

Electronic Supplementary Information (ESI):

$\text{Zn}_x\text{Cd}_{1-x}\text{S}$ /Bacterial Cellulose Bionanocomposite Foams with Hierarchical Architecture and Enhanced Visible-light Photocatalytic Hydrogen Production Activity

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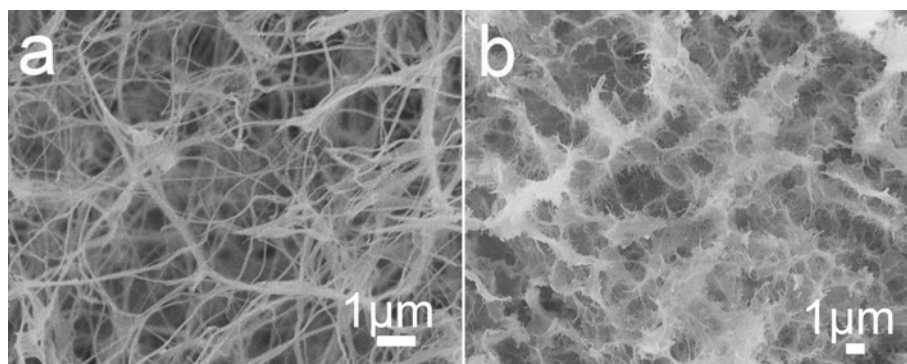


Fig. S1. SEM images: (a) BC showing the hierarchical architecture of hydrogen-bonded cellulose nanofibers. (b) ZnO/BC showing the hierarchical architecture based on highly networked nanosheets.

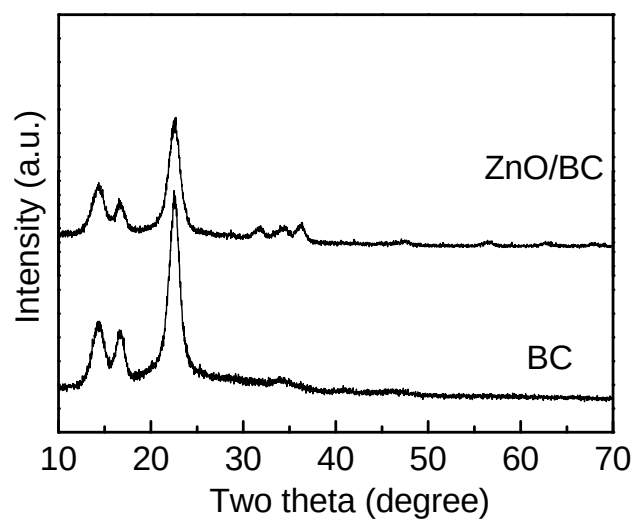


Fig. S2. XRD patterns of BC and ZnO/BC.

Table S1. Collection of the BET surface area, mean pore size, pore volume, Cd/Zn molar ratio and H₂ evolution rate.

Samples	BET (m ² g ⁻¹)	Mean pore size (nm)	Pore volume (cm ³ g ⁻¹)	Cd/Zn ICP (molar ration)	H ₂ evolution rate (μmol h ⁻¹ g ⁻¹)
Zn _{0.88} Cd _{0.12} S/BC	52	15.4	0.20	0.13	280
Zn _{0.18} Cd _{0.82} S/BC	72	14.4	0.27	4.64	405
Zn _{0.14} Cd _{0.86} S/BC	93	14.3	0.34	5.91	680
Zn _{0.09} Cd _{0.91} S/BC	101	14.1	0.36	9.65	1450
Zn _{0.06} Cd _{0.94} S/BC	87	14.5	0.26	12.35	591
Zn _{0.03} Cd _{0.97} S/BC	47	16.4	0.14	29.64	82
Zn_{0.06}Cd_{0.94}S/BC	46	16.2	0.19	14.25	40
Powder CdS	56	21.9	0.30	-	96
ZnO/BC	92	14.2	0.33	-	0
BC	166	-	-	-	0

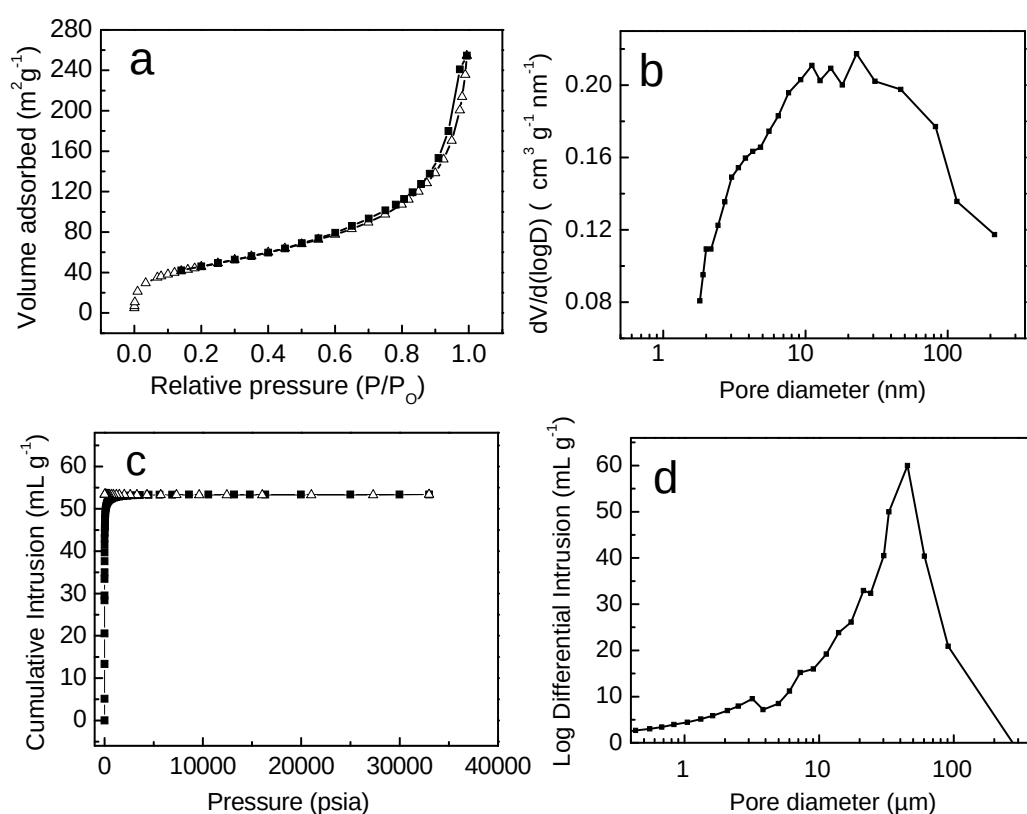


Fig. S3. Textural properties of BC: (a) N₂ adsorption and desorption isotherm. (b) BJH pore size distribution. (c) Hg intrusion porosimetry measurement. (d) Micrometer pore size distribution.

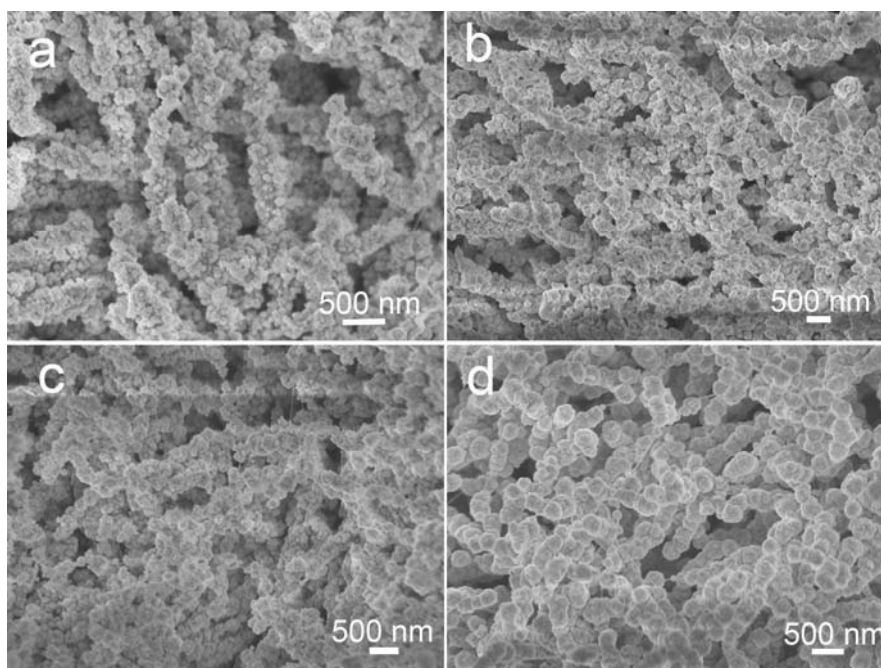


Fig. S4. Tracking the structural transformation from ZnO/BC to $\text{Zn}_{0.09}\text{Cd}_{0.91}\text{S}/\text{BC}$ by SEM after 30 min, 1 h, 4 h and 6 h of the ion exchange/seeded growth process under solvothermal conditions in ethanol at 120 °C.

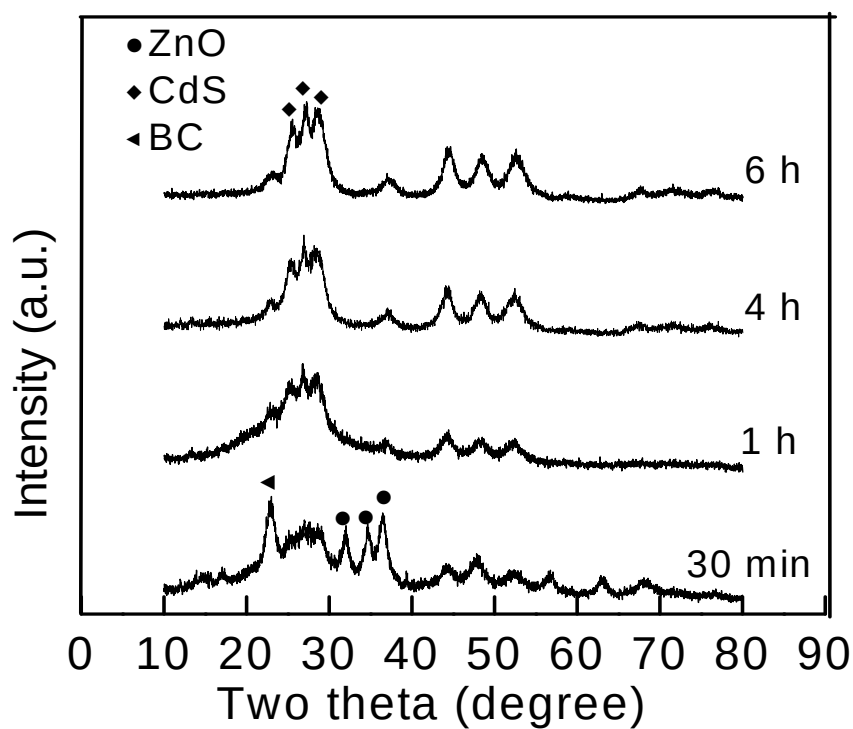


Fig. S5. Tracking the structural transformation from ZnO/BC to $\text{Zn}_{0.09}\text{Cd}_{0.91}\text{S}/\text{BC}$ by XRD after 30 min, 1 h, 4 h and 6 h of the ion exchange/seeded growth process under solvothermal conditions in ethanol at 120 °C.

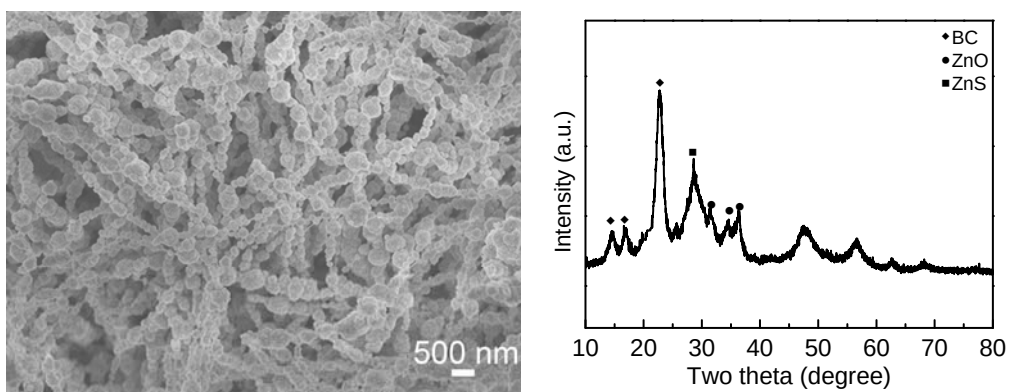


Fig. S6. Characterizing the products obtained from solvothermal reaction of a stoichiometric amount Zn/BC, thiourea and ethanol: (a) SEM and (b) XRD.

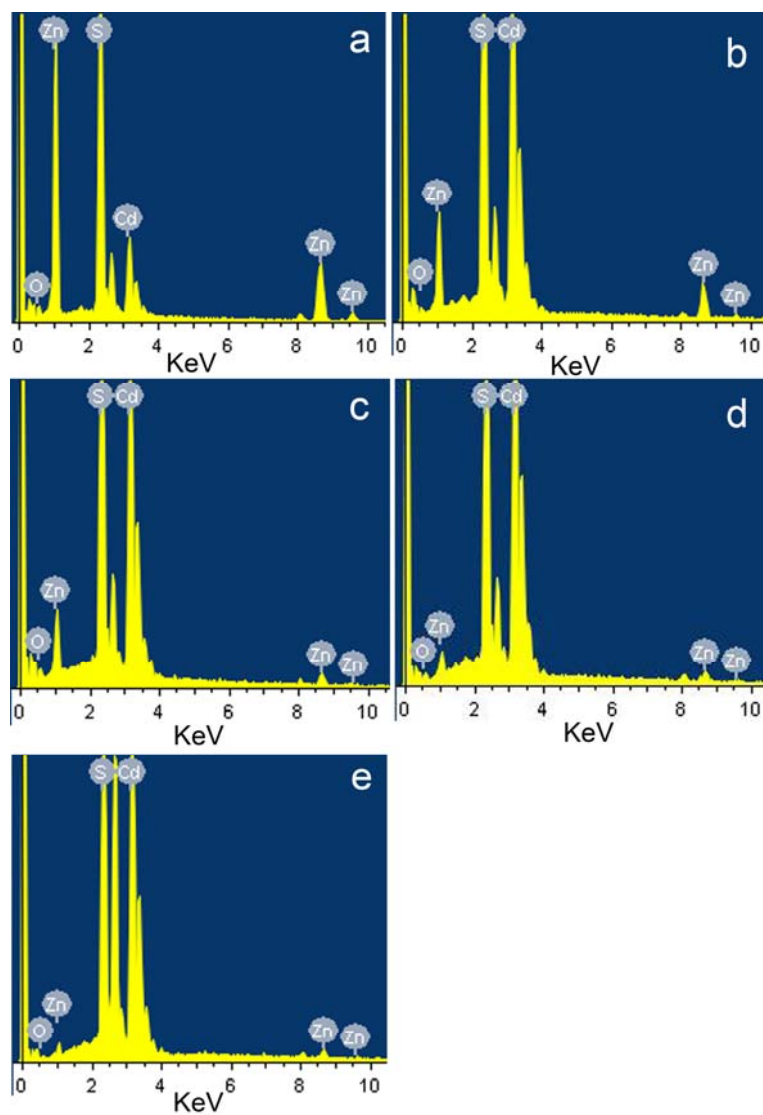


Fig. S7. EDS analysis: (a) $\text{Zn}_{0.88}\text{Cd}_{0.12}\text{S/BC}$. (b) $\text{Zn}_{0.18}\text{Cd}_{0.82}\text{S/BC}$. (c) $\text{Zn}_{0.14}\text{Cd}_{0.86}\text{S/BC}$. (d)

$\text{Zn}_{0.06}\text{Cd}_{0.94}\text{S}/\text{BC}$ and (e) $\text{Zn}_{0.03}\text{Cd}_{0.97}\text{S}/\text{BC}$.

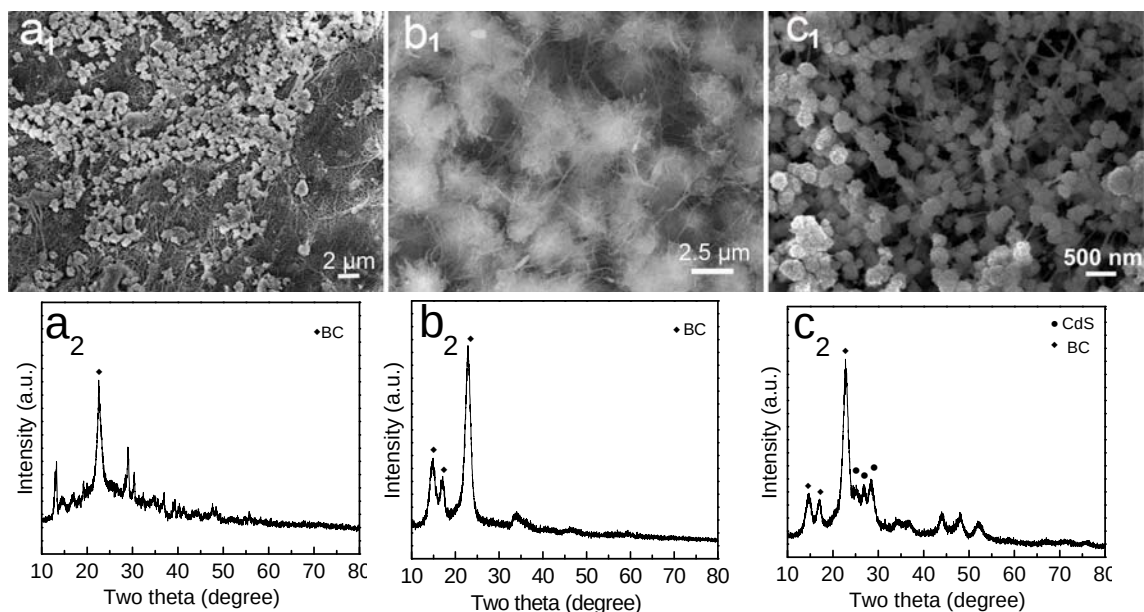


Fig. S8. Characterizing the products obtained from solvothermal reactions involving different precursor scaffolds: (a₁, a₂) SEM and XRD of the product using BC as precursor scaffold, showing unidentified nanoparticles spread around BC. (b₁, b₂) SEM and XRD of the precursor scaffold prepared by refluxing BC and $\text{Zn}(\text{AC})_2 \cdot 2\text{H}_2\text{O}$ in ethanol at 80 °C for 3 h, showing weak diffractions of wurtzite ZnO . (c₁, c₂) SEM and XRD of the product obtained by solvothermal reaction involving the precursor scaffold (b), showing wurtzite CdS .

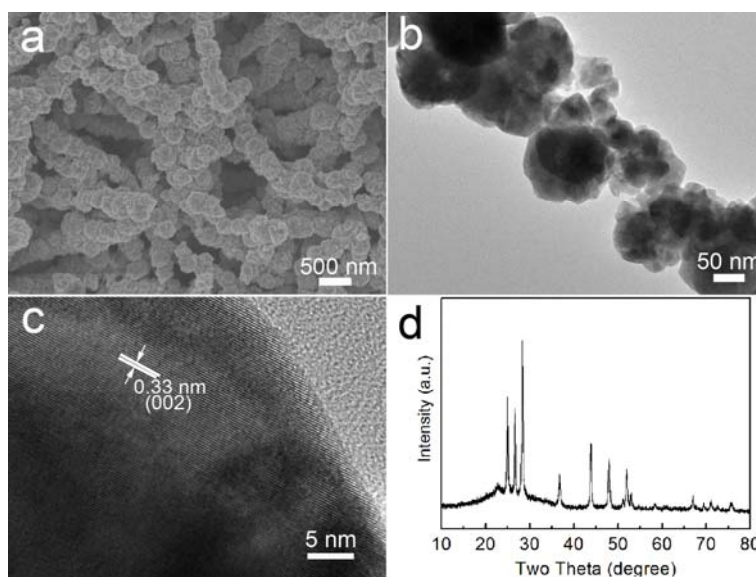


Fig. S9. Characterization of $\text{Zn}_{0.06}\text{Cd}_{0.94}\text{S}/\text{BC}$: (a) SEM. (b) high magnification TEM. (c) HRTEM. (d) XRD.

Table S2. Band gaps of $\text{Zn}_x\text{Cd}_{1-x}\text{S}/\text{BC}$

Samples	UV-vis adsorption edge (nm)	Band gap (eV)
ZnO/BC	379	3.21
$\text{Zn}_{0.88}\text{Cd}_{0.12}\text{S}/\text{BC}$	466	2.66
$\text{Zn}_{0.18}\text{Cd}_{0.84}\text{S}/\text{BC}$	501	2.47
$\text{Zn}_{0.14}\text{Cd}_{0.86}\text{S}/\text{BC}$	526	2.36
$\text{Zn}_{0.09}\text{Cd}_{0.91}\text{S}/\text{BC}$	531	2.33
$\text{Zn}_{0.06}\text{Cd}_{0.94}\text{S}/\text{BC}$	542	2.28
$\text{Zn}_{0.03}\text{Cd}_{0.97}\text{S}/\text{BC}$	550	2.25
$\text{Zn}_{0.06}\text{Cd}_{0.94}\text{S}/\text{BC}$	604	2.05

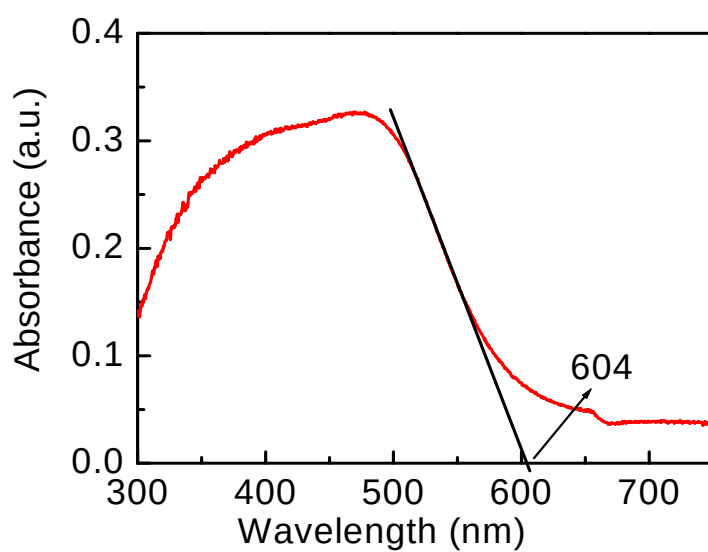


Fig. S10. UV-vis spectrum of $\text{Zn}_{0.06}\text{Cd}_{0.94}\text{S}/\text{BC}$.

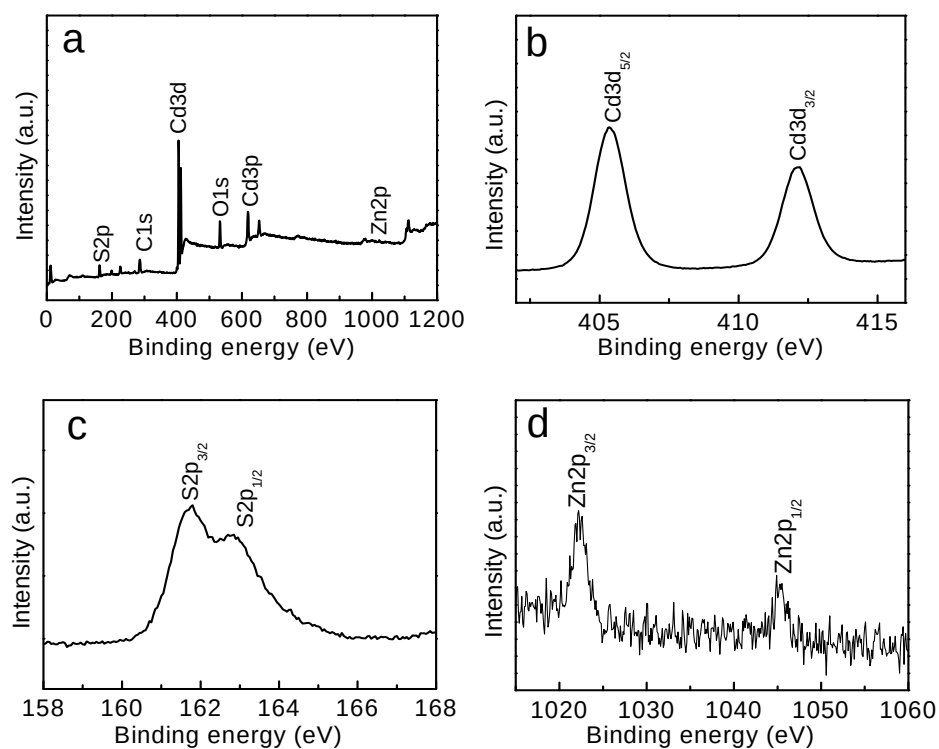


Fig. S11. XPS analysis of $\text{Zn}_{0.09}\text{Cd}_{0.91}\text{S}/\text{BC}$: (a) survey spectrum. (b) Deconvoluted XPS peak of Cd. (c) Deconvoluted XPS peak of S. (d) Deconvoluted XPS peak of Zn.

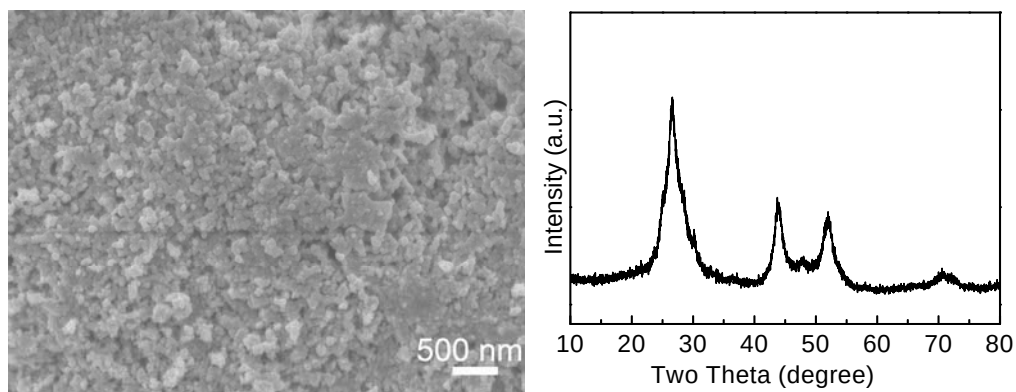


Fig. S12. Characterizing the commercial CdS powder: SEM and XRD pattern.