**Table S1.** The amounts of precursors in preparing CdSe-DETA, $ZrO_2$ and ZO/CS nanocomposites and the BET surface area, average pore size and total pore volume of above materials.

| Samples | $ZrO_2$ (g) | $CdCl_2 \cdot 2.5H_2O$ (mmol) | Se (mmol) | BET surface area ($m^2\ g^{-1}$) | Average pore size (nm) | Total pore volume ($cm^3\ g^{-1}$) |
|---|---|---|---|---|---|---|
| **CdSe-DETA** | **0** | **1** | **1** | **14.87** | **18.8042** | **0.06626** |
| **ZO/CS-0.4** | **0.1** | **0.4** | **0.4** | **13.73** | **19.6798** | **0.06852** |
| **ZO/CS-0.6** | **0.1** | **0.6** | **0.6** | **18.64** | **13.4430** | **0.04833** |
| **ZO/CS-0.8** | **0.1** | **0.8** | **0.8** | **14.97** | **24.4874** | **0.097095** |
| **$ZrO_2$** | / | / | / | **16.41** | **24.9942** | **0.097077** |

**Table S2.** Comparison of photocatalytic H2 production rate of the catalysts in references and this work.

| Catalyst | Light source | Sacrificial agent | $H_2$ production rate ($mmol\ g^{-1}\ h^{-1}$) | Ref. |
|---|---|---|---|---|
| $WO_3(H_2O)_{0.333}$/CdSe-DETA | 300 W Xe lamp | $Na_2SO_3$+$Na_2S$ | 2.3 | 11 |
| CdSe QD/B-rGO/O-g$C_3N_4$ | 500 W Xe lamp | ascorbic acid | 1.435 | 14 |
| $TiO_{2-x}$ | 150 W Xe lamp | aqueous methanol | 1.166 | 20 |
| $WO_3$/g-$C_3N_4$ | 350 W Xe lamp | lactic acid | 0.982 | 30 |
| $WO_3$/$TiO_2$ | 350 W Xe lamp | aqueous methanol | 0.246 | 33 |
| CdS/ZnS | 300 W Xe lamp | $Na_2SO_3$+$Na_2S$ | 1.238 | 36 |
| $ZrO_2$ | 300 W Xe lamp | $Na_2SO_3$+$Na_2S$ | 1.75 | This work |
| CdSe-DETA | 300 W Xe lamp | $Na_2SO_3$+$Na_2S$ | 4.27 | This work |

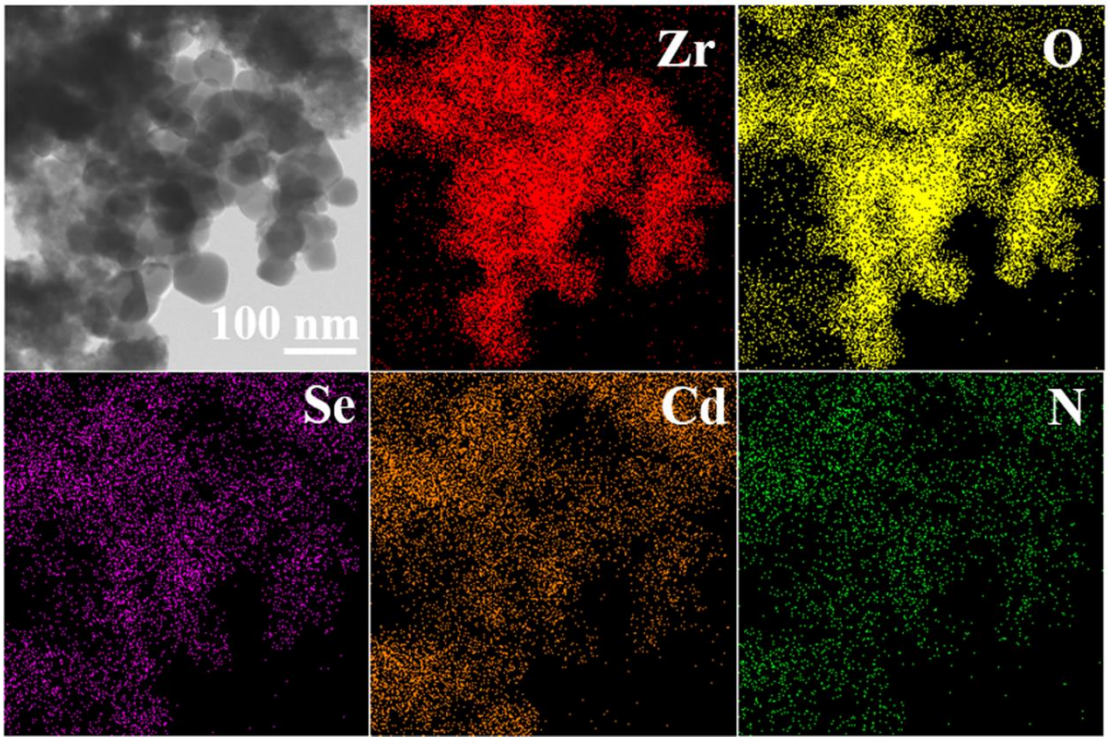


**Figure S1.** HAADF and elemental mapping images of ZO/CS-0.6 nanocomposite.

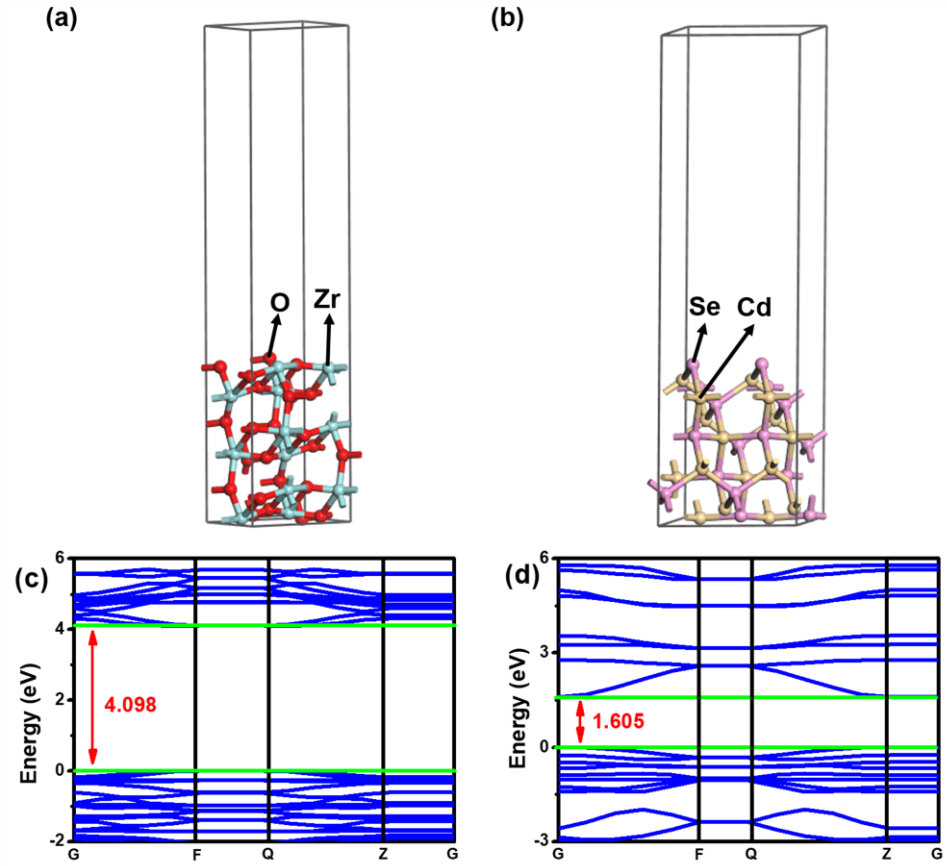


**Figure S2.** Optimized models of (**a**) $ZrO_2$ and (**b**) CdSe. Calculated energy band structures for the (**c**) $ZrO_2$ and (**d**) CdSe.

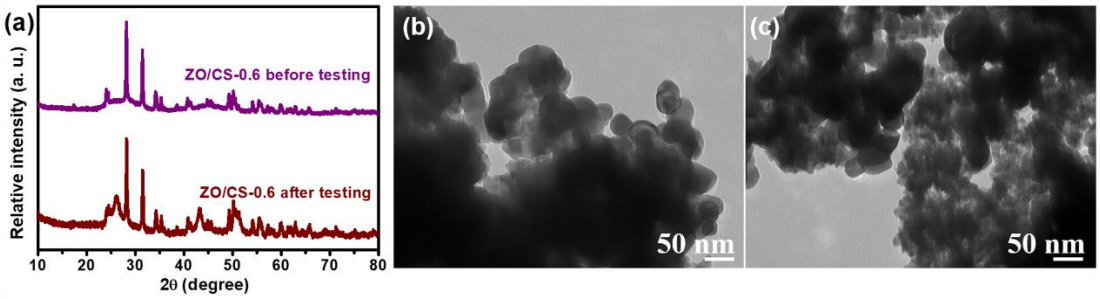


**Figure S3.** (**a**) XRD patterns of ZO/CS-0.6 nanocomposite before and after cycling test. (**b**) TEM image ZO/CS-0.6 nanocomposite before cycling test. (**c**) TEM image ZO/CS-0.6 nanocomposite after cycling test.