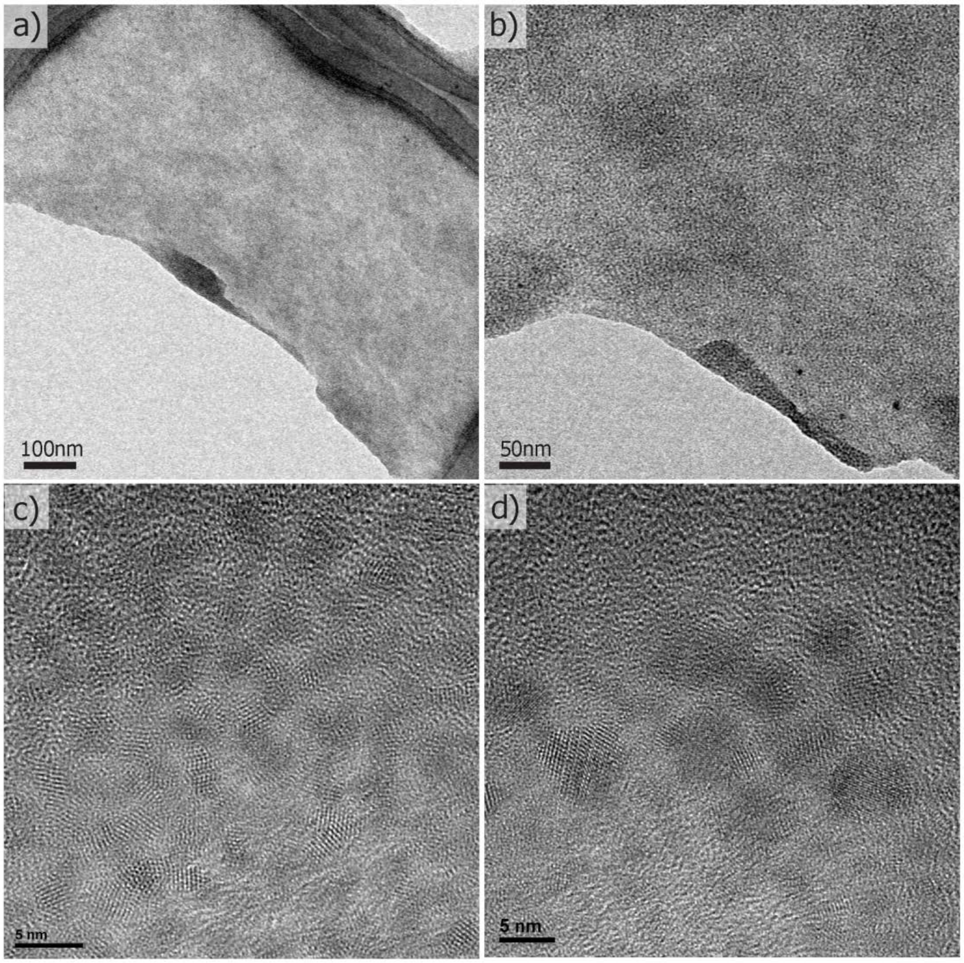

Fig. S6-16 (a-d) TEM images of ZnSe/CCG hybrid.

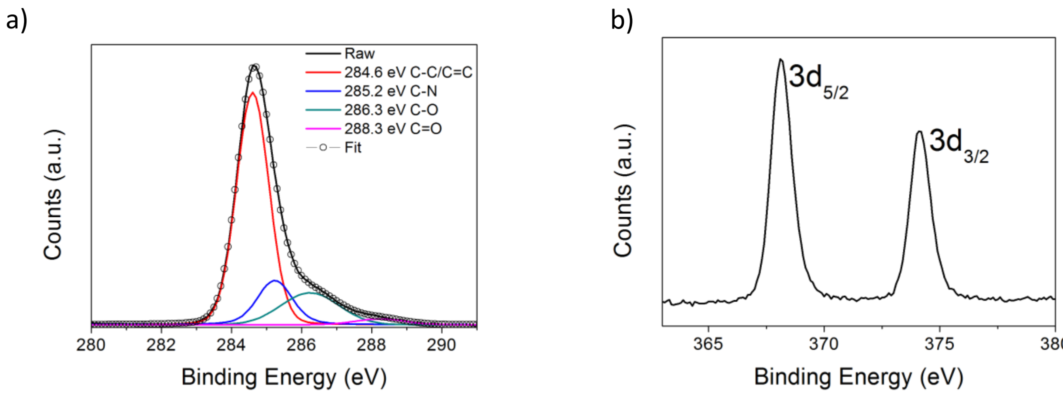

Fig. S7-1 HR-XPS analyses of Ag/CCG hybrid. a) C 1s and b) Ag 3d core level spectrum.

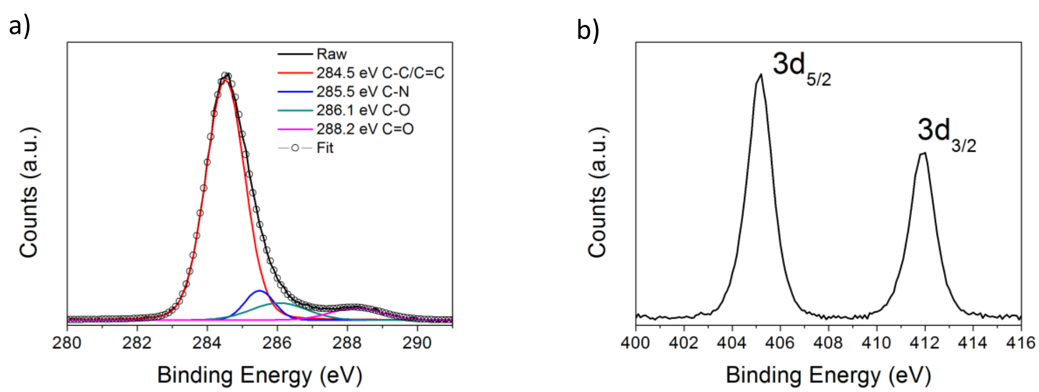

Fig. S7-2 HR-XPS analyses of CdS/CCG hybrid. a) C 1s and b) Cd 3d core level spectrum.

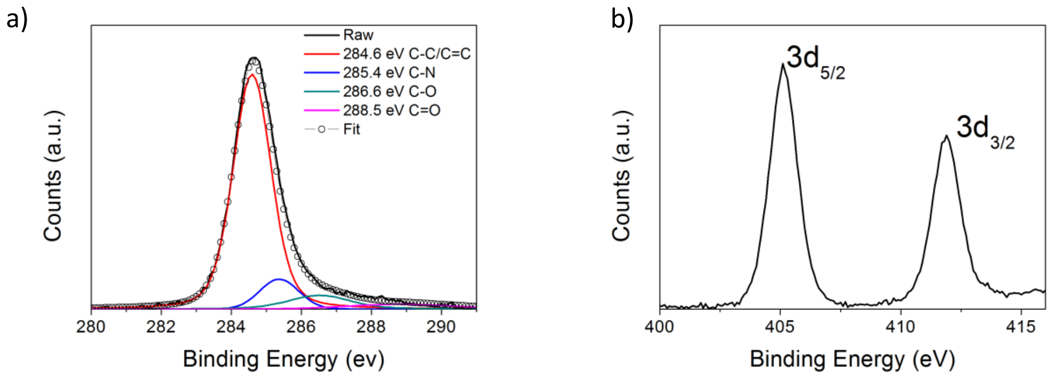

Fig. S7-3 HR-XPS analyses of CdSe/CCG hybrid. a) C 1s and b) Cd 3d core level spectrum.

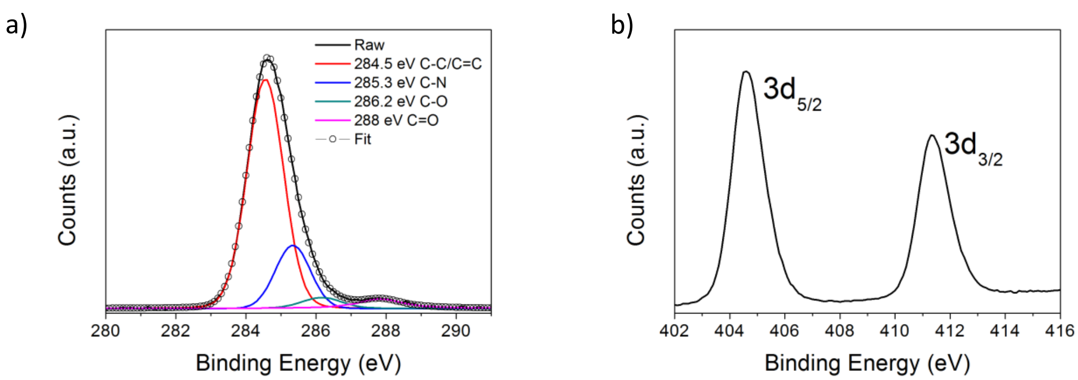

Fig. S7-4 HR-XPS analyses of CdTe/CCG hybrid. a) C 1s and b) Cd 3d core level spectrum.

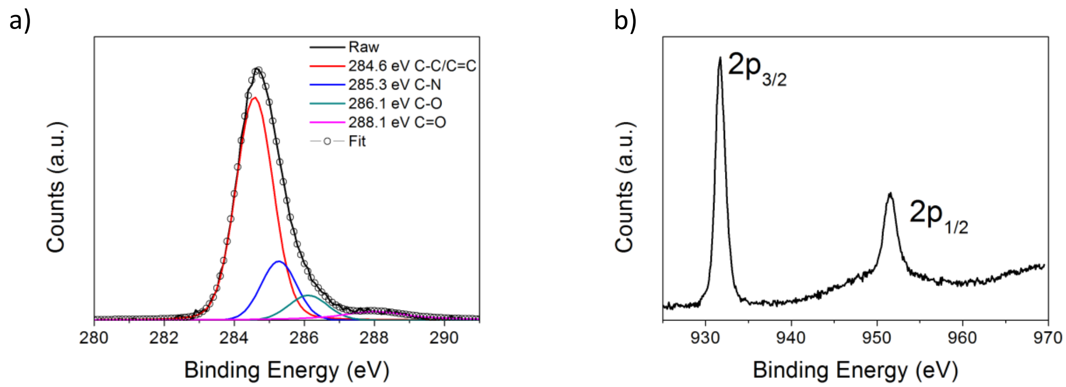

Fig. S7-5 HR-XPS analyses of $CuInS_2$/CCG hybrid. a) C 1s and b) Cu 2p core level spectrum.

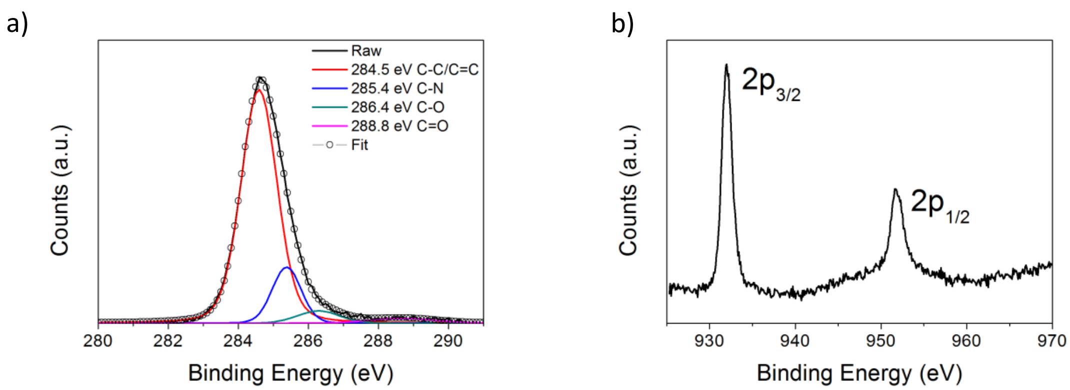

Fig. S7-6 HR-XPS analyses of $CuInSe_2$/CCG hybrid. a) C 1s and b) Cu 2p core level spectrum.

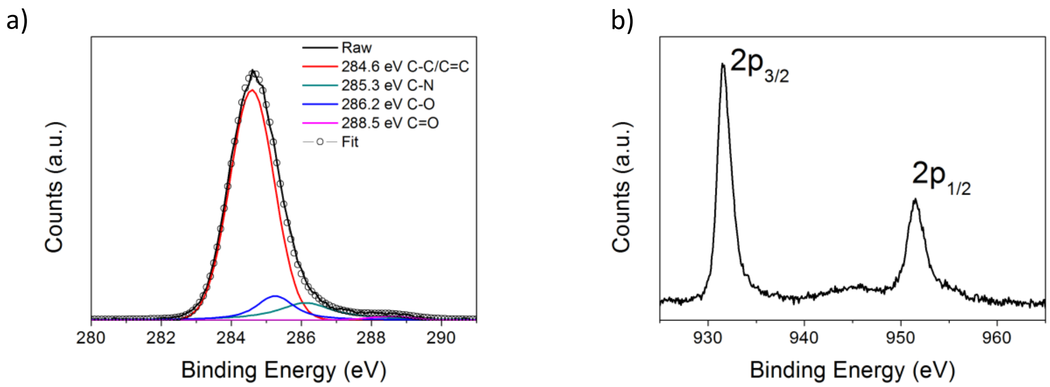

Fig. S7-7 HR-XPS analyses of Cu/CCG hybrid. a) C 1s and b) Cu 2p core level spectrum.

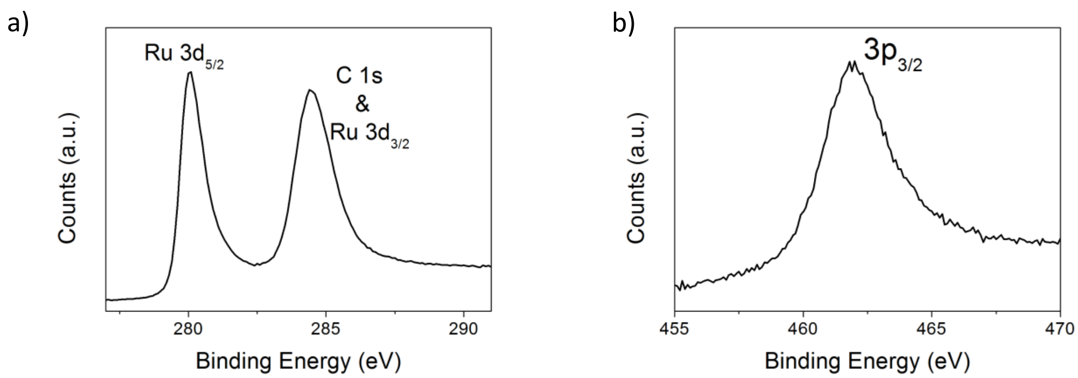

Fig. S7-8 HR-XPS analyses of Ru/CCG hybrid. a) C 1s and b) Ru 3p core level spectrum.

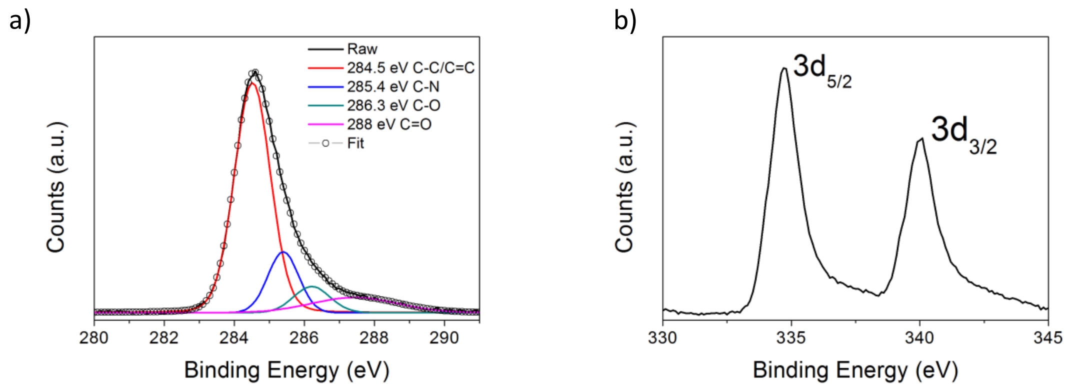

Fig. S7-9 HR-XPS analyses of Pd/CCG hybrid. a) C 1s and b) Pd 3d core level spectrum.

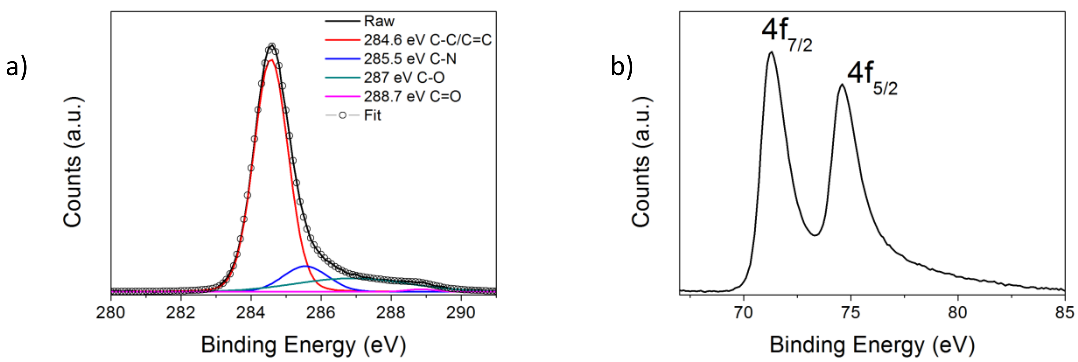

Fig. S7-10 HR-XPS analyses of Pt/CCG hybrid. a) C 1s and b) Pt 4f core level spectrum.

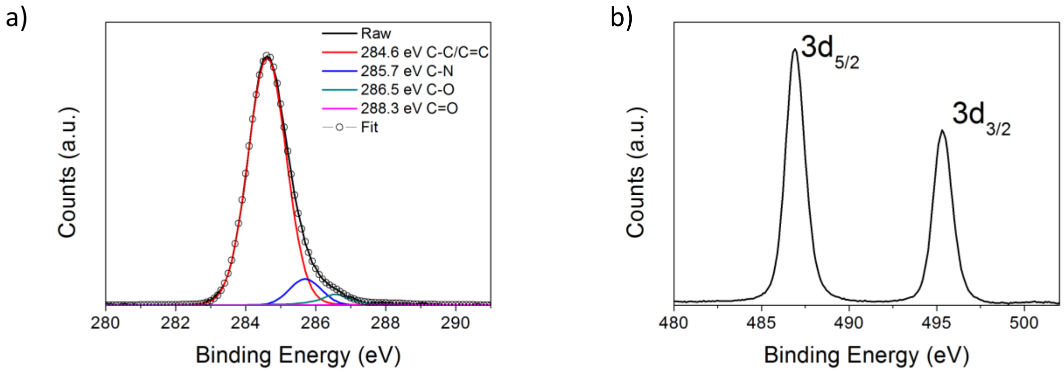

Fig. S7-11 HR-XPS analyses of SnO_2/CCG hybrid. a) C 1s and b) Sn 3d core level spectrum.

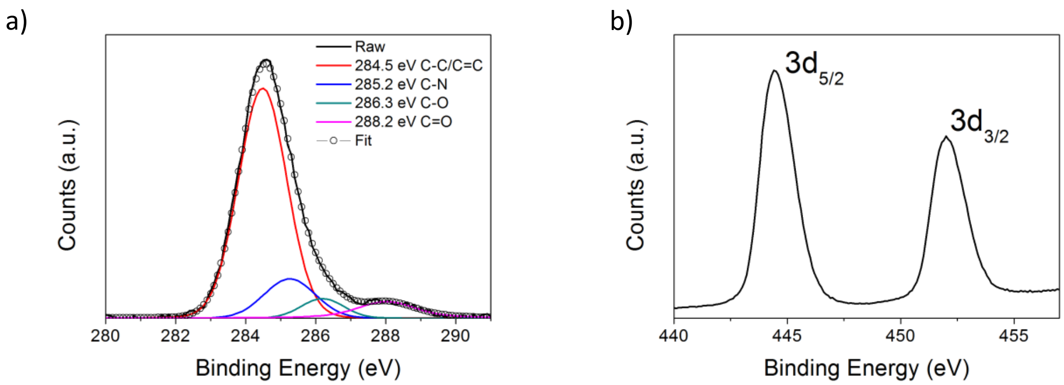

Fig. S7-12 HR-XPS analyses of In_2O_3/CCG hybrid. a) C 1s and b) In 3d core level spectrum.

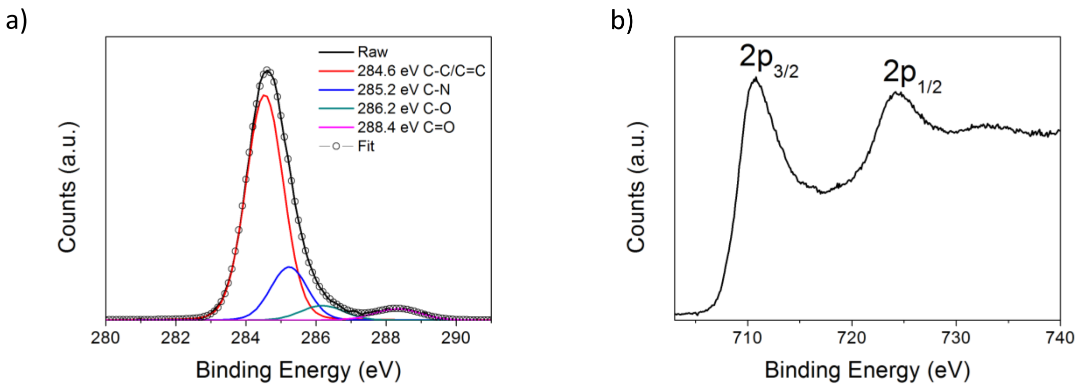

Fig. S7-13 HR-XPS analyses of Fe_2O_3/CCG hybrid. a) C 1s and b) Fe 2p core level spectrum.

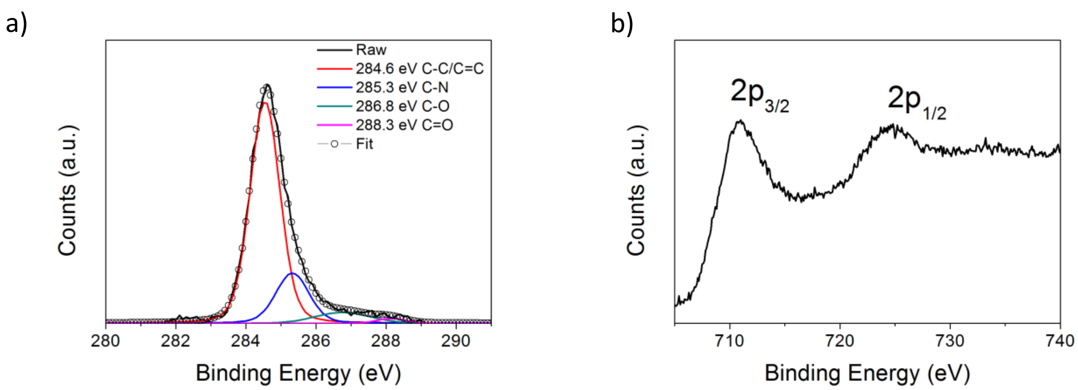

Fig. S7-14 HR-XPS analyses of Fe_3O_4/CCG hybrid. a) C 1s and b) Fe 2p core level spectrum.

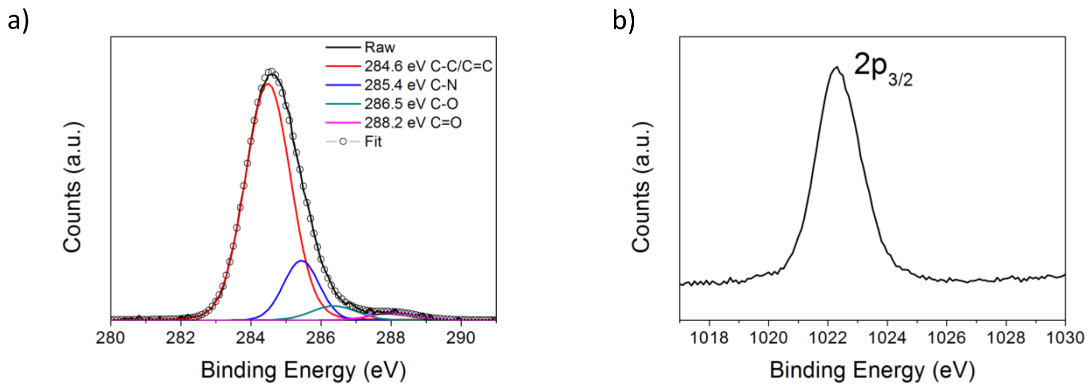

Fig. S7-15 HR-XPS analyses of ZnS/CCG hybrid. a) C 1s and b) Zn 2p core level spectrum.

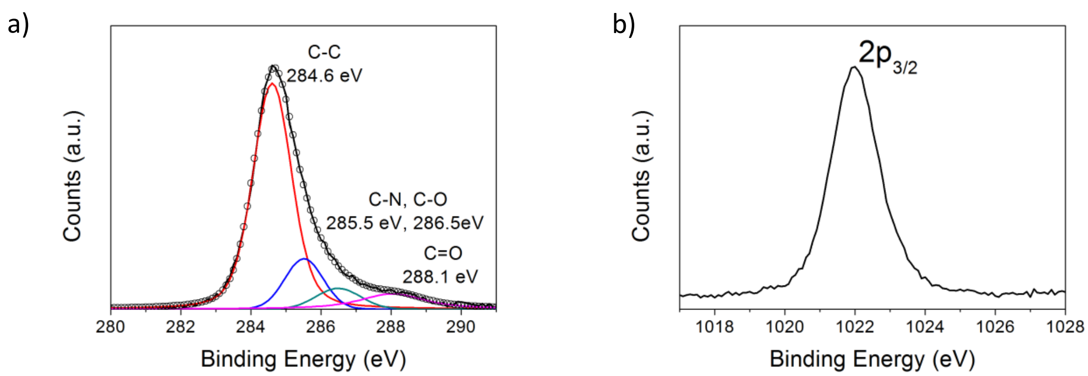

Fig. S7-16 HR-XPS analyses of ZnSe/CCG hybrid. a) C 1s and b) Zn 2p core level spectrum.

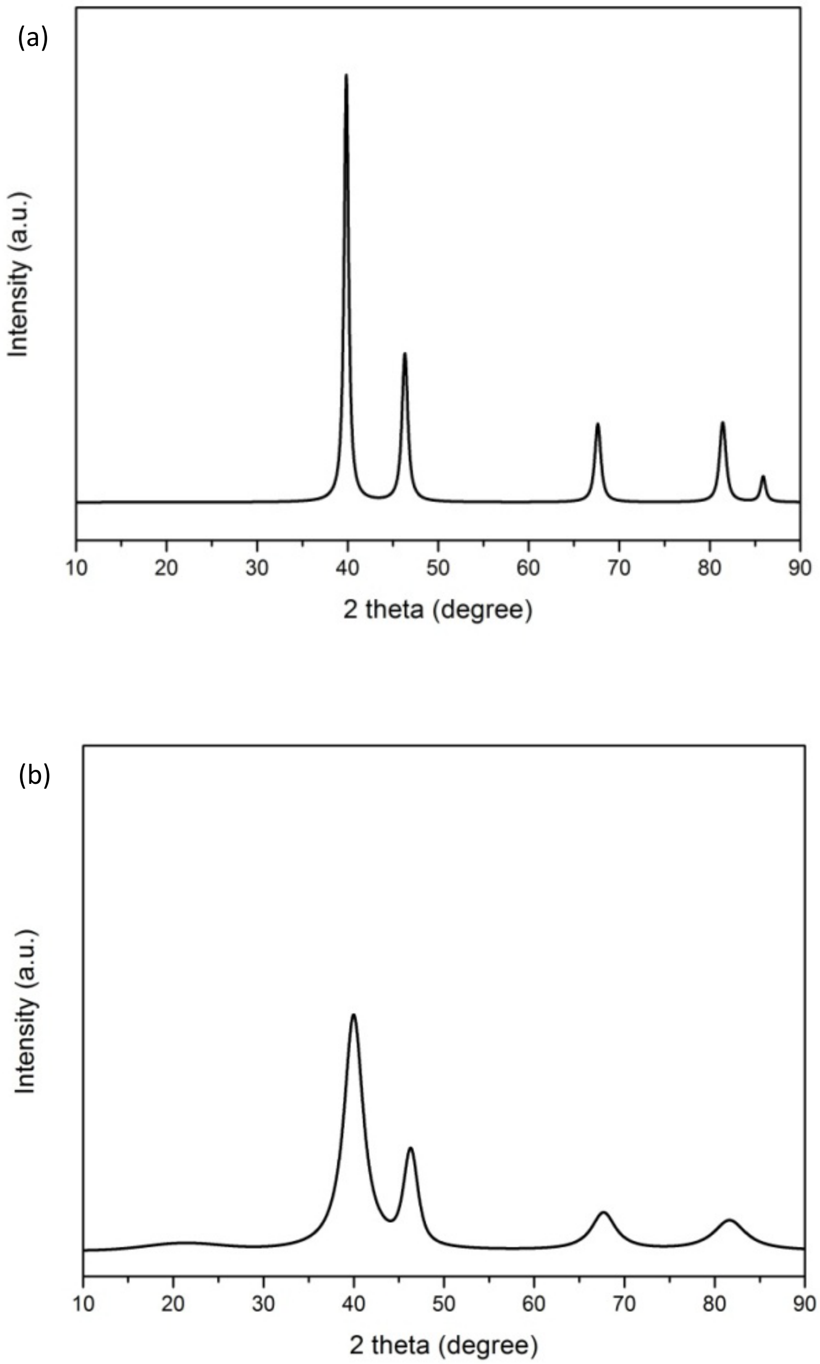

Fig. S8 XRD spectra of Pt nanocrystals synthesized from reactions (a) without and (b) with the addition of OLA-GO.